Lecture Notes in Educational Technology

Guang Chen
Vive Kumar
Kinshuk
Ronghuai Huang
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Emerging Issues in Smart Learning

Springer

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Guang Chen · Vive Kumar
Kinshuk · Ronghuai Huang
Siu Cheung Kong
Editors

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Editors
Guang Chen
Ronghuai Huang
Beijing Normal University
Beijing
China

Vive Kumar
Athabasca University
Athabasca
Canada

Kinshuk
Athabasca University
Edmonton, AB
Canada

Siu Cheung Kong
Hong Kong Institute of Education
Hong Kong
Hong Kong SAR

ISSN 2196-4963 ISSN 2196-4971 (electronic)
ISBN 978-3-662-44187-9 ISBN 978-3-662-44188-6 (eBook)
DOI 10.1007/978-3-662-44188-6

Library of Congress Control Number: 2014945144

Springer Heidelberg New York Dordrecht London

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

The rapid development and popularization of information technology significantly increase the speed of the generation of human knowledge, which has brought fundamental impacts on the modes of education and the methods of instruction. The traditional ways of learning are facing a revolution to adapt to the requirements of the information age. In order to facilitate easy, engaging and effective learning for the learners, current digital learning environment is gradually evolving into the smart learning environment.

The International Conference on Smart Learning Environments (ICSLE) is a conference organized by International Association on Smart Learning Environments. It aims to provide an archival forum for researchers, academics, practitioners, and industry professionals interested and/or engaged in the reform of the ways of teaching and learning through advancing current learning environments towards smart learning environments. It will facilitate opportunities for discussions and constructive dialogue among various stakeholders on the limitations of existing learning environments, need for reform, innovative uses of emerging pedagogical approaches and technologies, and sharing and promotion of best practices, leading to the evolution, design and implementation of smart learning environments.

The focus of the contributions in this book will be on the interplay of pedagogy, technology and their fusion towards the advancement of smart learning environments. Various components of this interplay include but are not limited to:

- Pedagogy: learning paradigms, assessment paradigms, social factors, policy
- Technology: emerging technologies, innovative uses of mature technologies, adoption, usability, standards, and emerging/new technological paradigms (open educational resources, cloud computing, etc.)
- Fusion of pedagogy and technology: transformation of curriculum, transformation of teaching behavior, transformation of administration, best practices of infusion, piloting of new ideas.

ICSLE2014 received 81 papers from 13 countries and regions. All submissions were peer-reviewed in a double-blind review process by an international panel of a minimum of two and maximum of five referees and decisions were taken based on assessing research quality. We are very pleased to note that the quality of the submissions this year turned out to be very high. A total of 36 papers were accepted as full papers in the ICSLE conference; that is a 44 % acceptance rate. Furthermore, 16 papers were selected for presentation as short papers and another three as posters.

We acknowledge the invaluable assistance of the program committee members, who are named on another page. Most reviewers opted to provide detailed comments to the authors, making it a valuable experience for the authors, even if their submission was not selected for the conference.

With all the effort that has gone into the process, by authors and reviewers, we are confident that this year's ICSLE proceedings will immediately earn a place as an indispensable overview of the state of the art and will have significant archival value in the longer term.

July 2014

Guang Chen
Vive Kumar
Kinshuk
Ronghuai Huang
Siu Cheung Kong

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A Blended Learning Environment for enhancing Meaningful Learning using 21st Century Skills

Gustavo Zurita[1], Beatriz Hasbun[3], Nelson Baloian[2], Oscar Jerez[3]
[1] Management Control and Information Systems Department, Business and Economics Faculty, Universidad de Chile, gzurita@fen.uchile.cl
[2]Department of Computer Science, Universidad de Chile, nbaloian@dcc.uchile.cl
[3] CEA – Teaching and Learning Center, Business and Economics Faculty, Universidad de Chile, {bhasbun,ojerez}@fen.uchile.cl

Abstract. In this work we present a study that documents how a blended learning environment could enhance students' meaningful learning practicing 21st Century Skills. This study examines the outcomes of an experience done with 119 students of an undergraduate course on "Information Technology" for Business at a University level education. Students had to practice 21st Century Skills regarding communication, information literacy and ICT literacy supported by a blended-learning environment. Results show a significant increase in meaningful learning by the end of the course. This study illustrates the potential that blended learning environments offer for higher education.

Keywords: Blended-learning, 21st Century Skills, meaningful learning.

1 Introduction

Higher education in developing countries is moving from a content-based curriculum to a competence-based one. There is a consensus that along with acquiring the traditional knowledge, acquiring skills like communication, information literacy and ICT literacy to perform any professional activity in an increasing complex and demanding world is also very relevant [2]. In our contemporary society, business people are constantly supported by ICT to search information, work in teams, create new ideas, products, and services and share these with their colleagues. In this context, it is crucial to flexibly respond to complex problems, communicate effectively, manage information dynamically, work and create solutions in teams, use technology effectively, and produce new knowledge continuously. According to many authors, all of these skills are needed by the individual of the 21st century in order to perform properly at work [2, 7]. Moreover, the Association to Advance Collegiate Schools of Business (AACSB), a renowned organization for accreditation of business school established that school program learning goals should include those that address the acquisition of communication skills, problem-solving abilities, ethical reasoning skills, language skills, technology skills, as well as management-specific knowledge [8].

To embrace these new challenges, Universities have developed different approaches; however, those on the so-called meaningful learning approach [3], and making extensive use of Information and Communication Technologies (ICT) in blended-learning (b-learning) scenarios, have been some of the most attractive and most used alternatives [2 - 6]. But how it is possible to train the 21st century skills in a b-learning course in order to achieve meaningful learning?

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_1

Meaningful learning occurs when the learner is able to relate new information to already known ideas and knowledge [3, 6]. Its quality also depends on the conceptual richness of the new material being learned, and the quantity and organization quality of the relevant knowledge the learner has already acquired. Meaningful learning has three requirements: a) relevant prior knowledge; b) meaningful material; and c) a learner must choose to learn meaningfully which means that the learner must consciously and deliberately choose to relate new knowledge to relevant knowledge the learner already knows [6].

At a primary stage educational technologies were often only used to generate efficiencies in content delivery and testing, although nowadays many educational technologies focus on developing thinking skills and allowing students to rehearse for future performances in a technology-rich workforce. We can find various examples of frameworks proposed for describing and characterizing the 21st century skills in the literature [2, 7, 9]; particularly the KSAVE model seems to present characteristics, which are also present in most of the other models [2]. KSAVE considers ten skills grouped into four categories: a) ways of thinking - creativity and innovation, critical thinking, problem solving, decision making, learning to learn, metacognition; b) ways of working - communication, collaboration; c) tools for working - information literacy, ICT literacy; and d) living in the world – local and global citizenship, life and career, personal and social responsibility.

B-learning is becoming increasingly popular among the e-learning modalities, which combines face-to-face (f2f) presence learning with technology-mediated distance teaching/learning [5, 10]. It is considered a learning modality, which favors meaningful learning because it supports its processes in various dimensions and with various resources [4, 5], since it allows for the active integration and of the student and combines different learning modes. It is necessary to design the learning process as a single multidimensional formative experience, which considers the following aspects: the learner, the teacher, the curriculum and assessment, the structure of schooling, the essential conditions for ICT integration and the research on the role of IT in education [11]. This contrasts with the traditional teaching style that includes just lectures, paper readings, the out-of-context use of ICT, and content evaluation [3, 12]. According to our experience, b-learning environments are able to foster the process of linking previous knowledge with new information in relevant and motivating contexts [3], using diverse multimedia resources causing real impacts on learning and practicing communication, information literacy, and ICT literacy skills (see section 3.2, last paragraph)..

Taking the above arguments into consideration, we propose to carry on an experience in order to research the role of using b-learning to support the learning of certain contents and their practice in an undergraduate course on "Information Technology for Business", in the 8th semester of the Information and Management Control Engineering degree program of Economics and Business at the University of Chile. The hypothesis of this work is that b-learning enhances meaningful learning, through the practice of communication, information literacy, and ICT literacy skills, relating concepts learned in the classroom with current news containing examples of using Information Technologies to support Business.

2 Related work

According to [5, 10], b-learning is an efficient teaching model because it combines self-paced learning, (students learning anytime, anywhere, by executing the e-learning activities), live e-learning (takes place in a virtual environment where students communicate among one another, share information, etc.), and face-to-face (f2f) classroom learning (social interaction with both the teacher and other students in a room).

Various positive and successful experiences of b-learning are reported in the literature. It has been said that it reduces the time needed for preparing the exam, ensures deep-level learning, enhances student retention of the course, etc. [13]. However, there is still little research exploring the relationships between b-learning and meaningful learning.

Therefore, in our understanding, a successful b-learning environment must be carefully designed to provide the development of meaningful learning and certain skills in the students, by achieving specific learning objectives involving teacher and students in face-to-face and online activities [14].

B-learning environments have been applied to support learning of different areas of knowledge: information science, engineering, nursing, and business [5], among others. It has taken on increasing importance and research attention for business education (Information System, Management, Marketing, Accounting, Economics, and Finance) during the first decade of the 21st century [15]. Regarding b-learning environments in the area of Information Systems, many conceptual frameworks have provided alternative perspectives, which have promoted the development of applications for specific contexts [16] proposing a conceptual framework by focusing on system design and elements of quality, system delivery, and system outcomes [17]. They propose a context-specific conceptual framework that includes objectivist and constructivist approaches to synchronous and asynchronous delivery of learning material [18], arguing that effective technology-mediated learning depends on participants' interaction, technology, and instructional design. Unfortunately, though IS scholars have been actively involved in developing conceptual frameworks; they have not been as active in testing them [5], which is exactly the aim of this work. Nevertheless, there are studies showing empirical evidence: a) In [19] authors examined the impact of "virtual interaction" using five different treatment groups with varying levels of learner control of the virtual instructor, concluding that b-learning might lead to more effective learning; b) In [20], authors examined the extent to which a learning platform could help undergraduates in ICT skills development.

3 Design of a b-learning environment

This section describes the f2f and e-learning facets of a b-learning environment, based on the constructivist approach, which is the most widely used. By using this environment students are helped while constructing their own meaning of knowledge, enabling them to communicate and exchange their ideas by using their ICT literacy skills [21].

3.1 Design of the f2f environment

The course "Information Technology for Business" aims at developing student skills that will allow them to create technological solutions to solve problems or take advantage of opportunities within an organization. The course has 10 credits, and is compulsory in the fourth year of the Information and Management Engineering degree at the University of Chile.

As part of their mandatory assignments for completing the course, students have to perform three short projects, pass three exams and regularly contribute in an on-line discussion board by including recent news found in diverse media related to the different topics covered in the lecture sessions. The lecture sessions are complemented with the discussions on the board. The integration of both elements is performed by collecting news from the discussion board to initiate discussion within the classroom. In this way, students are motivated to deliver better news and the task acquires a sense.

Likewise, the teacher promotes students participation with questions, allowing them to exercise the use of technical concepts to give an oral opinion. The same task has to be carried out in written form, considering the contents of the course and possible applications of technological developments at companies.

3.2 Design of the e-learning environment

The on-line learning platform that students regularly use to support their activities during the semester offers a discussion board with the following services: publication of new topics, possibility of replying to others' contributions, notifications concerning user availability and recent activity, metric of participation level (high, medium, low), a tag cloud, and a search bar.

In order to make a contribution, students have to select news, cite their respective sources (e.g. a link to the original Web article), and write a short personal opinion on it. Once this contribution is made publicly available in the software platform, other students have the chance to rate the article (according to their own perception on quality and pertinence) and comment on the contribution.

Fig. 1. General user interface of the online discussion board

The user interface is divided into two modules: 1) a main page where users can read the different contributions published in the site, and 2) a detailed view of one of these contributions. The first module displays a list of the 10 most recent contributions, a tag cloud and a panel of links pointing to other articles classified by categories and relevant tags (see Fig. 1). This element, alongside with the search bar, helps users identify and find relevant documents, facilitating thus the interaction between the author and the reader. Users can access the detailed view of any contribution by either clicking on its title, content, or dedicated icon at the bottom of the box. Other articles can be found by navigating through different pages at the bottom of the site.

The second module, displays the complete text (citing the source from where it was taken), the personal opinion of the author regarding the content of the article, and a list of reactions other students posted. In both modules, students can practice communication skills while writing, presenting their ides as well as understanding other students' messages in a variety of situations and for different purposes, or formulating their arguments in a convincing way [2]. At the same time, students practice their information literacy abilities when searching, collecting, organizing and distinguishing relevant electronic data and information, as well as when accessing and searching for information media [2].

4 Research design

For this study, we worked with three groups of students enrolled in the course Information Technology from the Business School at the University of Chile. The first group was composed of 46 students (17 men and 29 women), and they participated in this study between August and November 2012. The second group involved 34 students (19 men and 15 women) that participated between March and June 2013. And the third group involved 39 students (18 men and 21 women) that participated between August and November 2013. None of the students were in both groups simultaneously.

The platform was in service for all groups over 15 weeks. We established three milestones where we gathered information about the data traffic on the site, and afterwards reinitialized the counters. These milestones were roughly placed every five weeks in order to make results comparable between groups.

The instruction for students was to search for news, articles and/or interesting cases from different sources like Newspapers, Internet or videos, which were linked to the use of information technologies, and attach it to the site. They also had to write a "Personal Comment" of at least 300 words length aimed at a college audience, meeting the following requirements:

1. Justify the value of the technological contribution of the news, explaining its use or application on a specific subject and indicating what is better now with this technology;
2. Identify and explain how it can be transferred to other areas, highlighting some contribution to any component of the value chain of an organization;
3. Relate the news content seen in classes or in previous courses.

The last requirement is crucial to the b-learning environment, in terms of integrating the discussion board to the classroom. The instructions were designed considering 3 of the 10 skills included in the KSAVE model: communication, information literacy and ICT literacy.

The students practice their ICT literacy abilities while using e-learning technology as a tool to research, organize, evaluate and communicate information; access ICT efficiently (time) and effectively (sources); employ knowledge in the application of ICT and media to communicate and present ideas [2].

From the perspective of a quantitative educational research methodology, we chose a quasi-experimental design with measures before and after the intervention. In the context of Higher Education, where students are already grouped according to degrees, the level of control over the formation of the group for performing experimental assignment is usually low. This type of research in natural contexts aims to maintain the internal validity of the study by means of different strategies (control of extraneous variables, pre/post-test measures, etc.). We subsequently introduce a research instance under these methodological assumptions.

The data used corresponds to student participation in the online forum of the course in terms of own news publication. This news were evaluated using a rubric that included six dimensions, 3 associated with formal aspects of writing called "own voice" (spelling and writing, internal consistency, and personal perspective) and 3 associated with the application and interpretation of the contents of the course named "Argument" (meaningful learning, justification, and argumentation). Each dimension has 4 levels of achievement. The rubric was applied three times during each semester, to find out if students improved their learning throughout the semester. We randomly selected one of the article published by each student three times (milestones) during each academic semester involved in this study. The dimension “meaningful learning” was assessed in the news using the rubric descriptor by assigning each student a level of development and therefore a score.

This study presents the results of the evaluation of the meaningful learning dimension, which measures whether "students associated specific content to knowledge previously acquired during the course in written and/or oral speeches, using technical concepts with relevance".

5 Outcomes of meaningful learning

Of a total of 119 students who completed the course considered along the different semesters, the 1st milestone had 117 records; the 2nd 111 and the 3rd had 119. To determine if the data collected in the rubric assessment were distributed normally, the Kolmogorov Smirnov (KS) for a sample was calculated for the first and third milestones. For both cases, the asymptotic significance (p) corresponds to 0.00 (Table 1).

KS for one sample		***1st milestone***	***3rd milestone***
Number of contributions per student		117	119
Normal parameters, b	*Mean*	2.18	2.47
	SD	0.627	0.687
Extreme differences	*Absolute*	0.356	0.358
	Positive	0.356	0.358
	Negative	-0.305	-0.23
Z de Kolmogorov-Smirnov		3.863	3.91
Sig. asintot. (bilateral)		0.00	0.00

Table 1. Descriptive statistics by milestones**.** The contrast distribution is Normal. b - Calculated based on the data.

As $p < 0.05$ the normal distribution hypothesis is rejected. Therefore, a non-parametric statistic was used for the calculation of the mean difference between the 1st milestone and the 3rd. As shown in Table 1, observed means are increasing from the 1st and 3rd milestone. Moreover, dividing the results according to the four levels of performance, a decrease in the relative frequency in the first level and an increase in levels three and four, as observed on Table 2.

To determine whether there is significant difference between the 1st and 3rd milestone, a Wilcoxon test for related samples was calculated, with the null hypothesis, meaning that the difference is zero. Being $P = 0.01$ ($p < 0.05$) the null hypothesis is rejected and therefore there is statistically significant difference between the mean scores on the meaningful learning in the 3rd and 1st milestone.

L-of-P dimension	*1st milestone*	*2nd milestone*	*3rd milestone*
1	8.5%	6.3%	1.7%
2	66.7%	70.3%	58.8%
3	23.1%	21.6%	30.3%
4	1.7%	1.8%	9.2%
Total	100.0%	100.0%	100.0%

L-of-P dimension = Levels of performance "Meaningful learning" dimension

Table 2. Relative Frequency

6 CONCLUSIONS

One of the contributions of this research is to provide a detailed instructional design of a blended learning environment, with particularly attention to how b-learning support 21st century skills training and potentially enhance students meaningful learning. At implementing this instructional design, we hope that the second contribution is to present a real experience on how to operationalize KSAVE 21st Century Skills framework and test its results.

B-learning environments have a great potential in higher education. This study shows that a learning activity combining b-learning with the 21st Century Skills may lead to meaningful learning. In fact, the analysis of the experimental data shows a positive development while students performed a learning activity where they had to practice some of these skills supported by a b-learning environment. Comparing performance of the students at the end of the 1st and 3rd milestones we see a statistical meaningful improvement.

This experience was performed as a quasi-experimental study, which means results cannot be generalized to contexts other than the one of the experiment, though it gives a positive feedback for utilizing this approach. Future research could produce additional information about student's satisfaction and skills development. With this kind of research, researchers could better measure the impact of blended learning environments in training the 21 Century Skills.

References

1. M. Last, "Towards a Framework for Analyzing and Implementing 21st Century Teaching and Learning with Attention to Educational Reform," in Society for Information Technology & Teacher Education International Conference, 2012, pp. 3373-3380.
2. P. E. Griffin, B. MacGaw, and E. Care, Assessment and teaching of twenty-first century skills: Springer, 2012.
3. D. P. Ausubel, The acquisition and retention of knowledge: A cognitive view: Springer, 2000.
4. F. Alonso, G. López, D. Manrique, and J. M. Viñes, "An instructional model for web-based e-learning education with a blended learning process approach," British Journal of educational technology, vol. 36, pp. 217-235, 2005.
5. J. Arbaugh, M. R. Godfrey, M. Johnson, B. L. Pollack, B. Niendorf, and W. Wresch, "Research in online and blended learning in the business disciplines: Key findings and possible future directions," The Internet and Higher Education, vol. 12, pp. 71-87, 2009.
6. J. D. Novak, Learning, creating, and using knowledge: Concept maps as facilitative tools in schools and corporations: Taylor & Francis, 2010.
7. M. Binkley, O. Erstad, J. Herman, S. Raizen, M. Ripley, M. Miller-Ricci, et al., "Defining twenty-first century skills," in Assessment and teaching of 21st century skills, ed: Springer, 2012, pp. 17-66.
8. A. I. A. C. Committee, "AACSB assurance of learning standards: An interpretation," An AACSB White Paper, vol. 20, 2007.
9. A. R. Saavedra and V. D. Opfer, "Learning 21st-century skills requires 21st-century teaching," Phi Delta Kappan, vol. 94, pp. 8-13, 2012.
10. E. Y. Huang, S. W. Lin, and T. K. Huang, "What type of learning style leads to online participation in the mixed-mode e-learning environment? A study of software usage instruction," Computers & Education,58, pp. 338-349, 2012.
11. W. F. McComas, "21st-Century Skills," in The Language of Science Education, ed: Springer, 2014, pp. 1-1.
12. S. R. Relles and W. G. Tierney, "Understanding the Writing Habits of Tomorrow's Students: Technology and College Readiness," The Journal of Higher Education, 84, pp. 477-505, 2013.
13. N. Hoic-Bozic, V. Mornar, and I. Boticki, "A blended learning approach to course design and implementation," Education, IEEE Transactions on, vol. 52, pp. 19-30, 2009.
14. M. Martyn, "The Hybrid Online Model: Good Practice," Educause Quarterly, vol. 26, pp. 18-23, 2003.
15 C. J. Popovich and R. E. Neel, "Characteristics of distance education programs at accredited business schools," The American Journal of Distance Education, vol. 19, pp. 229-240, 2005.
16. C. W. Holsapple and A. Lee - Post, "Defining, Assessing, and Promoting E - Learning Success: An Information Systems Perspective*," Decision Sciences Journal of Innovative Education, vol. 4, pp. 67-85, 2006.
17. R. Benbunan-Fich, "Improving education and training with IT," Communications of the ACM, vol. 45, pp. 94-99, 2002.
18. Z. Wan, Y. Fang, and D. J. Neufeld, "The Role of Information Technology in Technology-Mediated Learning: A Review of the Past for the Future," Journal of Information Systems Education, vol. 18, pp. 183-192, 2007.
19. J. Cao, J. M. Crews, M. Lin, J. K. Burgoon, and J. F. Nunamaker Jr, "An empirical investigation of virtual Interaction in supporting learning," ACM SIGMIS Database, vol. 39, pp. 51-68, 2008.
20. R. Santhanam, S. Sasidharan, and J. Webster, "Using self-regulatory learning to enhance e-learning-based information technology training," Information Systems Research, vol. 19, pp. 26-47, 2008.
21. V. N. Morphew, "Web-based learning and instruction: A constructivist approach," Distance learning technologies: Issues, trends and opportunities, pp. 1-15, 2000

A correlative research on the relationship between awareness in collaborative learning and its impact on academic performance

Zhong Keding[1,*], Li Nan[2]

[1]Beijing Normal University at The School of Educational Technology, Beijing，China

zhongkeding@bnu.edu.cn

[2] China National Institute of Educational Research, Beijing, China

allsa296@163.com

Abstract. In the collaborative learning environment, the learners will produce certain awareness within the group based on all kinds of relevant information, that is, collaborative-learning awareness. Through survey method, the research tries to understand the status quo of collaborative-learning awareness and to explore the structural components of collaborative-learning awareness and the relationship between collaborative-learning awareness and academic performance. Research shows that: collaborative-learning awareness is divided into four categories: social awareness, task awareness, concept awareness and workspace awareness. Among the four categories, task awareness exerts a direct impact on academic performance; the other three categories, i.e. social awareness, concept awareness and workspace awareness impact on academic performance through task awareness. The research conclusion has certain guiding significance for evaluation of the status of collaborative learning, improvement of learning effectiveness, as well as elevation of collaborative learning awareness.

Keyword: Collaborative Learning, Awareness, The Awareness in Collaborative Learning

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_2

1 Introduction

In recent years, the collaborative learning model is gradually popularized and spread under the drive of the increasingly developing theory study. Many teaching and learning activities, including distance education are organized considerably based on collaborative learning model in order to train students' teamwork and collaboration capabilities[1] As a new mode of teaching, what are the other changes concerning psychological characteristics in addition to the change of collaborative learners' studying behavior? How will these changes affect the learner's cognitive process, and what roles will they play in the future learning activities in their academic performances? In the literature research, however, we have not obtained any such literature as collaborative learning awareness, particularly in the aspect of how the learners' social awareness impacts on the learners' learning activities after a full literature search worldwide. This study explores each learner's psychological characteristics and awarenesses and their impact on this learner's academic performance in the collaborative learning activities through awareness theory.

1.1 What are the changes collaborative learning has made by the learners

Collaborative Learning(CL)is what that's all about-learners working together as a group to accomplish shared goals and maximize the learning of each individual by an incentive scheme [2]. At present, computer-supported (networks) collaborative learning CSCL indeed has a prominent role (the collaborative learning discussed in this article mainly aims at CSCL) to play in changing the behavior and acquisition results of individual students, as well as group collaboration performance[3]. For example: extension of time and space has broken through all kinds of separation barriers so that learning has been developed into social learning which is no longer bound by time. Computer and network systems have provided learners not only a wealth of learning resources, but also improvement of learning efficiency [4]. Collective knowledge and wisdom have been given full play to the extreme, and individual learning achievement and collective learning effectiveness have both been upgraded[5]][6] Individual's learning behavior is no longer regarded his/her own behavior because he/she gradually becomes aware of: (1) His/her individual role and function when interacting with the surrounding environment; (2) common goal and his/her own individual goal in collaboration with other members; (3) his/her individual knowledge structure related to overall knowledge structure; and (4) his/her individual activities related to those of other collaborative members. These changes above will affect the learner's future collaborative learning awareness, values and codes of conduct[7]. And more than those, it will internalize into learners' psychological activities.

1.2 Awareness theory and research done in the aspect of collaborative learning

Awareness is the cognition of a certain fact [8]. And the word "awareness" is also translated into "perception" by some scholars. Awareness is the first step to understand the surrounding environment, also the beginning of all behavioral expressions, which is an important indicator to guide an individual's behavior. In the field of psychology, awareness is a psychological characteristic to distinguish and measure different psychological states[9]. In the field of computer application, awareness mainly focuses on the research of awareness modeling in network virtual environment through appropriate technologies, e.g. agent technology to support the practical application of awareness model [10]. However, learner's awareness is the target of research in collaborative learning aspect, mainly focusing on the application of collaborative learning, known as "collaborative learning awareness", which refers to awareness situation of all the key elements involved in collaborative learning based on the members of the collaborative group.

Goldman (1992) brought forward learners' three awarenesses: social awareness, task awareness and concept awareness [11]. On this basis, Gutwin (1995) also proposed a "workspace awareness" [12] which believes that in collaborative learning, group peers must have four awareness elements: social awareness, task awareness, concept awareness and workspace awareness. And he also presented students' awareness framework as in Table 1.

Table 1. Type list of learners' awareness

Types of awareness	Connotation
Social awareness	What should I expect from the other members of the group? How can I communicate with the group, influence one another? What role will I play in the group? What roles will other members of the group undertake?
Task awareness	How much do I know about the task's theme and structure? How much do I know about the other people's task-based theme and structure? What are the steps need to complete the tasks? How to evaluate the result of the task? What are the tools and resources needed to complete the task? How much time needed to complete the task? How much time available?
Concept awareness	How is the task related to the existing concept? What knowledge do I also need to find out from the theme? Do I need to change my existing concept in the light of new information? Can I pose a hypothesis in order to forecast the outcome of the task based on the existing knowledge?
Workspace awareness	What are the other members of the group doing in order to complete the task? Where are they? What are they doing? What have they completed? What are they going to do for the next step? How can I help with the other members for the completion of their task?

Gutwin's framework of the four collaborative learning awarenesses can be interpreted as:

Social awareness refers to the learner's cognition to the social relations within the group;

Task awareness refers to the learner's cognition to learning task;

Concept awareness refers to the learner's cognition to the existed knowledge and the knowledge required for completion of the task;

Workspace awareness refers to the learner's cognition to the work space and the activities with his/her companions. Work space mainly indicates the collaborative learning environments, including space environment, hardware environment, resource environment, and so on.

The features of collaborative learning awareness include: (1) Collaborative learning awareness is the beginning of learning behavior, and is produced in the process of collaborative learning; (2) collaborative learning awareness guides and influences the learner's learning behavior in the group; (3) since it is the learner's cognition to a variety of dynamic information in the collaborative environment, the collaborative learning awareness is varied according to the changes of environment.

Goldman and Gutwin in their perception theory concerning collaborative learning activities reveals the learners' awareness characteristics as follows: (1) the initiation of learning behavior; (2) outcome in the process of collaborative; (3) to guide and influence the behavioral expression of the learners in the group (4) the cognition of learners' various dynamic information in the collaborative environment; and (5) to change with the changes of the environment. Accordingly, the main concern toward collaborative learning research has shifted from the external learning subject to the internal learning subject, from activity environment and activity forms to cognitive psychology of learners. The theory, however, only needs evidences to be supported by a large number of quantitative studies.

2 Research methods and tools

The research adopts questionnaire method, and uses the data collected as the basis for quantitative research.

2.1 Questionnaire preparation and selection of subjects

On the basis of literature investigation, the questionnaire prepared oriented for the research of collaborative learning awareness utilizes Gutwin's learner's awareness framework as the basis. The questionnaire is established for the following four dimensions: social awareness, task awareness, concept awareness and workspace awareness.

Social awareness

The contents of the dimension include:

◆ What is the role the learner playing in his/her own group? and what are the roles the other learners playing in the peer group in the process of completing the task in a collaborative way?

◆ How to communicate with group peers?

◆ Whether he/she is clear about what will be learned from other peers of the same group? etc.

Task awareness

◆ The contents of the dimension include:

◆ What are the theme and structure of the task?

◆ How to evaluate the result of the task?

◆ How to complete the task?

◆ How long does it take to complete the task? And when is the final deadline for the completion of the task?

Concept awareness

◆ The contents of the dimension include:

◆ What are the knowledge involved in the theme?

◆ What are the knowledge do I have?

◆ Which problems can an individual solve by using his/her original knowledge?

◆ What other new knowledge needs to be supplemented in order to solve a particular problem?

◆ What knowledge have I acquired when participating in the completion of activities or tasks? etc.

Workspace awareness

◆ The contents of the dimension include:

◆ What are the other group peers are doing at a particular stage?

◆ What are the views and attitude on a particular issue?

◆ How the other group peers are getting along with their learning? (What have been completed and what to do next?)

◆ What difficulties are the other peers going through in their learning?

◆ How to provide assistance to the other peers? etc.

See table 4 for specific connotations on four categories of learner's collaborative learning awareness.

Table 2. The dimensions and connotations of the questionnaire concerning collaborative learning awareness

Dimension of awareness	**Connotation of awareness**	**Specific contents of awareness**
Social awareness	The understanding of social relations within the group	The role played, and function exerted Exchanges and communication Group interaction
Task awareness	The learner's understanding of the group task	The theme and structure of the task Concrete requirements of the task The necessary preparation for the task to be completed Temporal-planning for completion of the task
Concept awareness	Learner's understanding of the existed knowledge and the knowledge required by the task	The new knowledge involved in completion of the task The relationship between the existed knowledge and the solution of the task The link between new knowledges
Workspace awareness	The learner's understanding of the latest activities of the group peers	Views and attitude of the group peers Peer learning progress The impact of the group peers The expected results whose responsibility is assumed by the other peers

The questionnaire adopts the most commonly used Five-point Likert Scale educational research. Except reverse design problem, the expression of problems in the questionnaire all represents a learner's collaborative learning awareness in a certain aspect in the positive sense. After reverse solution, it shows that the higher the scores of each problem, the higher the level of awareness of the learner's appropriate problem. The questionnaire is classified into two sections: self-evaluation and mutual evaluation among the group peers. Finally calculate the weighted average value based on scores of the subjective and objective evaluations.

The research is based on the subjects who are currently carrying out collaborative learning activities in the way of random sampling, that is, selecting regular undergraduates and graduate students with the exception of overseas students in the Beijing Normal University. Distribution of subjects' grades ranges from the first-year grade to the third year grade, as well as from first-year graduate students to second-year graduate students. The research also covers different academic courses, that is, liberal arts and science courses, for example, "Multi-media Technology and Web Page Making", "Basic Computer Application Course", "Curriculum Development", and so on. 129 subjects in the 33 collaborative study groups participated in survey. Finally, among the 122 questionnaires to be collected, 117 are valid questionnaires—the collecting rate is 94.6%, and the effective rate is 98.3%. Among the 117 subjects, 93 are undergraduates, accounting for 79.5%; 24 are graduate students, accounting for 20.5%; 35 are male students, accounting for 29.9%; 82 are female students, accounting for 70.1%. Most of the subjects usually prefer to independent learning, accounting for 71.6%; and the subjects who prefer to collaborative learning, however, only accounting for 28.4%.

2.2 Analysis of validity and reliability of the questionnaire data

The research uses Amos software, adopts confirmatory factor analysis method to implement structural validity analysis. The level of structural validity is reflected through the fitting degree of between data and theoretic hypothesis model. The theoretical model of collaborative learning awareness questionnaire includes four major dimensions (19-items).

Table 3. The fitting optimization indexes of model validation

Fitting indicators	X^2	P	X^2/df	NFI	IFI	TLI	CFI	RMSEA
Values	183.562	.019	1.257	.946	.989	.985	.988	.070

The indexes reflect that this model fits well in various indexes and show the questionnaire has fine structural validity。In a word, based upon literature investigation and study in statistical analysis, this study complete the awareness dimensions of learners in collaborative learning. Besides, it has also adjusted the structure of questionnaire after program distinguishing degree analysis.

By Using SPSS for truth test of questionnaire，the data internal consistency coefficient (Cronbach α) reflects that the reliabilities of four dimensions in collaborative learning awareness questionnaire -- conceptual awareness, task awareness, social awareness and workspace awareness as well as total scale are all above .6. It proves that data has good internal consistency.

Table.4. α- coefficients in dimensions and total scale

Total Scale	conceptual awareness	task awareness	social awareness	workspace awareness
.9031	.6289	.6833	.7309	.7304

3 Research Process

3.1 Relationship between learners' awareness and academic achievement in collaborative learning

The relationship between four dimensions of awareness and academic achievement in collaborative learning is planned to use correlation analysis to study the relationship of scores of conceptual awareness, task awareness, social awareness and workspace awareness and academic achievement. Considering the differences of teaching content and test difficulties in different classes, academic achievements are all represent by Z scores.

Table 5. The average awareness level based on the learners' self-assessment in collaborative learning

	N	Minimum value	Maximum value	Average score	Standard deviation
Concept awareness	117	1.75	4.75	3.40	.58
Task awareness	117	1.83	4.67	3.53	.51
Social awareness	117	1.25	5.00	3.49	.62
Workspace awareness	117	1.60	4.80	3.42	.60

Note: The full score of each average awareness dimension is 5 points.

Result of correlation analysis shows that, there is significant positive correlation relationship between Z scores of learners' academic achievements and learners' scores on conceptual awareness, task awareness, and workspace awareness. Detailed correlation coefficients are shown in Table 1. Therefore, we can conclude that academic achievements of learners in collaborative learning are close related with scores of conceptual awareness, task awareness and workspace awareness, showing consistent trend.

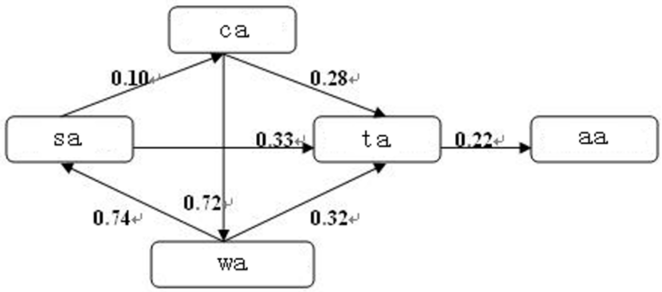
Table 6. Correlation analysis on learners' awareness level and academic achievement

		sca	sta	ssa	swa
aa	Pearson Correlation	.218*	.232*	.164	.237*
	Sig.（2-tailed)	.018	.013	.078	.011
	N	117	114	116	113

*.Correlation is significant at the 0.05 level(2-tailed).
Remarks:
aa: academic achievement
sca: score of concept awareness
sta: score of task awareness
ssa: score of social awareness
swa: score of workspace awareness

3.2 Path analysis on learners' awareness in collaborative learning and academic achievement

In the above correlation analysis, it shows that social awareness has no significant correlation with academic achievement. In order to further ascertain the relationships and interactions of different awareness and academic achievement，use Amos 4.0 to establish mutual paths. See Figure 1.



Remarks:
ca: concept awareness
sa: social awareness
ta: task awareness
wa: workspace awareness
aa: academic achievement

Figure.1. Path analysis on learners' awareness and academic achievement

In Figure 1, predictive values and directions show that in the influence that learners' collaborative learning awareness exerts to academic achievement，task awareness is a direct variable，which has direct impact on academic achievement. While other awareness all exerts the influence directly through task awareness, predictive values measuring three influences are respectively 0.5104 （0.72*0.32+0.28）, 0.358（0.10*0.28+0.33）, 0.3407（0.74*0.10*0.28+0.32）. We can conclude that, the impact of conceptual awareness, social awareness and workspace awareness to academic achievement are functioned through task awareness, indirectly.

3.3 Analysis on the influence of task awareness to academic achievement

According to the above path analysis, it is shown that task awareness can directly affect academic achievement. Here we adopt variance analysis to discuss the significance of the impact that task awareness exert to academic achievement and the mathematic model of the two factors.

Let task awareness be independent variable and academic achievement be dependent variable. The variance analysis in Table 7 shows that: task awareness has significant impact on academic achievement. Sig=.040<.05.

Table.7. Variance analysis on the impact of task awareness on academic achievement

	df	Mean square	F	sig
Between Groups	89	74.833	1.884	.040
Whin Group	24	39.711		

Remarks:
aa: academic achievement

..

Next, let task awareness be independent variable and academic achievement be dependent variable. Use regression analysis to establish mathematical model and we can obtain the following results. See Table 8:

Table 8. Regression analysis on the impact of task awareness to academic achievement

Model		B	Std.Error	Beta	t	sig.
1	(constant)	78.592	2.209	.237	35.576	.000
	gpta	2.651	1.044		2.540	.012

Remarks:

gpta: group placement of task awareness
aa: academic achievement

..The mathematical model is：

academic achievement=78.592+2.651* task awareness

4 Research Conclusions and Suggestions

By investigating awareness of learners in collaborative learning, we obtain the following main conclusions：

Correlation relationship of on learners' awareness level and academic achievement shows that, learners' conceptual awareness, workspace awareness and task awareness all have positive correlation relationship with academic achievement. Path analysis of learners' awareness in collaborative learning and academic achievement demonstrates that, task awareness directly exerts on academic achievement， while other three awareness affect academic achievement indirectly through task awareness. And impact of task awareness to academic achievement is significant. The regression analysis reveals the mathematical relationship between the two.

This study is confined to a comparative study of collaborative learning activities without diverse cultural backgrounds from the East and the West. Consequently, differences of collaborative learning awareness levels under the background of different cultures of the East and the West cannot be really discovered. However, from the statistical data that 71.6% of the subjects preferred to independent study, the collaborative learning awareness level of Chinese learners is relatively low level. Based on the conclusion of the research, several suggestions are put forward regarding collaborative learning.

4.1 Collaborative learning awareness is reasonable index to assess collaborative learning situation

Collaborative learning awareness is a psychological feature which functions on collaborative learning in different degrees. In this sense, awareness level is also an important index in collaborative learning assessment. It can help to allocate different characters within groups according to different awareness levels of learner. Besides, it also provides basis for heterogeneous combination.

4.2 Increase of task awareness is the key point to effects of collaborative learning

Since task awareness is the most direct key factor affecting academic achievement, teaching organizers should focus on reasonable design of teaching activities in different stages of collaborative learning. For example, objective-oriented teaching strategy helps to raise different awareness level of learner. Besides, increase of task awareness level is one of the most effective strategies to raise efficiency of collaborative learning.

4.3 Cultivation of conceptual awareness, social awareness and workspace awareness is of the same importance.

Since conceptual awareness, social awareness and workspace awareness affect academic achievement in collaborative learning indirectly through task awareness, the influence cannot be overlooked. Especially, social awareness and workspace awareness are the important factors of group interpersonal relationship. Students higher in social awareness level are generally suit for leader or coordinator characters, which may help the group face study task easily, and at the same time, he or she is also good at coordinating relationships of group peers and promoting task awareness level of other group peers.

Reference

[1]Jeffrey R.Huntsinger, Stacey Sinclair, Gerald L.Clore.. Affective regulation of implicitly measured stereotypes and attitudes:Automatic and controlled processes. [J]. Journal of Experimental Social Psychology Volume45:(2009)560–566

[2]Liuhuang Lingzi, Huang Ronghuai. Assessment of cooperative learning.[J]. Modern Educational Technology, Volume1:(2002)24-29.

[3]Hsu Jung-Lung, Chou Huey-Wen, Hwang Wu-Yuin, Chou, Shyan-Bin. A

Two-Dimension Process in Explaining Learners' Collaborative Behaviors in CSCL. [J].Educational Technology & Society Volume11(4): . (2008)66-80
[4]Okamoto T. E-collaborative learning technologies and e-pedagogy. [J]. 3RD IEEE International Conference On Advanced Learning Technologies, Proceedings: (2003)516-517
[5]Chen Charlie C, Wu Jinpo, Yang Samuel C, Tsou Hsin-Yi.Importance of diversified leadership roles in improving team effectiveness in a virtual collaboration learning environment. [J]. Educational Technology & Society Volume11(1):(2008) 304-321
[6]Chih-Ming Chen Personalized E-learning system with self-regulated learning assisted mechanisms for promoting learning performance. [J]. Expert Systems with Applications Volume36:(2009)8816–8829
[7]El-Bishouty Moushir M, Ogata Hiroaki, Yano Yoneo. PERKAM: Personalized knowledge awareness map for computer supported ubiquitous learning.[J]. Educational Technology & Society Volume10(3): (2007) 122-134
[8]Zhao Yawei, Zhang Haisheng, Gu Leye. Technology of dynamic information awareness in CSCW. [J].Computer Application, Volume4:(2003)29.
[9]Jessica J.Summers , David A.Bergin , James S.Cole. Examining the relationships among collaborative learning, autonomy support, and student incivility in undergraduate classrooms.[J]. Learning and Individual Differences Volume19: (2009)293–298
[10]Wiberg Mikael. Netlearning and learning through networks. [J].Educational Technology & Society Volume10(4):(2007) 49-61
[11]Goldman, S. V. Computer resources for supporting student conversations about science concepts. [J].SIGCUE Outlook, Volume3: (1992)4-7.
[12]Carl Gutwin1, Gwen Stark, Saul Greenberg. Support for workspace awareness in educational groupware.[C]. In: Proceedings of CSCL 1995, 147-156, Indiana University, Bloomington, Indiana, USA October 17-20, Distributed LEA Press.

A Framework to Automatically Analyze Regulation

Lanqin Zheng[1, 2], Moushir M. El-Bishouty[2, 3], Colin Pinnell[2], Jason Bell[2], Vive Kumar[2], Kinshuk[2]

[1]School of Educational Technology, Faculty of Education, Beijing Normal University
[2]School of Computing and Information Systems, Athabasca University
[3]City for Scientific Research & Technological Applications, Egypt
{bnuzhenglq@bnu.edu.cn, moushir.elbishouty@athabascau.ca, maleficus1234@gmail.com, slysavant@gmail.com,vive@athabascau.ca, kinshuk@athabascau.ca}

Abstract. Self-regulated learning has achieved prominence in recent years. Helping students to become self-regulated learners is becoming a favorite target of researchers and educational practitioners. This study proposes a novel framework that can automatically analyze online self-regulated learning processes and competencies. It presents an analytics dashboard that encourages students to initiate activities of self-regulation and guide them to reflect on their competencies. The architecture of the framework and an applied scenario are presented and discussed in detail.

Keywords: Self-regulated learning, Competency, Learning analytics, Dashboard.

1 Introduction

In recent years, self-regulated learning (SRL) research in online learning environments has elicited a growing interest [1, 2, 3, 4, 5]. SRL is viewed as one of the most important skills for lifelong learning [6]. SRL refers to the self-directive and initiative processes that learners use to set their goals, select and deploy tactics, monitor actions, and evaluate their effectiveness [7]. SRL tends to guide learners metacognitively and motivate them intrinsically [8, 9]. Further, SRL can mediate among learning contexts, learners' characteristics, and learning outcomes [10].

Self-regulation happens at the initiative of the learner, not being explicitly told to do so. Self-monitoring and self-evaluation are the necessary and crucial processes during self-regulated learning. Self-regulation activities are typically meta level in nature and are indirectly triggered by setting goals, making plans, applying strategies, and adapting metacognition.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_3

It is widely acknowledged that self-regulated learning is the crucial factor for success in an online learning environment [11, 12]. Literature has reported that high performance learners have exhibited distinct self-regulatory abilities such as setting goals, using various strategies, monitoring their own behaviors, and adapting metacognition [13, 14]. Fostering the abilities of self-regulation traits should become the central concern in the area of online educational research and practice.

This study proposes to showcase self-regulatory competencies of learners within and across learning contexts. In doing so, it even ventures into big data learning analytics, with a particular focus on self-regulation, where an interactive dashboard enables learners to contemplate, design, build, and execute initiatives that correspond with self-regulatory activities in the domain of programming with emphasis on UML design, writing code, debugging code, documenting code, and testing code.

The innovation in our approach lies with the ability for students to reflect on and regulate their own programming habits using an interactive dashboard. The dashboard allows learners to create traceable SRL activities. That is, students can create initiatives, where each initiatives contains a main goal, tactics and strategies to be adopted by the student to achieve the goal, tools to be used in realizing said tactics and strategies, and continuous monitoring of the progress made by the student towards achieving the goal.

2 Characteristics of self-regulation

This section provides the groundwork for the framework with respect to the current literature and a select set of SRL tools. A number of key models have been proposed from different perspectives about self-regulated learning [15, 16, 17]. These models can be classified into two main types: the sociocognitive and the information processing perspective.

A sociocognitive perspective regards self-regulated learning as a triadic process influenced by personal, behavioral, and environment events [15, 17]. The information processing perspective highlights the role of information as the catalyst of self-regulation across multiple phases. These phases of information processing perspective include defining the task, setting goals and planning how to reach them, enacting tactics, and adapting metacognition [16].

The information processing perspective has its unique contributions that provide insights into the nature of self-regulated learning. First, this model provides alternative methods to measure self-regulated learning as an event and as an aptitude. Second, this model emphasizes the monitoring and control as the core of each regulation phase. Third, the recursive nature of self-regulated learning is also

explicated by continually updating the products of each phase. Finally, this model separates the phases of task definition from goal setting and planning.
A few self-regulated learning tools have been developed, including gStudy [18], metacognitive tool [19], and Learn-B [20].We provide, in Table 1, a comparison of these three tools in terms of the learning context, self-regulatory processes and adopted learning technologies.

Table 1. Key characteristics of self-regulated learning tools.

Dimensions	gStudy	Metacognitive tool	Learn-B
Learning context	Any topic in reading comprehension	Biology	Organizational context of workplace learning
Self-regulatory processes	Metacognitive Monitoring, Enacting tactics	Planning, Monitoring, Enacting tactics, Handling task difficulties	Setting goal,Monitoring learning processes
Adopted technologies	Multimedia technologies	Hypermedia; Agent	Semantic web-based technologies

These tools can be treated as contemporary in SRL and yet they do not automatically analyze learners' self-regulated learning abilities, especially across different learning contexts. The proposed framework aims to engage learners in creating SRL-specific activities, to trace earners' interactions related to those SRL-specific activities, to measure the degree of self-regulation in these activities, and infer the relation between enacted SRL activities and learning performance.

3 Framework Architecture

As shown in Figure 1, the framework consists of three main components: Learning Events Sensor, Analytics Server, and Analytics Dashboard. A discussion on the learning events sensor is available from [21, 22]. The proposed framework uses IMS Caliper [23] framework to capture and share online learning interaction data. Caliper employs the IMS Sensor API for the instrumentation, collection and exchange of data from Learning Tools/Systems and associated Learning Content elements. This will enable the availability of standard metrics accessed via any given Analytics Store and associated APIs. All collected data are stored on the Analytics Storage.

The Analytics Server has two key functionalities. First, it aims to relate different datasets available in the Analytics Storage. For instance, it relates the performance of a student on a particular assignment with the learning outcomes associated with that assignment and the skills associated with the outcomes. Quantitative measurement of application of skills with respect to this specific assignment can then be related to the overall skills development of the student. Second, the Analytics Server engages the student in creating 'initiatives-based intelligent interactions' (III). Each initiative is explicitly created by the learner or modified by the learner based on a pre-existing initiative. Based on Winne's model [16], the initiative contains information on task, goals, plans, tactics, strategies, and adaptation mechanisms. More importantly, each element within the initiative is self-monitoring by design. For instance, if the student has outlined a time-based plan to achieve a goal using a particular strategy, the framework will continuously monitor the time constraints specified in the plan, continuously assess the degree of success of study strategies used by the student, and continuously measure the progress of the student with respect to the goal. The initiatives are 'intelligent' in that they classify themselves and provide an ontological big picture view of the study habits of the learners in terms of competencies and competency growth.

The Analytics Dashboard presents learners with an interactive interface to reflect on content, study habits, and initiatives. Further, students can also create, visualize, interact with, or control initiatives from within the dashboard. Key functionalities of the dashboard include reporting on study activities, customizing initiatives, visualizing datasets, and recommending course of action.

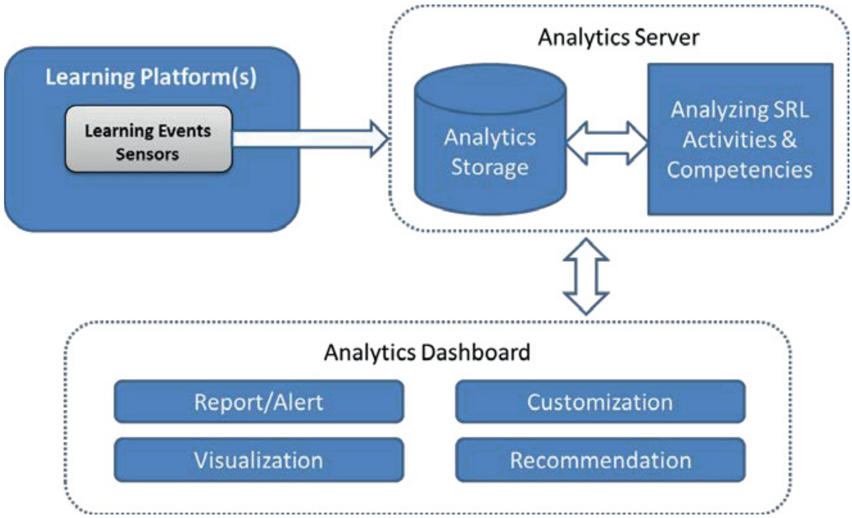


Fig.1. A framework for analyzing self-regulated learning & competencies

The rest of the paper consolidates ideas behind this framework with application-specific scenarios.

4 Applied Scenarios

This section illustrates different scenarios for using a tool based on the proposed framework in a particular domain, learning a programming language, as an example. The students of the programming language course are learning though LMS and using IDE for completing the learning tasks. It is assumed that software sensors are installed on IDE. Before the course delivery, the course instructor identifies the course learning outcomes in terms of competencies and skills associated with each competency. Each course unit is related to a subset of the course competencies and skills. For example, a course unit introduces object oriented programming (OOP). Coding OOP competency is associated with that unit, which consists of a set of skills: class, constructor, interface method and object coding. The instructor initiates a set of tasks for the unit and defines the required level for each associated skill. The skill level is measured based on several data captured in IDE such as: frequency of errors, number of code lines, number of debugging and others.

Once a student receives a task, he/she can use the proposed tool to monitor and measure his/her self-regulation information, both metrics and beliefs, such as the similarity of the task with other accomplished tasks, level of difficulty, required knowledge, motivation, self-efficiency and so on. Student can also define the task goals in terms of skill levels, strategy, plan and tactics to achieve those goals. For example, one tactic could be using the dashboard to visualize error data. The dashboard allows the student to monitor, evaluate and adapt his/her self-regulation during the task. It informs the students of other students' skill levels, which might trigger him to take an initiative towards improving his/her skill level. The student can design a task to target specific skills or select one of the recommended tasks to accomplish, based on his current competency level. During the evolution of self-regulation and co-regulation process, big data analytics is conducted to examine the strength of triggers and initiatives on competency development.

A concrete scenario is a student who is skilled in basic programming but lacks code testing skill. He/she has not been taught any practical testing methodology in any courses up until now. Because of this, this student thinks each programming course should have testing competencies. However, testing methodologies vary according to the type of code written - testing the efficiency of a sorting algorithm is quite different from testing how an artificial intelligence behaves. The proposed tool accounts for one testing competency encompassing multiple methodologies, each uniquely presented in an initiative for each unit. The tool engages the student in a conversation such as "Unit 3 introduces new concepts that require different testing methods than those presented previously. Would you like to learn more?", then assists the student understand testing in the context of the new unit.

Furthermore, student self-evaluations are supplemented by the proposed tools' own evaluations. In example, a student indicates that "I'm very experienced at exception handling, don't pester me about it". However, the first assignment has a question about exception handling, and the student does poorly on it. This triggers the exception handling competency, and the tool begins a dialog with the student "I know you said you understand this competency, but you did poorly on a related question. Would you like to reconsider?" Or "You said that you don't understand this competency, but have been doing exceptionally well. Would you like me to stop prompting you about it?"

The proposed tool is also capable of assisting students in goal-setting. Another student has received a lower grade than expected in an assignment and isn't yet sure where the problem is. Because of this, this student goes into the tool and then finds the tutor's comments noted that he/she was having a hard time using loops cleanly and suggests that the student review the unit on Control structures. The student still has no strong understanding of what he/she misunderstands, so doesn't select any more specific areas of focus. The tool pulls all of competencies and skills from the Control unit of the course. Each of these has a set of resources which the student can use, if desired, as well as links to outside resources. These have all been set up by the course coordinator several months ago. The proposed tool selects the competencies which the student seems to have scored lowest on, since the student hasn't selected any specific direction of study.

The proposed tool monitors student activity and provides feedback when thresholds are met. Suppose the previous student has set him or herself two hours to complete a thorough reading of course materials, but when the two hour threshold approaches the student has not registered the task as complete. The tool will engage the student in a conversation at this threshold, presenting the initiative details and encouraging changes without requiring them. The student changes the time limit from two hours to four, and changes the task details to cover what he or she has discovered to be the most vital areas of the problem. The student may also change his or her strategy choice, add resources, or invite commentary from a tutor.

5 Conclusion

To sum up, a novel framework of analyzing online self-regulated learning processes and competencies is proposed in this study. Based on this framework, the tool of self-regulated learning is designed to capture the evolution of competency triggered by self-regulated learning activities. Several application scenarios shed light on how the tool provides just-in-time feedback by the initiatives. This promising tool can also provide personalized and adaptive recommendations for teachers and students. The big gap between researchers and educational practitioners can be minimized by creating personalized initiatives by teachers and students. In future studies, the effectiveness of the tool will be validated based on empirical data. The longitudinal study should be conducted to investigate the influence of the tool on students' competency.

References

[1] Azevedo, R., Cromley, J.G., Winters, F.I., Moos, D. C. & Greene, J. A.: Adaptive human scaffolding facilitates adolescents' self-regulated learning with hypermedia. Instructional science. 33(5-6), 381−412 (2005)
[2] Biesinger, K., Crippen, K.: The effects of feedback protocol on self-regulated learning in a web-based worked example learning environment. Computers & Education, 55(4), 1470−1482 (2010)
[3] Tsai, C.W.: How much can computers and internet help?: A long-term study of web-mediated problem-based learning and self-regulated learning. International Journal of Technology and Human Interaction. 7(1), 67−81 (2011)
[4] Sha, L., Looi, C. K., Chen, W.: Understanding mobile learning from the perspective of self-regulated learning. Journal of Computer Assisted Learning, 28(4), 366−378 (2012)
[5]Tsai, C.W., Shen, P.D., Fan, Y.T.: Research trends in self-regulated learning research in online learning environments: A review of studies published in selected journals from 2003 to 2012. British Journal of Educational Technology.44(5), E107−E110 (2013).
[6] Ifenthaler, D.: Determining the effectiveness of prompts for self-regulated learning in problemsolving scenarios. Educational Technology & Society.15(1), 38–52 (2012)
[7] Zimmerman, B. J.: Investigating self-regulation and motivation: Historical background, methodological developments, and future prospects. American Educational Research Journal. 45(1),166−183 (2008)
[8]Zimmerman, B. J.: Self-regulated learning and academic achievement: An overview. Educational psychologist. 25(1), 3−17 (1990)
[9] Winne, P. H.: Experimenting to bootstrap self-regulated learning. Journal of educational Psychology. 89(3), 397 (1997)
[10] Pintrich, P. R.: A conceptual framework for assessing motivation and self-regulated learning in college students. Educational psychology review. 16(4), 385−407 (2004)
[11]Adeyinka, T., Mutula, S.: A proposed model for evaluating the success of WebCT course content management system. Computers in Human Behavior.26(6), 1795−1805 (2010)
[12]Kistner, S., Rakoczy, K., Otto, B., Dignath-van Ewijk, C., Büttner, G., Klieme, E.:
Promotion of self-regulated learning in classrooms: investigating frequency, quality, and consequences for student performance. Metacognition and learning. 5(2), 157−171 (2010)
[13]Zimmerman, B. J., Martinez-Pons, M.: Student differences in self-regulated learning: Relating grade, sex, and giftedness to self-efficacy and strategy use. Journal of educational Psychology. 82(1), 51− 59 (1990)
[14] Isaacson, R. M., Fujita, F.: Metacognitive Knowledge Monitoring and Self-Regulated Learning: Academic Success and Reflections on Learning. Journal of Scholarship of Teaching and Learning. 6(1), 39−55 (2006)
[15]Pintrich, P. R.: The role of goal orientation in self-regulated learning. In: Boekaerts, M., Pintrich, P.R., Zeidner, M. (eds.) Handbook of self-regulation. pp. 451−502. CA: Academic Press, San Diego (2000)
[16]Winne, P.H., Hadwin, A.F.: Studying as self-regulated learning. In: Hacker, D.J., Dunlosky, J., Graesser, A.C. (eds.) Metacognition in educational theory and practice. pp. 277−304. NJ: Lawrence Erlbaum Associates, Hillsdale (1998)
[17] Zimmerman, B.J.: A social cognitive view of self-regulated academic learning. Journal of educational psychology. 81(3), 329−339 (1989)

[18] Winne, P. H., Nesbit, J. C., Kumar, V., Hadwin, A. F., Lajoie, S. P., Azevedo, R., Perry, N. E.: Supporting self-regulated learning with gStudy software: The Learning Kit Project. Technology Instruction Cognition and Learning, 3, 105−113 (2006)
[19]Azevedo, R., Johnson, A., Chauncey, A., Self-regulated learning with MetaTutor: Advancing the science of learning with MetaCognitive tools. In: New Science of Learning. pp. 225− 247. Springer, New York, (2010)
[20]Siadaty, M., Gašević, D., Jovanović, J., Pata, K., Milikić, N., Holocher-Ertl, T., Jeremić, Z., Ali, L., Giljanović, A., Hatala, M.: Self-regulated Workplace Learning: A Pedagogical Framework and Semantic Web-based Environment. Educational Technology & Society, 15(4), 75–88 (2012)
[21] Boulanger, D., Seanosky, J., Kumar, V., Kinshuk, Panneerselvam, K. &Somasundaram, T. S., Smart Learning Analytics. The proceedings of International Conference on Smart Learning Environment (2014)
[22] Seanosky, J., Boulanger, D., Kumar, V., &Kinshuk, Unfolding Learning Analytics for Big Data. The proceedings of International Conference on Smart Learning Environment (2014)
[23] Learning Measurement for Analytics Whitepaper, IMS Global Learning Consortium, http://www.imsglobal.org/IMSLearningAnalyticsWP.pdf

A method for evaluating technology-rich classroom environment

Junfeng YANG[1, 2, 3]
[1]Educational School, Hangzhou Normal University, Hangzhou 311121 China
[2]Collaborative & Innovative Center for Educational Technology (CICET), Beijing Normal University, Beijing, China
[3]Beijing Key Laboratory of Education Technology, Beijing Normal University, Beijing, China

yangjunfengphd@gmail.com

Abstract. In response to the modest use of technology in most classrooms without significant influence on learning, we proposed a framework to design and evaluate the technology-rich classroom environment from the physical and psychosocial aspects. A survey was done to confirm the structure and the internal consistency reliability of the questionnaire we developed based on the framework. The results indicated the framework was useful for designing and evaluating technology-rich classroom environment. In the end, several suggestions have been put forward to indicate the methods for optimizing the classroom environment.

Keywords: classroom, learning environment, technology-rich classroom, evaluation.

1 Introduction

Since the 1990s a massive amount of resources has been expended to create universal access to technology in schools. The underlying assumption fueling these investments is that use of technology in the classroom will transform teaching and learning[1]. Despite the investment, researchers have consistently observed modest use of technology without significant influence on teaching and learning in most schools and classrooms[2][3][4]. Acknowledging the challenge of technological innovation in schools, scholars have argued for the need to shift our attention from technology and software to the design of learning environments and learning activities[5]. The design and evaluation of learning space are therefore emerged to focus on the rebuilding of formal and informal learning places in school by utilizing proper technology[6]. Classroom space is one of the most important learning spaces where most of the formal learning activities and teaching activities take place. However there are lots of problems exist in classroom environment when

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_4

considering the learning needs of the new generation of students who were born and grown up in digital technology[7]. How we help change classrooms into something fundamentally different from what is typically encountered by students today, and after that to improve teaching and learning efficiency to enhance learning experience and learning outcome? In order to answer these questions, we have developed a framework to design and evaluate technology-rich classroom environment.

2 The framework for designing and evaluating technology-rich classroom

Most of the classroom layouts are “rows of seats and tables facing forward ”; teachers are fixed on the podium for managing computer; classes with PPT is no better or even worse than traditional class[8]. All these problems in classroom make classroom a place of no attraction for digital native students have a culture of connectivity and online creating and sharing[9]. However, literature revealed that the design of learning space should consider the characteristics and behavior of learners[10]. The classroom design and evaluation should also consider the characteristics of learners.

Generally, the physical, social and psychological aspects are the three dimensions of evaluating classroom environment, and there are direct associations between psychosocial environment and physical environment[11]. We focus on the physical aspect and psychosocial aspect of classroom environment in this research.

Looking back the research about physical aspect of classroom environment, we could find that the layout, lighting and air quality were the main focus of research[12]. However, few researchers have done research about classroom environment from the perspective of pedagogy, but different pedagogy asks for different learning space[13]. Therefore we proposed a framework for designing and evaluating physical classroom environment, as shown in Fig. 1

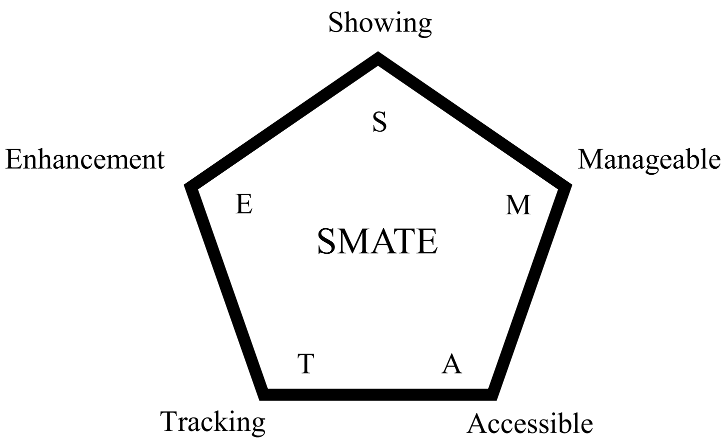


Fig. 1. Elements of physical classroom environment

When considering the psychosocial aspect of classroom environment, lots of scales and inventories have been developed and validated. “What Is Happening In this Class? (WIHIC)” is one of these scales which has been used extensively all over the world[14]. WIHIC includes seven dimensions of student cohesiveness, teacher support, involvement, investigation, task orientation, cooperation and equity. As we mainly discuss the classroom environment from pedagogy aspect, the student cohesiveness and equity are not included in this study. Therefore we formed a framework for designing and evaluating psychosocial aspect of classroom environment, as shown in fig.2.

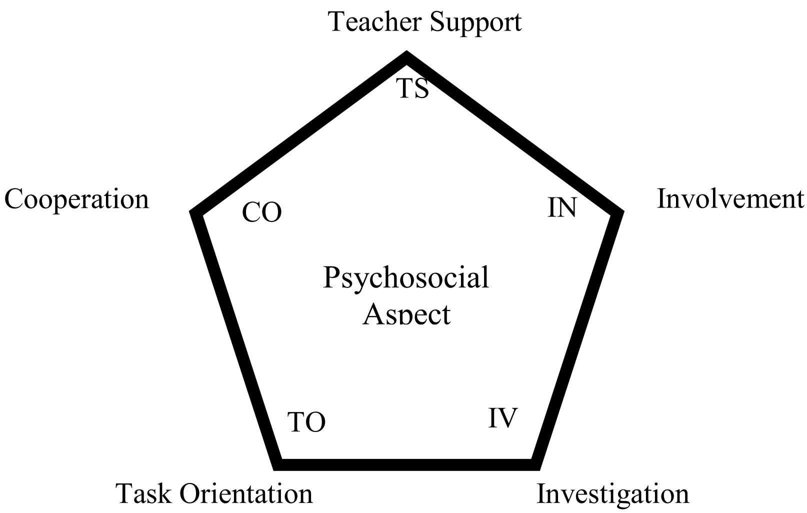


Fig. 2. Elements of psychosocial classroom environment

According to the elements of physical and psychosocial classroom environment, we finally proposed the framework for evaluating technology-rich classroom, as shown in table 1.

Table 1. Framework for evaluating technology-rich classroom

Dimensions	Annotation
Showing (S)	Showing of learning and instructional content
Manageable (M)	Managing of physical environment/instructional materials/students behavior
Accessible (A)	Accessing to digital resources
Tracking (T)	Tracking learning process/ environment
Enhancement (E)	Technology can promote physical environment factors
Teacher support (TS)	Students can feel the help from teacher in class
Involvement (IN)	Students feel engaged in classroom learning activity
Investigation (IV)	Students conduct inquiry-based learning in class and solve problems using inquiry method
Task orientation (TO)	Students feel they could finish the learning activities and focus on learning
Cooperation (CO)	Students feel they could collaborative with other students in class

3 Method

We first selected a middle school to do survey using the questionnaire Classroom Environment Evaluation Scale developed from the framework, and then data was analyzed in SPSS 21.0 and .

3.1 Sample

The sample employed in this study consisted of 283 students from a middle school in Beijing, China. The sample consisted of 87 grade 7 students, 73 grade 8 students, 70 grade 10 students and 58 grade 11 students. The female sub-sample constituted 53.3% of the full sample.

3.2 Instrumentation

Based one the framework for evaluating classroom environment, we developed a questionnaire Classroom Environment Evaluation Scale (CEES) for evaluating classroom environment, which consisted of 10 dimensions and 5 questions for each dimension.

3.3 Data analysis and interpretation

There were four distinct components to the analyses conducted in the present study. First, confirmatory factor analysis (CFA) and scale reliability analysis were employed to substantiate the structure of the CEES. A second-order CFA model was hypothesized. Fig. 3 illustrates this model in which classroom environment (as assessed by the CEES) was the second-order variable, which was indicated or assessed by 10 first-order variables (the 10 CEES scales). In turn each of these 10 scales were indicated by 5 observed variables (the 5 items for each CEES scale). Second, according to the data in the past large scale survey and the present study, we proposed a baseline for each dimension in CEES for evaluating classroom environment. Third, several suggestions have been put forward to indicate the methods on how the improve the classroom environment in that school.

4 Results

4.1 Confirmatory factor analysis

As indicated above, confirmatory factor analysis (CFA) was performed on the data to substantiate the structure of the 50-item CEES. Classroom environment (as assessed by the CEES) was the second-order latent variable, which was indicated or assessed by 10 first-order latent variables. In turn each of these 10 scales were indicated by 5 observed variables. Fit statistics for this model were: RMSEA=.056, CFI=.914 and NFI=0.928. These statistics indicate good model fit to the data and confirm the 10-scale structure of the CEES. For the paths between the 10 CEES scale latent variables and the CEES latent variable, loadings ranged from 0.610 to 0.943, as shown in Fig.3.

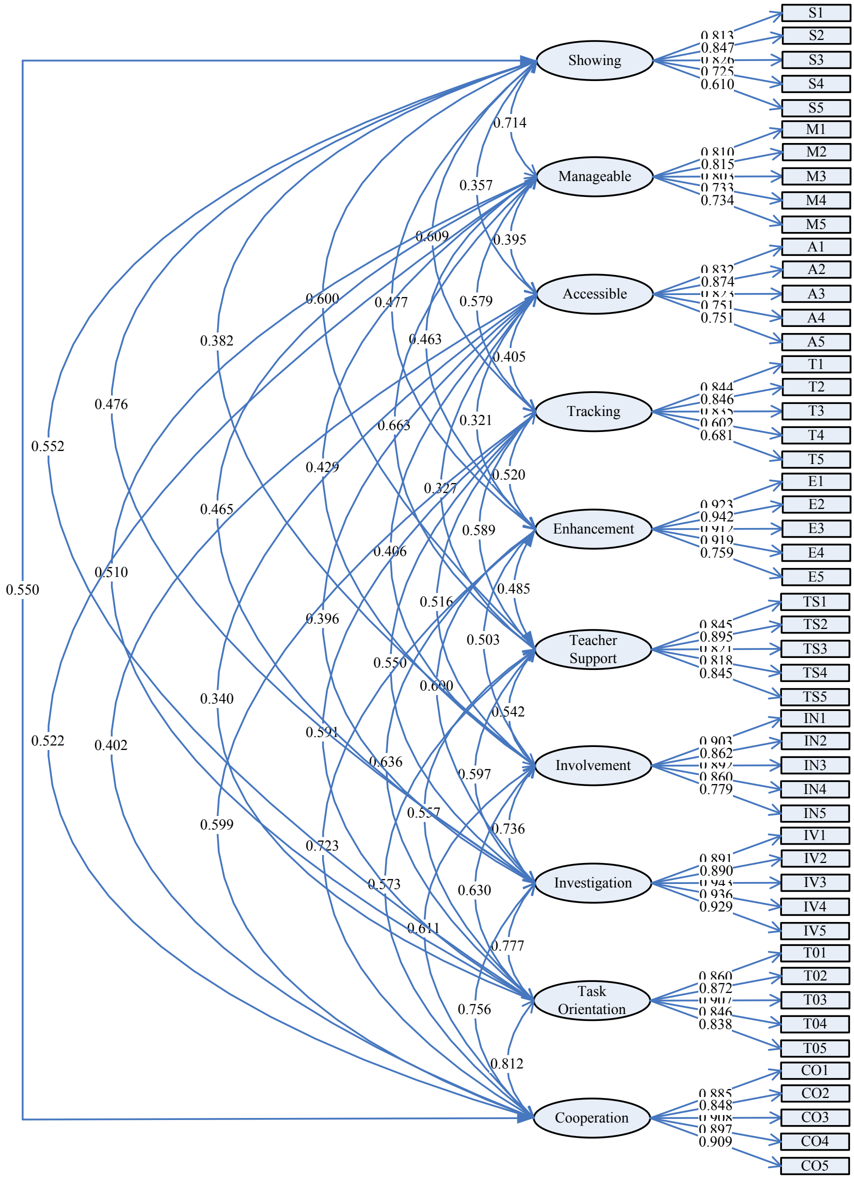


Fig. 3. CEES model and factor loadings

4.2 Scale statistics

Reliability coefficients (Cronbach coefficient alpha) were computed for each scale (see Table 2). Indices ranged from .77 for tracking to .95 for investigation show that all scales had very satisfactory internal consistency.

Table 2. Internal consistency reliability

Scale	S	M	A	T	E	TS	IN	IV	TO	CO
Cronbach α	0.81	0.84	0.87	0.77	0.93	0.90	0.91	0.95	0.92	0.93

4.3 Associations between Physical and Psychosocial Environment Factors

Simple correlation and multiple linear regression analyses were computed to explore possible associations between psychosocial environment scale variable and physical factors. In Table 3, a number of significant independent associations emerged between physical environment variable and psychosocial variable. Further, significant independent associations emerged between the physical variable and psychosocial variable. These results suggest that these physical attributes of a learning space could influence the psychosocial environment.

Table 3. Association between physical and psychosocial variable using simple correlation (r) and multiple regression analyses (ß)

Physical variable	Psychosocial variable									
	TS		IN		IV		TO		CO	
	r	β	r	β	r	β	r	β	r	β
S	0.600**	0.097	0.382**	-0.106	0.476**	0.019	0.552**	0.153*	0.550**	0.096
M	0.663**	0.325**	0.429**	0.045	0.465**	0.004	0.510**	0.0416	0.522**	0.016
A	0.327**	-0.102	0.406**	0.057	0.396**	0.037	0.340**	0.004	0.402**	0.033
T	0.589**	0.126*	0.516**	0.146*	0.550**	0.121*	0.591**	0.207**	0.599**	0.131*
E	0.485**	0.096*	0.503**	0.236**	0.600**	0.349**	0.636**	0.385**	0.723**	0.489**
Multiple correlation （R）		0.761		0.684		0.725		0.728		0.799

4.4 Indicators for classroom environment

We could calculate the mean value for each of the 10 scales in CEES, and a large scale sample survey could indicate the baseline for each scale. In this study, we have the assumption that 0-0.4 stands for bad status, 0.4-0.8 stands for normal status, 0.8-1 stands for the idea status, which should be tested in future research. As shown in Fig.4, the yellow line is the status of physical classroom environment in the school. It is easy to see that “A” is in the bad status that should be improved urgently. The psychosocial environment could also be expressed in this way of radar chart.

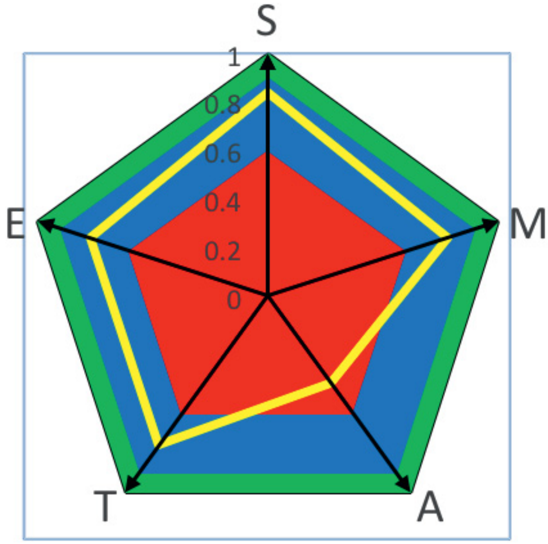


Fig. 4. Status of physical classroom environment

5 Discussion and Conclusion

The findings of this study on classroom environments have revealed several important conceptual and substantive implications for learning environment researchers, administrators and classroom practitioners.

First, SMATE model has been tested the usefulness to design and evaluate the physical aspect of classroom environment. The five dimensions of showing, manageable, accessible, tracking and enhancement could be used as the indicators for the optimization of physical classroom environment, and the five dimensions of TS, IN, IV, TO and CO could be seen as the guidance for the development of psychosocial environment.

Second, Classroom Environment Evaluation Scale (CEES) has been validated with limited samples, and a large-scale survey needed to be done to validate the scale in a broader sense.

Third, both the five indicators of physical classroom environment aspect and the five dimensions of psychosocial aspect could be represented in a radar diagram which could show clearly which dimension is strong and which is weak, and then the school could adopt strategies accordingly.

In order to promote the fully infusion of technology in classroom learning and teaching, the design and evaluation methods for classroom environment become more and more important, which is also one important part of smart learning environment.

Acknowledgements. This paper is supported by the 2012 national project of 12th five year plan for education science “the implementation strategy for cross-cultural synchronous online classroom (ECA120341)”.

References

[1] C. Mouza and N. Lavigne, “Introduction to Emerging Technologies for the Classroom: A Learning Sciences Perspective,” in *Emerging Technologies for the Classroom SE - 1*, C. Mouza and N. Lavigne, Eds. Springer New York, 2013, pp. 1–12.

[2] L. Cuban, *Oversold and underused: Computers in the classroom*. Harvard University Press, 2009.

[3] B. Ramsden, “Evaluating the impact of Learning Space,” *Ref. Serv. Rev.*, vol. 39, no. 3, pp. 451–64, 2011.

[4] JISC, “Designing Spaces for Effective Learning： A guide to 21st century learning space design,” Bristol, UK, 2009.

[5] N. Simsek, “Perceptions and Opinions of Educational Technologists Related to Educational Technology.,” *J. Educ. Technol. Soc.*, vol. 8, no. 4, pp. 178–190, 2005.

[6] P. D. Long and S. C. Ehrmann, “Future of the Learning Space: Breaking Out of the Box,” *Educ. Rev.*, vol. 40, no. August, pp. 42–58, 2005.

[7] J. Yang, R. Huang, and Y. Li, “Optimizing Classroom Environment to Support Technology Enhanced Learning,” in *Human-Computer Interaction and Knowledge Discoversy in Complex, Unstructured, Big Data (LNCS 7947)*, 2013, pp. 275–285.

[8] R. Huang, J. Yang, and L. Zheng, “The Components and Functions of Smart Learning Environments for Easy, Engaged and Effective Learning,” *Int. J. Educ. Media Technol.*, vol. 8, no. 1, 2013.

[9] W. Ng, “Can we teach digital natives digital literacy?,” *Comput. Educ.*, vol. 59, no. 3, pp. 1065–1078, Nov. 2012.

[10] D. Oblinger, *Learning spaces*. EDUCAUSE, 2006, pp. 1–444.

[11] D. B. Zandvliet and B. J. Fraser, “Physical and Psychosocial Environments Associated with Networked Classrooms,” *Learn. Environ. Res.*, vol. 8, no. 1, pp. 1–17, Jan. 2005.

[12] P. Taylor, D. B. Zandvliet, and L. M. Straker, “Physical and psychosocial aspects of the learning environment in information technology rich classrooms,” no. February 2013, pp. 37–41, 2010.

[13] D. Radcliffe, “A pedagogy-space-technology (PST) framework for designing and evaluating learning places,” *Learn. spaces High. Educ. Posit.* ..., 2008.

A New Physical-Digital Environment for Discussion and Presentation Skills Training

Katashi Nagao[1], Mehrdad Panahpour Tehrani[2], and Jovilyn Therese B. Fajardo[3]

[1] Department of Media Science, Graduate School of Information Science, Nagoya University, Japan
nagao@nuie.nagoya-u.ac.jp
[2] Department of Electrical Engineering and Computer Science, Graduate School of Engineering, Nagoya University, Japan
panahpour@nuee.nagoya-u.ac.jp
[3] Department of Information Engineering, Graduate School of Information Science, Nagoya University, Japan
jtfajardo@sqlab.i.is.nagoya-u.ac.jp

Abstract. Our university is currently developing an advanced physical-digital learning environment that can train the students with better discussion and presentation skills. The environment guarantees an efficient discussion among users with state-of-the-art technologies such as touch panel discussion tables and posters. It includes a data mining system that efficiently records, summarizes, and annotates the discussion. It will be further enhanced by using a vision system to facilitate the interactions enabling a more automated discussion mining.

Keywords: learning environment, skill training, discussion skill, presentation skill, discussion mining

1 Introduction

Recently, a lot of attention has been paid to evidence-based research, such as life-logging [1] or big data applications [2], that proposes techniques to raise the quality of human life by storing and analyzing data of daily activities in large quantities. This technique has been applied in the education sector but a key method has not been found yet because it is generally hard to record intellectual activities, accumulate and analyze data in a large scale, and compare it with a person's physical activities, position, movement information, and the like. Although there are some recent studies on the automated recording of intellectual activities in more detail, their techniques are not sufficient to be applied to an automated evaluation of a person's intellectual activities. Thus, this study aims to develop a new environment to empower the skills of students based on the abundant presentation and discussion data analyses.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_5

This study focuses on the new graduate leading program of Nagoya University that aims to cultivate future industrial science leaders (http://www.rwdc.is.nagoya-u.ac.jp/index-e.php). The leading graduate program has a new physical-digital environment for facilitating presentations and discussions among the selected students of the program. In particular, the presentations and discussions of the students are recorded in detail, and the mechanism for knowledge emergence is analyzed based on a "discussion mining" system.

2 Discussion Mining System

The "discussion mining" system generates knowledge discovery from discussion contents during face-to-face meetings. This previously developed system [3], shown in Fig. 1, generates structured minutes for meetings semi-automatically and links them with audiovisual data. This system summarizes discussions by using a personal device, which captures information, called "discussion commander." The created content is then viewed using the discussion browser, which provides a search function that lets users browse the discussion details.

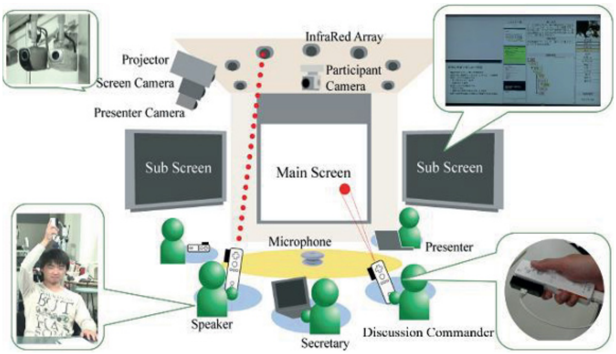


Fig. 1. Discussion mining system

Since it is difficult to apply the discussion mining system to informal discussions and poster presentations, the current system was extended and new facilities were built, which led to the creation of the Leaders' Saloon.

3 Leaders' Saloon: A New Physical-Digital Learning Environment

The Leaders' Saloon shown in Fig. 2 is capable of creating discussion contents using the discussion tables, the digital poster panels, and the wall-size whiteboard.

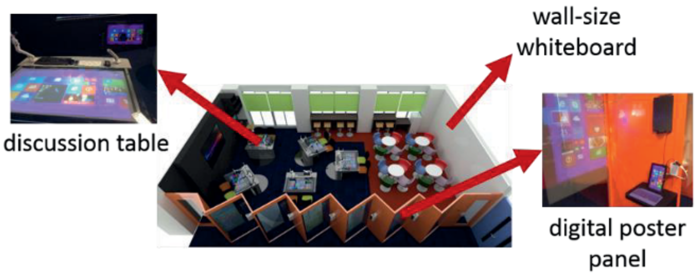


Fig. 2. Leaders' saloon environment

3.1 Discussion Table

Each student uses a tablet to connect with the facilities including the discussion table. The content and operation history of the whiteboard are automatically transferred and shared to the server, the "meeting cloud." Previous whiteboard contents can easily be retrieved and any texts or images can be reused. Such reference and quotation operations are recorded and analyzed to discover semantic relationships between discussions. Furthermore, a software that analyzes temporal changes of the whiteboard contents with the corresponding users is also being developed.

3.2 Digital Poster Panel

For poster presentations, a digital poster panel system is used for content and operation analyses. The system helps the users create digital posters and analyze their creation process. The system also supports the retrieval of previously presented posters and allows the users to annotate them, which are automatically sent to the author and analyzed to evaluate quality. The poster presentations are also broadcasted by streaming on the Web as well as the regular slide-based presentations. The system collects and analyzes the feedbacks from comments and reviews by Internet viewers.

3.3 Discussion Mining

In this study, machine learning techniques are employed to obtain deep structures of presentation and discussion contents. Techniques like deep neural networks integrate several context information such as users' operation histories. By integrating the results of subject experiments on presentations and discussions, different methods to evaluate the quality of students' intellectual activities and to increase their skills are discovered. The system tries to perform some consensus building processes to make evaluation results appropriate for each student.

4 Future Features of the New Learning Environment

The current training environment contains a 2D interactive system, such as touch panel discussion tables and posters, facilitating the interactions of users with the system. However, to further enhance the performance of the current learning environment, a vision system will be incorporated to increase the interaction dimension to 3D. The system will consist of a multi-camera system, or Kinect that has a camera and rang sensor device. Moreover, an automated evaluation and facilitation of intellectual activities will be applied to confirm whether the skills of the students improve, and whether their created contents obtain a higher evaluation than previous ones.

5 Conclusion

A novel physical-digital learning environment for discussion and presentation skills training has been developed at our university under the leading graduate program. By using state-of-the-art technologies, the selected students of the program will achieve an effective, interactive, and smooth discussion with the discussion mining system simultaneously summarizing and annotating the ongoing discussion. The discussion contents are available to the community or to the faculty for evaluation, feedback, and follow-up activities. With this prototype environment, a new education system may emerge promoting an efficient and advanced learning.

Acknowledgements. This work is supported by the Real-World Data Circulation Leaders' Graduate Program of Nagoya University.

References

[1] Sellen, A.J., Whittaker, S.: Beyond Total Capture: A Constructive Critique of Lifelogging. Commun. ACM, vol. 53, no. 5, pp. 70–77 (2010).

[2] Mayer-Schönberger, V., Cukier, K.: Big Data: A Revolution that Will Transform how We Live, Work, and Think. Houghton Mifflin Harcourt (2013).

[3] Nagao, K., Kaji, K., Yamamoto D., Tomobe, H.: Discussion Mining: Annotation-Based Knowledge Discovery from Real World Activities. Advances in Multimedia Information Processing – PCM 2004. LNCS, vol. 3331, pp. 522–531. Springer, Heidelberg (2005)

A Study on the Development of the Smart Classroom Scale

Bao Ping LI [1,*], Siu Cheung KONG[2], and Guang CHEN [1]

[1] School of Educational Technology, Beijing Normal University, Beijing, China
libp@bnu.edu.cn,teastick@gmail.com
[2] Department of Mathematics and Information Technology The Hong Kong Institute of Education, Hong Kong, China
sckong@ied.edu.hk

Abstract. This paper discusses the development and validation of the smart classroom scale (SCS). The SCS is derived from existing technology integration learning environment instruments, including TROFLEI, TICI and CCEI. To accurately describe the smart classroom, the scales of flexibility use of smart classroom, learning data, and learning experience are added to SCS. More than three hundred 11 to 15 years old learners were invited to validate the instrument. Result of the study indicated that there are ten scales of the SCS: Spatial design, Flexibility use of smart classroom, Technology usage, Learning data, Differentiation, Investigation, Cooperation, Learners cohesiveness, Equity, and Learning experience. The Cronbach's alpha reliability of the SCS instrument is 0.902. This shows that SCS is a parsimonious instrument for assessing the technology-rich smart classroom.

Keywords: instrument; smart learning environment; smart classroom; technology-rich classroom

1 Introduction

1.1 Learning environment and the instruments for measuring technology integration learning environments

The learning environments in schools were described as "a classroom or school climate, environment, atmosphere, tone, ethos, or ambience" [1]. Lizzion, Wilson & Simons found perceptions of a good teaching environment influence learners towards deep approaches to studying; and perceptions of teaching environments influence learning outcomes both directly and indirectly [2].

The use of computer in the classroom altered the relationship between teachers and learners. It allows learner more freedom and power to plan and complete his own learning activities, and it also changed the teaching and learning patterns and procedures in school classrooms. In order to describe accurately the new

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_6

characteristic of classrooms with learners using computers for learning, instruments about learning and teaching in classrooms with learners using computers for learning were developed.

Aldridge, Dorman, and Fraser developed the Technology-rich Outcomes-focused Learning Environment Inventory (TROFLEI) which includes 8 dimensions as learner cohesiveness, teacher support, involvement, investigation, task orientation, cooperation, equity, differentiation, computer usage, and young adult ethos [3]. WU et al developed the Technology Integrated Classroom Inventory (TICI) which includes technological enrichment, inquiry learning, equity& friendliness, learner cohesiveness, understanding & encouragement, competition & efficacy, audiovisual environment, and order [4]. Based on the application of portable computers in the secondary school math class, Newhouse developed the New Classroom Environment Instrument (NCEI) including 8 dimensions as involvement, affiliation, teacher support, group work, competition, order and organization, teacher control, and innovation [5]. Zandvliet constructed the Computerized Classroom Ergonomic Inventory to describe the physical environment and equipment of the classroom [6].

1.2 Assessing the characteristics of smart classroom

Smart classroom often described as the technology-rich classroom, equipped with wireless communication, personal digital devices, sensors, as well as virtual learning platforms [7]. The digital facilities enable smart classrooms to be an open learning environment and they provide opportunities for learners to learn in authentic learning context; explore in virtual learning environment as well as provide multichannel for learners to communicate, interact and cooperate. The environment of the smart classroom can stimulate learners' learning motivation and provide opportunities for learners to engage in individualized and social learning activities [8, 9].

Learning in smart classroom emphasizes 1) usage of ambient intelligent technology, 2) support for seamless learning activity, 3) collection and model of learners' data, and 4) authentic learning experiences.

Although smart classroom can be treated as the technology integration classroom, some existing instruments like TROFLEI, TICI could be adopted to assess smart classroom. However, several measurements have not been considered in the existing instruments, such as flexibility use of smart classrooms, adaptive learning support, and offering of authentic learning experience. The exclusion of such distinct features will obscure the characteristics of smart classroom to be fully reflected. The aim of the study is to develop a comprehensive instrument focusing on all the characteristics of smart classroom, as well as addressing the limitation of previous instruments.

2 Method and Procedure

2.1 Instrumentation

This study starts to develop the smart classroom scale by initially gathering salient scales form existing technology-integrated classroom instruments, including Technology-Rich Outcomes-Focused Learning Environment Inventory (TROFLEI), Technology Integrated Classroom Inventory (TICI) and Computerized Classroom Ergonomic Inventory (CCEI).

This study chooses specific scales from various existing instruments in relation to the characteristics of smart classroom. For example, TROFLEI's computer usage scale and TICI's technological enrichment scale measure the application of computer for teaching and learning activities were selected. TICI's inquiry learning, competition & efficacy scales highlight information technology impact on the active, constructive teaching and learning activities and TROFLEI's differentiation scale measures the individualized learning were selected. CCEI's workspace environment scale describes the spatial arrangement of classroom was also selected.

Trickett and Moos described a schema for evaluating the classroom environment in three dimensions: system maintenance and change, personal development, and relationship [10]. This schema is popularly used as the conceptual framework for development instruments of learning environment. The collective scales were categorized into three dimensions of moos schema, as shown in table 1. The items of each collective scale were added into the item pool. If there is more than one scale with identical meaning, only one was retained. For example, TROFLEI's investigation and TICI's inquiry learning have similar meaning; this study selected the TROFLEI's investigation items into the item pool.

Table 1 collective scale from TROFLEI, TICI, and CCEI

Trickett and Moos schema	TROFLEI	TICI	CCEI	Collective scales
System maintenance and change	Computer Usage	Audiovisual environment Technological enrichment	Workspace environment Computer environment Visual environment Spatial environment Air quality	Workspace environment Spatial environment Computer usage
Personal development	Task Orientation Investigation Cooperation Differentiation	Inquiry learning Competition & efficacy		Differentiation Investigation Cooperation

Relationship	Learners cohesiveness Teacher support involvement Equity	Learner cohesiveness Understanding & encouragement Equity & friendliness Order		Learners cohesiveness Equity

Although the collective scales contained the physical environment, the teaching and learning scenarios, and the relationship in smart classroom, some critical feature of smart classroom, such as flexibility use of smart classroom, learner data based pedagogical decision making and adaptive learning support, and authentic learning experience were not included. This study added items in the dimensions of learning data, flexibility use of smart classroom and learning experience into the item pool. Items of the new scales were derived from two approaches: 1) some research for smart classroom, for example, item like “the devices and software help me to get hands-on experience with the learning objects or learning context” was derived from Huang’s study of 4-grade science class in the butterfly garden [7]; and 2) brain storm with experts in domain of smart classroom, for example, the item like “I can find out my learning history, like my homework, and discussions in the last semester”.

Finally, this study constructs the smart classroom scales with 63-items, focus on the physical appearance, teaching and learning activities, and ecology of smart classroom, as shown on table 2.

Table 2. Description of the SCS

Scale	Description	Sample of Item
Spatial design	The extent to which the spatial area, furniture equipment, and information technology infrastructure of smart classrooms	I have adequate workspace for putting textbooks, tablet PCs and other resources.
Flexibility	The extent to which the flexible support for users by classroom environment	The classroom can be a theater, a group working place or other scenes for different learning purposes.
Technology usage	The extent to which learners use information technology as a tool to learn and to access information.	I deal with my assignments using computer or other digital devices.
Learning data	The extent to which the information technology was used to acquire and compute the learn data of the users.	I can find out my learning history, like my homework, and discussions in the last semester.
Differentiation	The extent to which teachers cater for learners differently on the basis of ability, rates of learning and interests.	I can learn at my own pace.
Investigation	The extent to which skills and processes of inquiry and their use in problem solving and investigation are	I carry out investigations to test my ideas.

	emphasized.	
Cooperation	The extent to which learners cooperate with one another on learning tasks	I can cooperate with somebody through Internet in the classroom when doing assignment work.
Learners cohesiveness	The extent to which learners know, help and are supportive of one another.	I help other class members.
Equity	The extent to which learners are treated equally by the teacher.	The teacher gives as much attention to my questions as to other learners' questions.
Learning experience	The extent to which learners' satisfaction and some special learning experience in smart classroom	The devices and software help me to get hands-on experience with the learning objects or learning context.

2.2 Validation of the newly constructed scale

In total, 324 learners age from 11 to 15, in eight classes of 4 primary and secondary schools in metropolitan area of Shenzhen, China were invited to make response to the newly constructed small classroom scale. These four schools are all practicing e-learning for more than one decade. All learners have experience of learning in the one student with one tablet PC learning environment with wireless connectivity.

With the consensus of the school administration, the SCS questionnaire survey was conducted with the targeted learners. The questionnaire contained a cover sheet in recording the details of the survey and learners' information. The survey contained three parts: participants' basic information, response to the SCS questionnaire with experience of existing use of digital technology in classroom, and the response to the SCS questionnaire with preferred classroom environment in the future. The existing practice in classroom asked about the current learning environment; and the preferred classroom environment asked about the ideal learning environment of learners. All questions were measured using a 5-point Likert-type scale with anchors from almost never (scored as 1) to almost always (scored as 5). Seventeen questionnaires were discarded due to incomplete data. Finally 307 learners' responses were used for data analysis.

3 Results

3.1 Psychometric Characteristics of the SCS Instrument

Internal reliability was tested using the individual learner as a unit of analysis for the Cronbach's alpha coefficient. As shown in table 3, the Cronbach's alpha coefficient of existing practice in classroom of the SCS is 0.902 and preferred classroom environment of the SCS is 0.954. The Cronbach's alpha coefficients of each dimension of existing practice in classroom of the SCS ranged from 0.584 to 0.854, and the Cronbach's alpha coefficients of each dimension of preferred classroom environment of the SCS ranged from 0.547 to 0.901. Besides flexibility use of smart classroom, the Cronbach's alpha coefficients of all dimensions in both existing practice in classroom and preferred classroom environment forms of response are all higher than 0.7.

Table 3 Summary of measurement scales

Scale name	Items	Cronbach α		Mean		Standard Deviation	
		Exist.	Pref.	Exist.	Pref.	Exist.	Pref.
Spatial design	4	0.711	0.846	13.52	18.68	3.41	2.68
Flexibility	3	0.584	0.547	8.75	13.21	3.06	2.42
Technology usage	4	0.854	0.859	12.40	18.03	4.78	3.45
Learning data	4	0.702	0.717	9.77	17.09	4.24	3.42
Differentiation	4	0.767	0.882	9.92	17.85	4.11	3.45
Investigation	5	0.818	0.901	14.63	21.42	4.92	4.82
Cooperation	4	0.719	0.810	11.44	17.70	3.84	3.29
Learners cohesiveness	4	0.812	0.895	16.56	19.06	3.17	2.14
Equity	4	0.786	0.825	14.76	18.55	3.62	2.60
Learning experience	3	0.741	0.769	10.60	14.12	3.02	3.59

3.2 Verification of the instruments

The results of exploratory factor analyses (EFA) on the Existing and Preferred Forms of the SCS were shown in table 4. A principal components analysis with varimax with Kaiser Normalization rotation yielded 10 factors for the existing form of SCS. These factors accounted for 56.3% and 67.5% of total variance explanation in scores on the existing form of the SCS. Items with Factor loading values below 0.4 on their own scales or greater than 0.4 on each of the other scales were eliminated.

Table 4 Result of EFA

Scale	**Factor Loading**				
	Item1	Item2	Item3	Item4	Item5
Spatial design	0.58(0.79*)	0.72(0.84)	0.76(0.73)	0.55(0.80)	
Flexibility	0.70(0.80)	0.67(0.67)	0.82(0.44)		
Technology usage	0.82(0.78)	0.77(0.78)	0.82(0.80)	0.80(0.83)	
Learning data	0.67(0.79)	0.81(0.59)	0.67(0.70)	0.63(0.63)	

Differentiation	0.64(0.80)	0.81(0.88)	0.78(0.86)	0.69(0.70)	
Investigation	0.68(0.73)	0.70(0.82)	0.73(0.83)	0.74(0.82)	0.65(0.74)
Cooperation	0.72(0.70)	0.71(0.73)	0.68(0.75)	0.75(0.76)	
Learners cohesiveness	0.81(0.84)	0.77(0.87)	0.77(0.82)	0.76(0.81)	
Equity	0.85(0.82)	0.83(0.84)	0.72(0.77)	0.59(0.66)	
Learning experience	0.76(0.71)	0.77(0.61)	0.83(0.69)		

* The numbers are the factor loading of preferred form.

Thus, a total of 39 items in10 factors were extracted, with the KMO 0.858 and total accounting for 62.54% of the explained variance in existing form and KMO 0.902 and total accounting for 68.19% of the explained variance in preferred form. The 10 extracted factors are the same with the proposed 10 factors.

4 Conclusions

This study developed the Smart Classroom Scales (SCS) using data from primary and secondary schools in China. The results of validation support the fact that SCS has a parsimonious structure and sound psychometric properties. Ten scales of spatial design, flexibility use of smart classroom, technology usage, learning data, differentiation, investigation, cooperation, learners cohesiveness, equity, and learning experience, and 39 measurements are included in SCS in order to access learners' perceptions of technology-rich smart classroom. In the future, researchers of this study will revise the items in flexibility use of smart classroom in order to improve its internal reliability, and confirmatory factor analysis will be conducted to the smart classroom scale to test the goodness-of-fit.

References

[1] Fraser, B. J.: Research on classroom and school climate. In D.L. Gabel (Ed.), *Handbook of research on science teaching and learning*. Macmillan, New York(1994)

[2] Lizzion, Wilson, Simons.: University Students' Perceptions of the Learning Environment and Academic Outcomes: implications for theory and practice. *Studies in Higher Education*. 27, 27-51(2002)

[3] Aldridge, J. M., Dorman, J.P., Fraser, B.J.: Use of Multitrait-Multimethod Modelling to Validate Actual and Preferred Forms of theTechnology-Rich Outcomes-Focused Learning Environment Inventory (Troflei). *Australian Journal of Educational & Developmental Psychology*. 4, 110-125(2004)

[4] Wu, Chang, Guo.: The Development of an Instrument for a Technology-integrated Science Learning Environment. *International Journal of Science & Mathematics Education*.7, 207-233 (2009)

[5] Newhouse, C. P.: Teachers' responses and classroom learning environments associated with student access to portable computers. Unpublished doctoral thesis, Curtin University of Technology, Perth, Australia (1998)

[6] Zandvliet, D.B.: The physical and psychosocial environment associated with classrooms using new information technologies-A cross-national study. Unpublished doctoral thesis, Curtin University of Technology, Perth, Australia (1999)

[7] Hwang, G.-J., Chu, H.-C., Shih, J.-L., Huang, S.-H., & Tsai, C.-C.: A Decision-Tree-Oriented Guidance Mechanism for Conducting Nature Science Observation Activities in a Context-Aware Ubiquitous Learning Environment. *Educational Technology & Society.* 13 (2), 53-64 (2010).

[8] Stephen S. Yau, Sandeep K. S. Gupta, Fariaz Karim, Sheikh I. Ahamed, Yu Wang, and Bin Wang.: Smart Classroom: Enhancing Collaborative Learning Using Pervasive Computing Technology. *2003 ASEE Annual Conference and Exposition: Staying in Tune with Engineering Education*.13633-13642 (2003).

[9] Li, B., & Kong, S.C.: Technology intelligence of the smart learning environment: A content analysis of publications in the past decade. In W. Chen, X. Gu & Y.-T. Wu (Eds.), *Proceedings of the 18th Global Chinese Conference on Computers in Education. Chungli, Taiwan: Global Chinese Society for Computers in Education*. 232-233 (2014).

[10]Trickett, E. J., & Moos, R. H.: Social environment of junior high and high school classrooms. *Journal of Educational Psychology*, 65(1), 93-102(1973).

Accelerate Location-Based Context Learning for Second Language Learning Using Ubiquitous Learning Log

Songran Liu, Kousuke Mouri, Hiroaki Ogata

[1] Advanced Technology and Science, The University of Tokushima, Japan
lb90518@gmail.com
[2] Faculty of Arts and Science and the Graduate School of Information Science and Electrical Engineering at Kyushu University, Japan
ogata@gmail.com
mourikousuke@gmail.com

Abstract. It is always difficult to solve the problem that how to help international students to learn second language (L2) out-class seamlessly. This paper considers using social network analysis with learners' location information to accelerate second language (L2) cold-start acquisition in context. This approach is based on the Ubiquitous learning log system called SCROLL. In proposal approach, first of all, when learners go to a new environment and do not know what they should learn there, they check in the location information. Secondly, proposal approach will recommend learning logs for them using social network analysis method based on learners' location information. At last, this paper does the evaluation experiment and discusses the result.

Keywords: context learning· location based· ubiquitous learning

1 Introduction

When international students begin living in new countries or environments, it is essential for them to use their language skills in context. But no matter whether he has learned it before or not, it is too hard to learn or use their second language skills in the real environments and in context. Therefore, how to help international students to learn second language (L2) in context out-class has become to a problem. Additionally, mobile devices can influence how information is gathered and used in education [1]. SCROLL, is developed to let learners to use mobile devices to learn second language in context [8]. When leaners study, SCROLL will record not only the learning contents, but also the learning environment data, like GPS information, temperature, speed, photos, audios, and even battery information. When learners enter the learning environment again, SCROLL will notice learners

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_7

to learn what they should learn. On the other hand, with learners' environment information, SCROLL can analyze learning habits to find similar learners, suitable learning content, and enhance willingness to learn.

But if learner has no learning log or not enough in the environment, SCROLL will not recommend any learning log for him.

This paper aims to accelerate international students' L2 acquisition and application in context using social network analysis method with learners' environment information. In proposal approach, when learners go to a new environment and check in the location information with the name of the location, proposal approach will generate a relationship network with the point of location to find related learners, words, locations. At last, recommend related learning logs for learners.

2 Previous Work and Issues

2.1 SCROLL

SCROLL allows the learners to log their learning experiences with photos, audios, videos, location, QR-code, RFID tag, and sensor data, and to share and to reuse ULLOs with others everywhere and anytime [8]. By this, language learner can record their learning experience whenever and whatever as the Ubiquitous Learning Log Object of SCROLL.

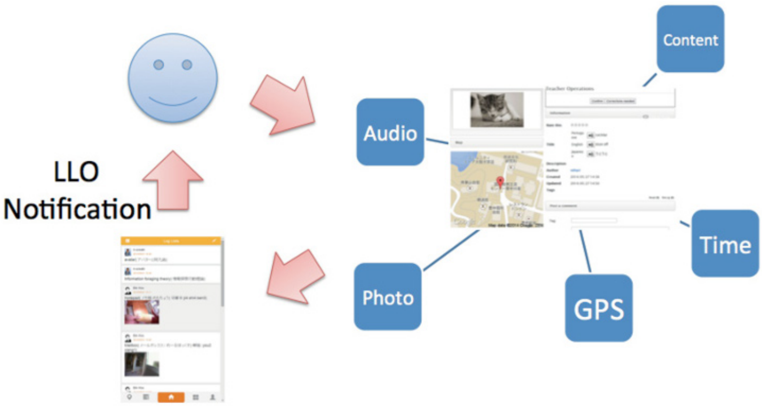


Fig. 1. SCROLL recalls learning contents for learners with LLO Notification.

Fig. 1 shows the LLO notification process to help recalling learning contents. When learn add a learning log to SCROLL, SCROLL will record the environment data. If the learners enter the same environment again, SCROLL will reminder learner that what they have learned there. Like this, SCROLL can help learners learning from their experiences.

2.2 Problems in SCROLL and Proposal Solution

When L2 learners add a log to SCROLL, SCROLL will record the GPS information, learning contents and time at that time.

In SCROLL, when learners go to the same location, SCROLL will remind the log they learned before for reviewing and finding related words.

But, the first time learners enter the new environment and do not know what they should learn, SCROLL will not recommend any learning log for them, until learners add learning log and location data to SCROLL..

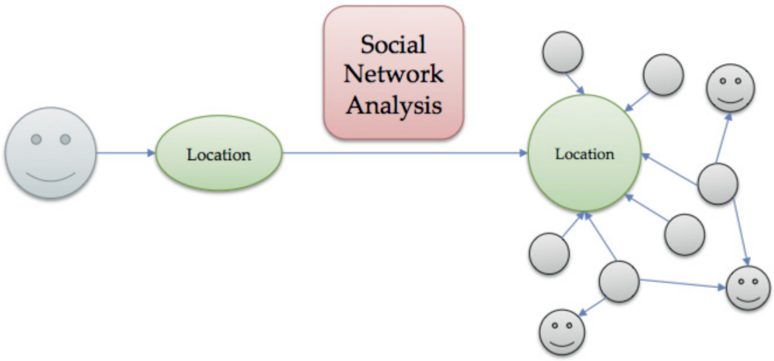


Fig. 3. Proposal Approach Network Chart.

The proposal approach is that when learners do not know what they should learn, they check in the location with the name. SCROLL will find suitable learning log for them using social network analysis method. The network chart of proposal approach is shown as Fig. 3.

When learners do not know what they should learn, they use proposal function to select location information. Then SCROLL will recommend suitable learning contents for them. With proposal function, learners' learning mode can be changed from passive learning to active learning.

Proposal approach will find suitable learning log as follow process.

- Learner check in location information with name;
- Proposal approach find logs that is added at the same place and similar time;
- Proposal approach find related place and suitable logs there;
- At last, proposal approach recommend ULLO list for the learner.

3 Related Works

Social network analysis investigates ties, relations, roles and network formations, and a social learning network analysis is concerned with how these are developed and maintained to support learning [5]. Therefore, a lot of researchers began to focus on using social network analysis to find the relationship between learning contents, learners, learning environment and so on.

Haythornthwaite, C used social network analysis to understand social learning that is based on the network learning "hotseat" discussion. [6]. Haythornthwaite, C also reputed that the most important contribution of social network analysis is this whole network view that takes the results of pair-wise connections to describe what holds the network together. [6]. Thus, it is easy to see the whole view and catch the point of learning network.

Additionally, Martınez, A. has developed a system called Computer Supported Collaborative Learning (CSCL) system for the study of classroom social interactions [7].

In this paper, location information is used as the point of the learning network with social network analysis method to find relations between learners and learning log contents.

4 Method

4.1 Developing Check-in Function

To find learning logs by location information, firstly, it is necessary to get learners' location information where they want to study.

- When learners want to study, but they do not know what they should learn, they open SCROLL, and check in the location.
- Proposal function get location data, and list names of location for learners to select.
- After selecting, the result and time will be saved in SCROLL database.

Fig. 4. Location Informati

In fig. 4, name means the name of the location. Address means the address of the location, type means type of the location. Lat means latitude and longitude means longitude of this location. With these data, proposal function can find similar location for learners.

As we all know, because of the defect of GPS technology in mobile phone, it is too hard to get the exact location data. Thus proposal function make learners to select their location name in a name list instead of determining it by system.

Learners can check in their location in SCROLL with proposal function. What's more, the location data can be prepared to generate the learner-location-content network.

4.2 Find Suitable Learning Contents

After getting learners location information, proposal function will build the network to find similar learning contents for learners with social network analysis.

- Firstly, find learning contents that added at the same place.
- Secondly, find learners who have added the learning contents here before.
- Thirdly, find similar location information with the data in database.
- At last, make up learning content list for learner.

Algorithm flow chart is shown as fig. 5. In third step, until all the similar location and contents are found, this step can be over. If there is the same station and type in two records in database, proposal function consider the two location are similar locations. Then, find the learning contents there.

When learners go to new environments and do not what should learn with SCROLL, they can use proposal approach to check in location information and suitable learning contents list will be recommended for them so that accelerate L2 learning in context.

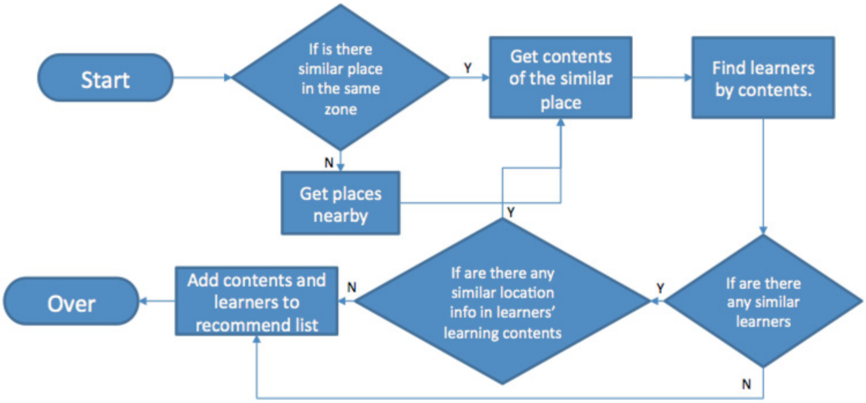


Fig. 5. Proposal Algorithm Flow Chart.

5 Evaluation

5.1 Method

This evaluation experiment has been conducted to find answers to following questions.

- Does this proposal function is helpful for students' L2 learning in context?
- Is the number of logs added by proposal function more than current function?

The participants are 6 international students who are studying abroad in Japan, and learning Japanese. They are not the students in SCROLL yet. Therefore, there is no learning log in their account of SCROLL. The time living in Japan is less than half year. Three of them come from China, another one comes from America, and another one comes from Mongolia, and the last one comes from France. They are all students in the University of Tokushima.

Then, they are divided into two groups, one is a study group which consisted of 3 students, the other was a control group which contains 3 students. They all use SCROLL smart phones version to complete this evaluation. SCROLL in the experimental group includes our proposed function, and the SCROLL in the control group includes only current function. They participated in this experimental evaluation for one week.

5.2 Result

Table 5 shows the number of learning logs in experimental evaluation for each group. And table 5 shows the number of learning location in experimental evaluation.

Table 5. Font sizes of headings. Table captions should always be positioned above the tables.

	Experimental Group	Control Group
Number of Logs	358	164
Number of different Locations	14	9
Average of per location logs	25.57142857	18.22222222

Obviously, in the same period, members in experimental group has added more learning logs than members in control group. In the other words, they learned more Japanese words than members in control group. Additionally, in the same period, more learning locations has been saved in database by experimental group than control group. Members in experimental group went to more place for L2 learning so that they can learn more in context. Therefore, this paper can consider that international student can get a better result for L2 learning in context with proposal function in SCROLL.

There are 4 same places both group have added to SCROLL. Fig.6 shows the 4 places and results.

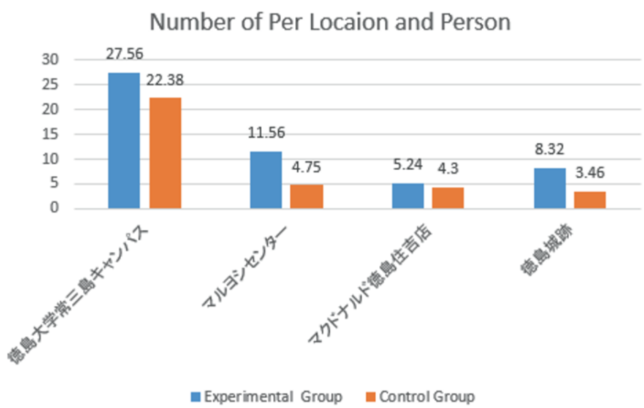


Fig. 6. Proposal Algorithm Flow Chart.

The first one is The University of Tokushima, the second one is a supermarket, the third one is a restaurant, and the last one is a park. Because participants are all international students in The University of Tokushima, Logs at The University of Tokushima is the most. The third one is fast food restaurant near school, participants often went there for dinner. The difference between each group is not so big at the first place and third place. But the number at the other two places is big. To current SCROLL system, the more learners study at the same place, the more SCROLL can recommend learning contents for learners. Therefore, proposal function can help learners learning at new environments.

6 Conclusion and Future Work

When international students go to new environments and do not know what they should learn, this paper uses social network analysis to build a learner-location-content network to find the relations between learners and contents to recommend learning contents for them, so that help them accelerating context L2 learning in SCROLL.

Proposal approach uses location information as the link to build analysis network and find learning contents just with similar location. In future, we should consider learning habit, time, learner profile or more conditions to find more suitable learning content for learners' L2 acquisition.

Acknowledgments

This research work was supported by JST PRESTO, and the Grant-in-Aid for Scientific Research No.25282059 and No.21650225 from the Ministry of Education in Japan.

References

[1] Johnson, Larry, et al. The 2010 Horizon Report. New Media Consortium. 6101 West Courtyard Drive Building One Suite 100, Austin, TX 78730 (2010)
[2] Gemmell, Jim, Gordon Bell, and Roger Lueder. "MyLifeBits: a personal database for everything." Communications of the ACM 49.1 (2006): 88-95.
[3] Vemuri, Sunil, and Walter Bender. "Next-generation personal memory aids." BT Technology Journal 22.4 (2004): 125-138.
[4] Ferguson, Rebecca, and Simon Buckingham Shum. "Social learning analytics: five approaches." Proceedings of the 2nd International Conference on Learning Analytics and Knowledge. ACM, (2010)
[5] Granovetter, Mark. "The strength of weak ties." American journal of sociology78.6 (1973)
[6] Haythornthwaite, Caroline, and Maarten De Laat. "Social networks and learning networks: Using social network perspectives to understand social learning." 7th International Conference on Networked Learning. (2010)
[7] Martınez, A., et al. "Combining qualitative evaluation and social network analysis for the study of classroom social interactions." Computers & Education 41.4 (2003): 353-368.
[8] Ogata, Hiroaki, et al. "SCROLL: SUPPORTING TO SHARE AND REUSE UBIQUITOUS LEARNING LOG IN THE CONTEXT OF LANGUAGE LEARNING."Research & Practice in Technology Enhanced Learning 6.2 (2011).

Adapted E-Assessment System: Based on Workflow Refinement

Fahima Hajjej[1,*], Yousra Bendaly Hlaoui[1], and Leila Jemni Ben Ayed[1]

[1]Laboratory LaTICE, University of Tunis, Tunisia
hajjejfahima@gmail.com, yousra.bendalyhlaoui@esstt.rnu.tn,
Leila.Jemni@fsegt.rnu.tn

Abstract. In this paper, we define a fundamental model of e-assessment in e-learning based on the analysis of the needs of learners and tutors. Therefore, we describe an innovative approach to specify an adapted workflow for flexible e-assessment system. This approach is based on refinements techniques which are specified by UML activity diagram language. Firstly, we propose an e-assessment generic workflow composition based on workflow refinement. Secondly, we provide from a composed generic workflow a flexible e-assessment workflow. We define a flexible e-assessment workflow as an e-assessment workflow tailored to each learner profile. This flexibility is defined by an adaptation workflow refinement. Based on adaptation workflow functions, we define a set of adaptation rules to specify a flexible e-assessment workflow.

Keywords: e-assessment; flexibility; workflow; specification approach; adapted workflow; UML-AD workflow refinement

1 Introduction

The importance of e-learning has considerably grown with the progress of the Internet and the performance of personal computers. The greatest benefit of e-learning is to be capable to take delivery of education in spite of proximity and distance between tutor and learner. However, e-learning faces many challenges and problems which have been reported by works published in [14,15]. Among these problems, the major one is that the number of learners signing up for a course and never finishing it is quite important (between 50% and 80%). As it is mentioned in [14,15], this is due to:

- The need of identification of the real problem or need for analyzing the e-learning problem.
- The poor overall strategic design of the structure of courses.
- The need of detailed instructional design of the e-learning and e-assessment processes and the need of their evaluation and revision.
- The problem of the automatic production, reproduction and distribution of pedagogic resources and modules in e-learning and e-assessment processes.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_8

To fulfill these needs, we propose, in this paper, a generic specification and design approach for e-learning and e-assessment processes based on workflow technology and learner profile adaptability.
As mentioned above, e-learning needs to be more adaptive and flexible to support any kind of learner according to his/her capability. In e-learning process, e-assessment plays a most important role not only to evaluate student knowledge but also to gather student feedback relatively to a learning content. An e-assessment activity is the fact that the learner responds to question given by the tutor to evaluate the learner knowledge. Therefore, in e-learning environment, learning and assessment processes must work together as a complete learning process.
Consequently, we need a solid e-assessment approach to evaluate efficiently the learner knowledge in one hand, and on the other hand to allow tutor to regulate, update and improve his teaching strategy. Such e-assessment approach could not be suitable for all types of learners as they present different knowledge profiles and learning behaviors. Some of them need to be assessed on the complete learning materials to evaluate their overall knowledge. Others may only need to estimate their knowledge at a particular stage of the learning process in order to access to the suitable learning material.
Hence, we need a flexible e-assessment approach which evaluates each learner's knowledge relatively to its learning behavior profile.
To attempt this objective, we propose an approach to specify a generic e-assessment process. We use workflow technology to coordinate different tasks and to model e-assessment process. To specify this e-assessment workflow process, we use UML activity diagram language [2]. Then, our approach is based on a workflow composition by refinement to reduce complexity. In addition, we define a set of refinement rules to adapt the e-assessment process for each learner.
The rest of the paper is structured as follows. In Section 2 we describe steps of our approach. Section 3 illustrates how to build a workflow e-assessment process. In section4, we define a workflow composition by refinement. Section 5 presents a flexible e-assessment refinement. We briefly conclude with the summary of the paper and outline the directions of the further work in Section 6.

2 Generic E-Assessment Specification Approach

We propose a generic approach for the e-assessment to fulfill the need of a strategic design of e-learning and e-assessment process. As mentioned in the introduction, the proposal of this approach is argued by the need of:

- A generic and pedagogic strategy adapted to different learner profiles.
- Standard models of e-assessment process allowing their evaluation and revision.
- Workflow structure and enactment engine to coordinate between different pedagogical modules and learning activities permitting the automatic production, reproduction and distribution pedagogic resources and modules.

Therefore, we propose a generic e-assessment specification approach based on the following steps:

- ***Step1: Generic E-assessment workflow:*** consists of describing the generic workflow model of e-assessment process. At this step, we analyze the existed LMSs and we identify their main and common activities or tasks. Then, we use a workflow technology for coordinate these activities, in order to acquire a workflow e-assessment process. As we could not separate the e-assessment process from the learning process, we propose to specify both of them in a same workflow pattern. To express and specify this e-assessment workflow process, we use UML AD [2] as a standard modeling Language.
- ***Step2: Refinement for composition of e-assessment Workflow:*** from step1 we get a generic e-assessment workflow. This workflow is composed of an important number of activities. We propose in this step an e-assessment workflow refinement. This refinement allows reducing the complexity and facilitating the management and analysis of this generic workflow.
- ***Step3: Refinement for e-assessment workflow flexibility:*** builds, for each learner, an adaptable and personal workflow relatively to his knowledge level and his availability. This adapting is defined by a set of refinement rules specifying the flexibility of the e-assessment workflow.

3 Generic E-assessment Process

In this section, we provide a generic e-assessment workflow process. To build this generic process, we are brought about following the next steps and activities. Our process to provide this generic e-assessment process is:

- ***Analyze and study the existing LMSs functionality:*** We studied and analyzed a set of existing LMSs (Learning Management System) such as [10,11,12,13] explored the functionalities that they offer to realize the e-assessment process. LMSs provide several e-assessment tools and not a global e-assessment process. Learning Management Systems (LMSs); such as Moodle, OLAT and LAMS.
- ***Collection of e-assessment tasks from exist LMSs:*** In this step we collect the e-assessment tasks used by several LMSs to specifying and define generic e-assessment tasks or activities. A typical e-learning system is represented by the following important concepts: (Student, Teacher, Course Administrator, Course, Content, Class, Goals, Test, Assignment, Assessment, …).
- ***Creation of workflow:*** Define e-assessment process by coordinating specified generic e-assessment activities in a workflow structure. By this we define a generic and an abstraction view of the assessment process. We use workflow technology to have flexible e-assessment systems. A workflow consists of a set of linked activities. It represents an abstract and global view of the work of a person or a group of persons. Therefore, workflow manages, in an abstract manner, the synchronization of e-learning and e-assessment activities of the course development between learners and tutors. This e-assessment workflow model should be a good communication axe between teachers, learners and the e-assessment system.

Due to the lake space, we reduce our e-assessment process to a normal scenario: we try to test learner on each level of training to guarantee its comprehension and to help him to reach a high level of knowledge. In our work, we are interested in the formative e-assessment because learners are more concerned in how they have performed their activities more than to compare their work to other learners. Furthermore, we are interested in the two varieties of question: objective and subjective tests.

As presented in **Fig.1**, the learning starts by choosing his studied course. Then, the e-learning content is composed into smaller parts to facilitate deployment and execution assignment. After the reading of each part, the learner carries out a set of objective test activities. The e-assessment system corrects automatically these activities and gives a score according to the answers of the learner. Learner passes to following part only when it reaches a score determined by the teacher. This score and the interval time of the execution activities are saved into file log. These files help teacher to follow learner behavior. If the result is under the score given by e-assessment system, the system must, for example, allow the tutor to add additional stages for a student to help him exceed her difficulty. In fact, learners need regular feedback in order to know how their performance was evaluated, and how they can improve it, and also how their grades are computed. At the end of the lesson, tutor proposes a set of subjective questions in order to observe the complete view of what a student comprehend from the lesson, as presented in **Fig.2**. If results are under the score given by e-assessment system, the teacher would give more clarification to learner. This, feedback could be presented more frequently for the users who have started to make more mistakes, and feedback can be delayed to slow down students who are answering too quickly and sloppily.

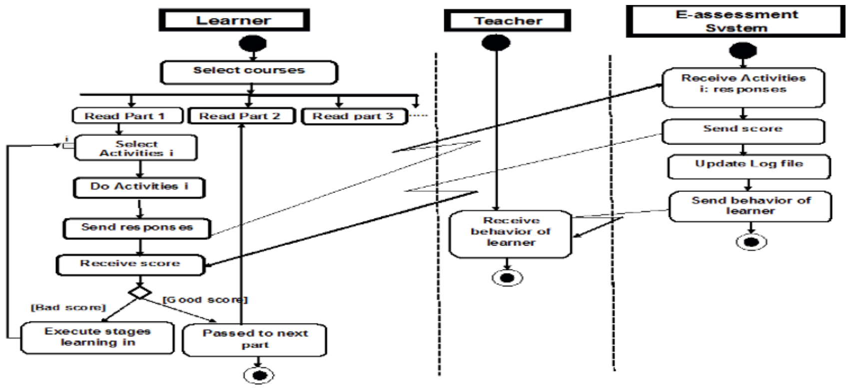


Fig. 1**.** Workflow e-assessment part

After correction of activities, system affects score and updates a file log. Using the generated file log, the tutor will define the design of the following lessons according to the behaviour of individual learner.

- ***Use of standard model notation:*** As we propose a generic approach for the e-assessment, we use UML AD as a standard workflow notation. The use of UML activity diagrams in the description of workflows is argued in several works such as works presented in [5] [4]. Thus, the advantage of UML activity diagrams is that they provide an effective visual notation and facilitate the analysis of workflows composition.

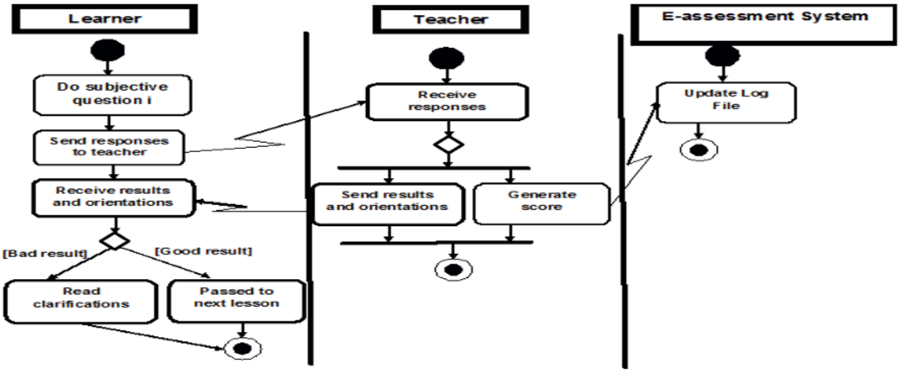


Fig. 2**.** Workflow e-assessment Lesson

4 Generic workflow: refinement for composition

As e-assessment process contains important number of activities, it is considered as one of the most large and complex process. To reduce this complexity and facilitate the e-assessment management and analysis, we propose in our generic specification approach to define the e-assessment workflow through several abstraction levels. Therefore, the e-assessment process is described at a high level of abstraction by a single UML AD activity. It represents the goal of the e-assessment. We consider this activity as a composed activity which will be subject of a series of iterative refinements. These refinements provide details for the e-assessment model. This model specifies the generic e-assessment workflow, presented in **Fig.3**. Thus, we use workflow composition by refinement based on UML activity diagram language [2] inspired form work presented in [7]. In the following, we present the architectural view of the generic approach for detail the refinement process that we use to provide a generic e-assessment workflow.

1) First level of the composition; Abstract level: This level specifies the process e-assessment activity which should be achieved by each learner.

2) Second level of composition; First Refinement: We have use a UML activity diagram to specify the global progression behavior and the work part of both actors: the learner, the teacher and e-assessment system. Each swim line of the activity diagrams represents a role of the workflow actor (teacher or learner or e-learning system). Workflow e-assessment Activity is composed in two alternative sub-process:

- *E-assessment Part*: it consists to test learner on each part of lesson content by using objective tests.
- *E-assessment Lesson*: consists to test learner on the whole of lesson content by using subjective tests.

3) *Third level of composition: Second Refinement:* We refine the workflow *E-Assessment Part* into activities performing the e-assessment for each part of lesson, presented in **Fig.1**. We refine the process *E-Assessment Lesson* into some activity, presented in **Fig.2**.

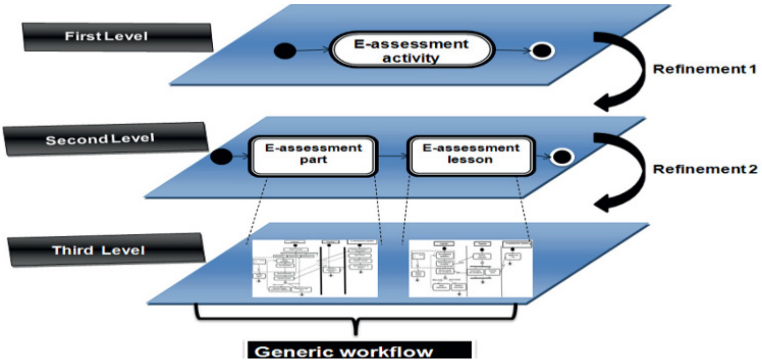


Fig. 3. Refinement for composition

5 Flexible e-assessment workflow

The flexibility of e-assessment systems provides accommodation for the evaluation of different types of learners styles in assessments. Students learning styles contribute significantly to the manner of how they assimilate information during the learning process. This paper is concerned a procedure to formalize and build learners personalized e-assessment. The approach suggests combining learner's dynamic assessment with adaptive course presentation. We observe the user during a learning process and adapt to his progress the learning and assessment materials. If the learner's performance does not meet the pre-defined expectations, the presentation of the course content is adapted to his level of knowledge and selection of the appropriate assessment content is then performed. Each learner is therefore able to get a highly personalizes course appropriate to his level of knowledge. Our approach is suitable for individual learners tacking a self study distance learning course. Generally, the level of assimilation of each learner is not the same. Thus, the number and the kind of e-assessment activities and the courses contents are not similar. The delivering of the same e-learning workflow model to different learners is not adapted to the specific needs of personal learners. In fact, to specify an adaptive and flexible e-assessment workflow, we need to provide an e-learning content according to a particular learner's needs, therefore a personal and adapted workflow model. Consequently, we propose to refine the generic e-assessment workflow in order to adapt it for each learner profile (Fig.4). This refinement is on a number of refinement rules such: ***AddAC***, ***DelAC*** and ***EditAC*** based on the knowledge learner and some exception. We define three *refinement rules* based on the following refinement functions: ***AddAc***, ***DelAc*** and ***EditAc***. Applying these functions on a generic workflow, we provide an adapted e-assessment workflow relatively to the learner profile. An adaptation rules is defined as follows:

if ***Condition*** *then* ***Action***

Where *Condition* specifies a criteria choice of the adapted rule and the *Action* represents the adapting action based on the relative adaptation function.

Next, we detail the role and the choice criteria of each of these functions.

1) ***AddAc****:*

a) *Choice criteria*: When a learner has difficulty in such part of the course content or he wants to be moreover evaluated in such part, we can insert a new activity which makes him to concrete his needs.

b) *Description*: Insert a new activity in a generic or adapted workflow *W*:

AddAc : $\mathcal{W} \times \mathcal{A}c \rightarrow \mathcal{W}$

$$(\mathcal{W}i, AC) \rightarrow \mathcal{W}f$$

Here, $\mathcal{W}$ represents a set of generic and adapted e-assessment workflow. $\mathcal{A}c$ is a set of standards activities such Do question, send activities, send result… .

2) ***Del Ac****:*

a) Choice criteria: Our e-assessment approach is flexible and can treat exception. For example, when the teacher builds a work plan, he can stop possible assistance points besides pertinent points (necessary for tutoring).

b) Description: Delete activity from workflow.

Del Ac : $\mathcal{W} \,/\, \mathcal{A}c \rightarrow \mathcal{W}$

$$(\mathcal{W}i, AC) \rightarrow \mathcal{W}f$$

3) EditAc

a) Choice criteria: If the teacher detects that the same exception arises at the same point in all workflow cases (the learners meet the same problem) then he can decide to modify the process model. It should be noted that adapted workflow can be constructed using the proposed rules. Then an adapted workflow is generated by applying the three rules.

b) Description: Modify one or some activities of workflow.

DEdit Ac : $\mathcal{W} \times \mathcal{A}c \times \mathcal{A}r \rightarrow W$

$$(\mathcal{W}i, AC, AR) \rightarrow \mathcal{W}f$$

$\mathcal{W}f$ is the workflow results from replacing AC by AR.

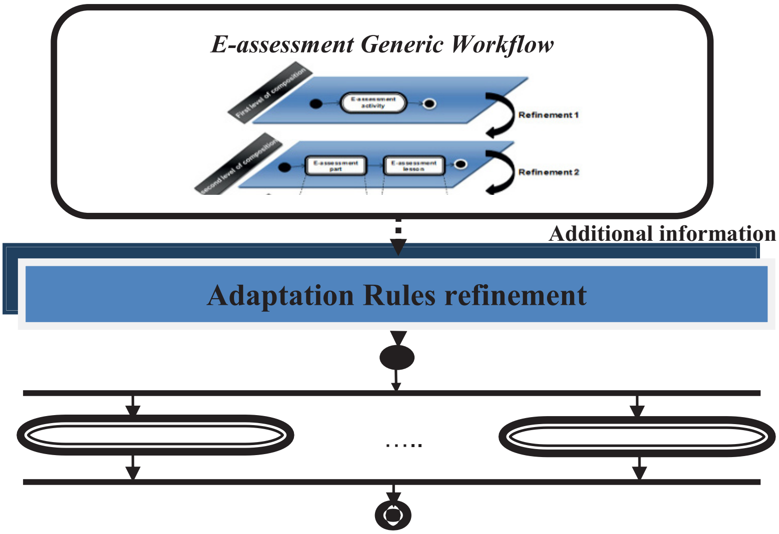


Fig. 4. Flexible workflow refinement

6 Conclusion And Future Work

In this paper, we have proposed a generic e-assessment approach based on flexible workflow for adaptation individual profile learner. We have specified the workflow model by a standard modeling language, the UML activity diagram language. We have used in our approach an UML-AD refinement technique for modeling and describing workflow applications. Based on this refinement, the first step of the approach provides an UML-AD specification of a generic workflow. In the second step, we have defined a set of adaptation rules to achieve an adaptable workflow for each learner. As future work, we plan to continue with the implementation of our approach to more improve our idea in flexible e-assessment system.

References

1. K. Scalise, B. Gifford, "Computer-Based Assessment in E-Learning: A Framework for Constructing "Intermediate Constraint" Questions and Tasks for Technology Platforms", The Journal of Technology, Learning, and Assessment, Vol. 4, No. 6. (2006)
2. OMG, Unified Modeling Language Specification, http://www.omg.org , March 20003.
3. C. M. Chen, H. M. Lee and Y. H. Chen, "Personalised e-learning system using item response theory," Computers & Education, vol. 44, pp. 237 - 255, 2005
4. A. B. Younes, L. J. B. Ayed, and Y. B. Hlaoui, "UML AD Refinement Patterns for Modeling Workflow Applications", in Proc. COMPSAC Workshops, pp.236-241, 2012.
5. Y. B. Hlaoui, and L. J. B. Ayed, "Toward and UML-based composition of grid services workflows", in Proceedings of the 2nd international workshop on Agent-oriented software engineering challenges for ubiquitous and pervasive computing, Sorrento, Italy, 2008.
6. L. Cheniti-Belcadhi, N. Henze and R. Braham. "An Assessment Framework for eLearning in the Semantic Web," Proceedings of the Twelfth International GI- Workshop on Adaptation and User Modeling in interactive Systems, ABIS 04, pp. 11-16, October 2004, Berlin.
7. P.Stalljohann, D.Herding and U.Schroeder: "Utilizing a Workflow Engine to Manage Semi-automatic Correction Processes across Domains" 14th International Conference on Interactive Collaborative Learning (ICL 2011): Piestany, Slovakia, 21-23 September 2011.
8. E.Altenbernd-Giani, U.Schroeder and P.Stalljohann: "eAIXESSOR : a modular framework for automatic assessment of weekly assignments in higher education" In: Proceedings of the Seventh IASTED International Conference on Web-Based Education : March 17 - 19, 2008, Innsbruck, Austria.
9. N.Vivekananthamoorthy and K.Sarukesi. "Enhancing effectiveness of e-learning framework using UML modeling and Self Regulation: A Case Study". *International Journal of Computer Applications* 48(6):49-56, June 2012. Published by Foundation of Computer Science, New York, USA.
10. OLAT Project, University of Zurich, Switzerland, http://www.olat.org, 1999.
11. Moodle project, Moodle Developper Documentation(Nov 2006), http://docs.moodle.org
12. Florian Gnägi: Olat 4.0 – Overview of functions, University of Zurich (Nov 2005), http://www.olat.org/downloads/material/OLAT_4_0_Overview_of_functions_v15.pdf
13. LAMS Project, http://www.lamsinternational.com
14. Gary Woodill (2004), "Where is the learning in elearning?" Operital Corporation, 2004.
15. Geoff Norman, "Effectiveness, efficiency, and e-learning," Adv in Health Sci Educ (2008) 13: pp. 249-251.

An Initial Development and Validation of Tablet Computer Familiarity Questionnaire

Xiaoxia Zheng[1], Wei Cheng[12], Bing Xu[1], Guang Chen[123]*, and Ronghuai Huang[123]

[1]School of Educational Technology, Faculty of Education
[2]Collaborative & Innovative Center for Educational Technology (CICET)
[3]Beijing Key Laboratory of Education Technology
Beijing Normal University, Beijing, China
{zhengxxbnu, chengweiet007, junexu216, teastick, ronghuai.huang}@gmail.com

Abstract: In the past few years, the advances of the tablet computer have captured the imagination of the educators all around the world. The determination of the tablet computer familiarity is an important issue. There were some computer familiarity questionnaires or scales developed in the past studies; however, the questionnaire of tablet computer familiarity was not concerned yet. The purpose of this study was to develop a tablet computer familiarity questionnaire. 409 college students took part in this study. According to the item analysis and the exploratory factor analysis (EFA), there were 32 items under 5 factors in the questionnaire. The Cronbach's alpha coefficient of the questionnaire was 0.916 and the Pearson's correlation coefficient was acceptable. In other words, the reliability was suitable. Further discussion would be given regarding to the questionnaire.

Keywords: Tablet Computer, Familiarity, Questionnaire

1 Introduction

In the past few years, tablet computers (such as Apple iPad, and Microsoft Surface) became one of the most important mobile devices in our daily life, was widely used in the teaching and learning all around the world. Tablet computer has come to be viewed as not just a new category of mobile devices, but indeed a new technology in its own right-one that blends feature of laptops, smartphones, and earlier tablet computers with always-connected Internet, and thousands of apps with which to personalize the experience.

Many policymakers, and the school leaders regarded the tablet computer as an ideal teaching and learning devices and encouraged the teachers and students to apply the tablet computer into the class. Thus, nowadays, many educational institution

*Corresponding author: Guang Chen
Email: teastick@gmail.com

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_9

and K-12 school have been using tablets as a cost-effective alternative to the notebook when carrying out the one-to-one technology-enhanced learning[1]. However, some studies indicated that the tablet computer would be the potential issue of the technology in the class and had a negative effect on the performance[2][3] of the teachers and students who were unfamiliar with it. So we should determine the tablet computer familiarity of the teachers and students.

There is not any questionnaire that has been particularly developed to measure tablet computer familiarity and for which validity and reliability have been proven. However, there were some computer familiarity questionnaires or scales developed in the past studies. With the widespread use of the computer in the language examinations (such as TOEFL, GRE), many researchers[4][5] have developed the questionnaires of computer familiarity and studied the relationship between computer familiarity and performance on computer-based TOEFL test tasks[6][7]. In their research, they developed the computer familiarity from four aspects: access, attitudes, experience or use, and related technology. There were 23 items include access or where use computers, self-assessment of attitude and ability, use of and experience with computers, and use of and experience with related technology. Goldberg and Pedulla [8] studied the performance differences according to test mode and computer familiarity on a practice graduate exam. The computer familiarity questionnaire was 31 items dealing with the participants' familiarity with specific computer hardware and software and the frequency with which they used various computer skills. Researchers [9] developed a Computer Aversion, Attitudes, and Familiarity Index (CAAFI). There were 10 items of the computer familiarity aspect. Yu[10] developed the computer familiarity questionnaire (CFQ) with five categories and 33 items. The five categories included assess/availability to computers, attitude to and ability of using computers, with computer-related technology, use of and experience with computers, problem solving when encountering difficulties. In summary, the computer familiarity questionnaire mainly included six aspects: access/availability to table computers, attitude to tablet computers, ability of using tablet computers, use of and experience with tablet computers, with tablet computer-related technology and problem solving when encountering difficulties.

As we know, the tablet computer has many characteristics that are different from the computer and will affect learning and reading performance. For example, the interactivity (multi-touch) and flexibility (easy to get the content) of the tablets will change the paradigm of reading and learning[11]. With significantly larger screen and richer gestured-based interfaces than their smartphone predecessors, the new tablet computers are ideal tools for sharing and getting content, videos, images, and presentations because they are easy for anyone to use, visually compelling, and highly portable. Therefore, it may be not suitable to use the computer familiarity questionnaire or scale directly to determine the tablet computer familiarity. So this study is to develop a tablet computer familiarity questionnaire, and confirm the validity and reliability in order to specify a tablet computer familiarity.

2 Methods

2.1 Participants

The participants of this research consisted of 409 students (287 females and 122 males) in different specialties, and they were all sophomore or junior students from 20 to 23 years olds (M = 22.25) in Beijing Normal University. Since all the students obtained education for twelve years, they do not have any trouble in reading. 135 participants were included in the item analysis, 150 participants were for the exploratory factor analysis, and 124 participants were for test-retest.

2.2 Development Process of the Questionnaire

The Development of Item Pool

We performed an initial literature review about computer familiarity and how computer familiarity influence reading or language exam[5]. By brainstorming, we adapted the items about the computer familiarity and developed the item pool included 46 items in six aspects: access/availability to table computers (6 items), attitude to tablet computers (10 items), ability of using tablet computers (12 items), use of and experience with tablet computers (7 items), with tablet computer-related technology (5 items) and problem solving when encountering difficulties (6 items). A five-point Likert type questionnaire method was used to each item's options, and they were organized and graded as “Strongly agree” (5), “Agree” (4), “Neutral” (3), “Disagree” (2), “Strongly disagree” (1).

Experts Review

First draft questionnaire was prepared to form and examined by three experts. Two are experts in the field of education technology who affirmed the validity of items and the questionnaire form's structure, and one is a linguistic expert who asserted the expression of the questionnaire form was articulate.

Procedure and Data Analysis

Firstly, the first draft questionnaire was examined online by 135 participants. An item analysis was conducted with the aim of determining how well the items discriminate between individuals with high familiarity and individuals with low familiarity. In this version, 46 items were demonstrated in random order and we carried out items validity analysis on the data collected. From the result, we removed 7 items which could not discriminate differences between individuals. There were 39 items left in the questionnaire with 31 positively formed items and 8 negatively formed items.

Secondly, the revised questionnaire was examined online by 150 participants. The exploratory factor analysis was carried out on the data collected in order to examine the structure of the questionnaire form. Initially, the principal component analysis was conducted to determine the number of factors and the factor structure. In addition, the Promax method was used to do factor rotation in the subsequent analyses, because it is most appropriate method for correlated factors. We removed 7 items.

Thirdly, the final adapted questionnaire was applied to 150 participants in order to implement the reliability. We tested the internal consistency level of the questionnaire. Four weeks later, 124 of the 150 participants completed the retest. The Cronbach's alpha reliability coefficient was calculated to test the internal consistency level. Test-retest reliability coefficient which showed the consistency of the measure from one time to another was calculated, as well.

3 Results

3.1 Item Analysis

With the purpose of determining how well the item discrimination of the items in the questionnaire was, the item analysis was conducted on the data collected with 135 participants. The sample *t* test was carried out to observe the differentiation between the lowest 27% of groups and the highest 27% of the groups after sorting raw scores obtained from the item forms the highest to the lowest. From results, there were 7 items in the questionnaire no significantly discriminated the individuals belongs to the lower and higher groups. So, there were 39 items left in the tablet computer familiarity questionnaire.

3.2 Exploratory Factor Analysis

In this session, firstly, we performed KMO and Bartlett test analyses. The KMO coefficient was .857 the χ^2 from the Bartlett was 3076.460 (p <.001). It suggested that the data was appropriate for the factor analysis. So the principal component analysis was carried out in the subsequent analysis. It can be concluded from the scree plot of the factors' eigenvalues that the questionnaire had a five-factor structure, which the total variance explained was 52.300%. Furthermore, we rotated the factors by Promax to calculate the factor loads. As a result, there were 7 items (Item 6, 8, 15, 17, 27, 30 and 33) in the questionnaire should be removed because these items cannot meet the requirement that the factor load value should be higher than .40 and the differences of between the factors load values should not be lower than 0.10.

Then, we found that the revised questionnaire with the 32 remaining items had a five-factor structure accounting for 45.381% of the total variance after rotated, and the factor load values ranged from 0.418 to 0.897. Since the value of the variance between 40% and 60% was claimed to be sufficient for social science studies, this questionnaire was within the acceptable limits. The contents of the remaining items in the factors were examined and the five factors were named based on the literature review and the aspects of tablet computer familiarity we came up with before. The factors' names can be showed as follows: ability of using tablet computers (F1), use of and experience with tablet computers (F2), availability to tablet computers (F3), use tablet computers for entertainment (F4) and problem solving when encountering difficulties (F5). The results of factor analysis could be shown in Table 1. Compared with the aspects of tablet computer familiarity we came up with before, the aspect named "computer related technologies" was removed and a new aspect named "use tablet computers for entertainment "was added, we think this difference may be caused by the unique product feature of tablet computer and we will discuss it more in the later discussion.

Table 1 Factor analysis results of the questionnaire as per factors

Statement	F1	F2	F3	F4	F5
2. I think tablet computer is easy to use.	0.437				
3. It is difficult to edit text by tablet computer.	0.418				
9. I do not know how to navigate information by tablet computer.	0.753				
11. I always try to get out by myself when in trouble with tablet computer.	0.571				
14. I am skilled at using tablet computer to get in touch with my friends.	0.642				
18. I'd like to try new apps on tablet computer.	0.460				
24. I do not know how to use tablet computer to watch videos.	0.595				
28. I am skilled with listen to music by tablet computer.	0.659				
32. I know how to download apps by tablet computer.	0.597				
35. I know how to uninstall apps on tablet computer.	0.769				
36. I know how to set up tablet computer into existing network.	0.780				
37. I know how to update the OS and apps on tablet computer.	0.673				
38. I know how to import files into tablet computer.	0.630				
39. I know how to set up personalized settings for tablet computer.	0.855				
1. I usually use tablet computer.		0.719			
4. I always browse the Web on tablet computer.		0.818			
5. I always use e-Reader to read (such as Amazon Kindle).		0.546			
10. I usually use tablet computer to read e-Book.		0.552			

13. I prefer tablet computer to computer.		0.564			
22. I already have a tablet computer.		0.672			
25. I often use tablet computer to listen to music.		0.897			
29. I rarely use tablet computers to watch videos.		0.516			
31. I do not like listening to music by tablet computers.		0.601			
34. I like logging in QQ and microblog on tablet computer.		0.450			
19. I am a tablet computer gaming master.			0.789		
20. I always use tablet computer to play games.			0.773		
23. I prefer to use tablet computer to play games.			0.507		
7. I can get a tablet computer anytime I need.				0.543	
12. I would buy a tablet computer anytime I need.				0.455	
16. I always refer to help docs when being stuck with an app.					0.555
21. I always surf the internet to find out solutions when stuck.					0.427
26. I always try to restart the tablet computer when it crashes.					0.480
Eigenvalue	10.588	3.300	1.524	1.245	1.042
Explained variance	27.148	8.461	3.908	3.193	2.671

3.3 Internal Consistency Reliability

In order to test the internal consistency level of the questionnaire, Cronbach's alpha coefficients were calculated. It was found that the Cronbach's alpha coefficient regarding all of the 32 items in the questionnaire form was 0.916. And the Cronbach's alpha coefficients related to the factors that constituting the questionnaire ranged between 0.543 and 0.900 and can be presented in the Table 2. The internal consistency level is acceptable because it is higher than 0.7.

Table 2 The result of Internal Consistency Reliability analysis

Factor	Number of items	Cronbach's alpha
F1	14	0.900
F2	10	0.869
F3	3	0.758
F4	2	0.653
F5	3	0.543
Total	32	0.916

3.4 Stability Level

We carried out test-retest to calculate the stability level of the questionnaire. The revised questionnaire with 32 items was re-applied to 124 participants after four weeks. The correlations between the scores after each application were tested using the Pearson's correlation coefficient. The results are summarized in Table 3.

Table 3 Test-retest results of the items in the questionnaire

Item	r	Item	r	Item	r	Item	r

1	0.761**	11	0.437**	21	0.468**	31	0.455**
2	0.396**	12	0.593**	22	0.863**	32	0.290**
3	0.607**	13	0.539**	23	0.454**	34	0.579**
4	0.693**	14	0.569**	24	0.456**	35	0.275**
5	0.539**	16	0.331**	25	0.621**	36	0.533**
7	0.654**	18	0.319**	26	0.425**	37	0.596**
9	0.306**	19	0.681**	28	0.566**	38	0.561**
10	0.579**	20	0.575**	29	0.523**	39	0.504**

**p<.001

As shown in Table 3, each item's correlation coefficients varied between 0.275 and 0.863 and each correlation was significant and positive. That is to say that there was a highly positive correlation between the two applications. So it can be said that the questionnaire can make stable measurements.

4 Discussions and Conclusion

In this study, we developed the item pool with 46 items from the literature. According to the results of the item analysis, it was determined that seven items were removed from the item pool, the other 39 items in the questionnaire had high discrimination power. The construct validity was calculated by the principal component analysis. It was showed that all the items gathered into five factors, and each item had been under their factors. The questionnaire's internal consistency coefficients calculated and it was found that the questionnaire could make reliable measurements. Furthermore, the test-retest process, which was carried out after an interval of four weeks, indicated that the questionnaire scores were stable.

The tablet computer familiarity questionnaire had a five-factor structure: (1) Ability of using tablet computers, (2) Use of and experience with tablet computers, (3) Availability to tablet computers, (4) Use tablet computers for entertainment and (5) Problem solving when encountering difficulties. Now, we can define tablet computer familiarity as not only the ability of, use of and experience with, and availability to tablet computer, but also the use of the tablet computer for entertainment and problem solving when encountering difficulties.

Comparing to what we presume according to literature review, the aspect of the attitude to the tablet computer was adapted, some items on attitude to the tablet computer were gather into the other factors (such as Factor 2: Use of and experience with tablet computer), and the others were removed from the questionnaire. It is deserved for further discussion. The experience of the tablet computer is highly related with the attitude; the discrimination to the questionnaire is low. Use tablet computers for entertainment was gather into a new aspect in the questionnaire. As we know, the tablet computer is a kind of consumer devices. It is always used for entertainment. Although it is easy to use for everyone, it needs highly skill for playing games on tablet computer. All the items of the tablet computer-related technology were removed. It is thought that tablet computer has come to be viewed as not just a new category of mobile devices, but indeed a new technology in its own right-one. In the future, we will do the confirmatory factor analysis (CFA) to confirm the factor structures of the questionnaire.

Acknowledgement

This research was supported by "the Fundamental Research Funds for the Central Universities" (Fund No. SKZZY2013010).

References

[1] L. Johnson, S. Adams Becker, and M. Cummins, "The NMC Horizon Report: 2012 Higher Education Edition," The New Media Consortium, Austin, Texas, USA, 2012.

[2] C. Gong, G. Chen, W. Cheng, X. Yang, and R. Huang, "Potential Issues on Initiatively Utilizing E-Textbooks in K-12 Classrooms," in *Advanced Learning Technologies (ICALT), 2013 IEEE 13th International Conference on*, 2013, pp. 314–318.

[3] W. Cheng, X. Zheng, and G. Chen, "Which is the Best for Reading: Paper, Computer or Tablet PC?," in *Advanced Learning Technologies (ICALT), 2014 IEEE 14th International Conference on*, 2014.

[4] I. S. Kirsch, J. Jamieson, C. Taylor, and D. Eignor, *Computer familiarity among TOEFL examinees*. Educational Testing Service Princeton, NJ, 1998.

[5] D. R. Eignor, C. Taylor, I. Kirsch, and J. Jamieson, *Development of a scale for assessing the level of computer familiarity of TOEFL examinees*. Educational Testing Service, 1998.

[6] C. Taylor, J. Jamieson, D. Eignor, and I. Kirsch, *The relationship between computer familiarity and performance on computer-based TOEFL test tasks*. Educational Testing Service Princeton, NJ, 1998.

[7] C. Taylor, I. Kirsch, J. Jamieson, and D. Eignor, "Examining the Relationship Between Computer Familiarity and Performance on Computer-Based Language Tasks," *Language Learning*, vol. 49, no. 2, pp. 219–274, Jun. 1999.

[8] A. L. Goldberg and J. J. Pedulla, "Performance differences according to test mode and computer familiarity on a practice graduate record exam," *Educational and Psychological Measurement*, vol. 62, no. 6, pp. 1053–1067, 2002.

[9] S. E. Schulenberg and A. M. A. Melton, "The Computer Aversion, Attitudes, and Familiarity Index (CAAFI): A validity study," *Computers in Human Behavior*, vol. 24, no. 6, pp. 2620–2638, Sep. 2008.

[10] G. Yu, "Effects of Presentation Mode and Computer Familiarity on Summarization of Extended Texts," *Language Assessment Quarterly*, vol. 7, no. 2, pp. 119–136, 2010.

[11] S. J. Margolin, C. Driscoll, M. J. Toland, and J. L. Kegler, "E-readers, Computer Screens, or Paper: Does Reading Comprehension Change Across Media Platforms?," *Applied Cognitive Psychology*, vol. 27, no. 4, pp. 512–519, 2013.

[April 10, 2014]

Analysis of Elementary Teachers' Readiness for Smart Learning in Korea

Soo-Young Lee[1,*], and Youngmin Lee[2]

[1] Seoul National University of Education, Seoul, Republic of Korea
sylee@snue.ac.kr

[2] Sookmyung Women's University, Seoul, Republic of Korea
ymlee@sookmyung.ac.kr

Abstract. The study aims to analyze the "smart learning readiness" of elementary teachers in Korea. The readiness for smart learning in our study was measured by multiple facets of elementary teachers' perceptions and practices in the classroom. We sent out the survey to teachers in Seoul and its suburban areas of South Korea, and 422 completed surveys were analyzed. The results showed that 1) the physical readiness of smart learning environments, in terms of the availability of smart devices/media, was low; 2) the professional development opportunities for smart learning were insufficient, and teachers wanted to know how to use smart technologies, devices, programs, and how to design smart learning environments; 3) teachers' expectation level for smart learning was not so high, and less experienced teachers expressed higher expectation than more experienced teachers; and 4) the biggest obstacle to implement smart learning was a lack of sufficient time for teachers to research and prepare for instruction.

Keywords: Elementary Teachers; Smart Learning Readiness; Smart Technologies; Professional Development

1 Introduction

The rapid development of Information and Communication Technology (ICT) has changed every aspect of our life. Over the past 20 years, the digital revolution has changed the way we play, work, and learn. Schools are not an exception to these changes. Yet, the changes from technological advances in schools are often slower than that of other parts of our society. Indeed, it is well known that innovations in schools are hard to achieve. Possible reasons might include the reluctance of school teachers to adopt any sort of changes or reforms, and the rigidness of schools and conservative educational systems [1].

In Korea, the government has since 2011 been driving efforts toward Smart Learning [2]. Based on Korea's strong IT infrastructure, Korean government envisions "anytime, anywhere, ubiquitous education to meet every student's needs." To realize its vision, the Ministry of Education has set action plans that

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_10

include the following topics; 1) developing and distributing interactive digital textbooks in schools, 2) fostering online learning and evaluation systems and infrastructures, 3) free use of educational contents, and cultivating safe environments for those contents, 4) developing smart learning and teaching competencies of teachers, and 5) setting the foundation for cloud services in education. The Ministry of Education defines SMART education as being *S*elf-directed; *M*otivated; *A*daptive; *R*esource-enriched; and *T*echnology-embedded education. In other words, SMART education is not just smart technology-utilized education; rather a reform of educational systems is envisaged that includes educational contents, methods, evaluation, and environments utilizing ICT and networked resources, so that every student can be a global leader who is maximizing his/her potential[2, 3].

Despite these ambitious plans under the national SMART education paradigm, it is not yet certain whether schools and teachers are quite ready for SMART education. To this end, this study aims to analyze the current state of schools and teachers' readiness to adopt, adapt, and implement smart learning.

In particular, we believe elementary schools and teachers are critical for this smart learning innovation due to a couple of reasons. First, elementary schools have more freedom to experiment with innovations than later schooling, since they are further away from university entrance competitions in Korea. Second, younger students are born with, and are more familiar with new technologies (i.e., digital natives). Thus, elementary teachers need to keep catching up with new technologies, and be able to utilize those new technologies in their teaching and learning practices to motivate students and hold the attention of students, who regard it as natural to have instant feedback and immersive interactions in their everyday life.

We designed a survey study to find out to what extent elementary teachers and their school environments are ready for smart learning, and what factors might influence the degree of readiness of the elementary teachers for smart learning in Korea. Due to a page limitation, we will only report partial results from the full survey data.

2 Literature Review

Technology integrations in the classroom have been a hot topic of research interest in the field of educational technology. Well known critical factors that hinder effective technology integration in the classroom include availability and access to computers [4, 5]; teacher beliefs and attitudes [6, 7, 8]; availability of curriculum materials [9]; and technical, administrative, and peer support [9, 10, 11]. Although the availability and access to hardware and Internet in the schools have been a less issue than other obstacles these days, new development of smart technologies requires schools to keep updating and upgrading their technical and technological resources. It leads to a need for ongoing training and support for teachers. Teachers need to keep updating their knowledge and skills of smart technologies and smart learning.

In this study, we investigate "smart learning readiness" in regards to what extent the general barriers of smart technology integration in the classroom have been overcome or remained at the present schools. In other words, we explores to what extents teachers are ready to integrate smart technology in their everyday teaching practices.

3 Research Method

3.1 Subjects

The survey on elementary teachers' smart learning readiness was developed by the authors, and sent out to 450 elementary teachers in Seoul and its suburban areas of South Korea, in the Fall semester of 2013. After cleaning incomplete surveys, a total of 422 responses (346 female and 76 male teachers) were used for statistical analyses. The respondents consisted of 313 BA degree holders, and 109 MA/Ph.D degree holders. Of the respondents, 15.4% had been teaching for less than 3 years, 24.9% had been teaching for 3~5 years, 27.2% had been teaching for 6~10 years, and 32.5% had been teaching for more than 10 years in schools.

3.2 Survey Instrument

The readiness for smart learning in our study was measured by multiple facets of elementary teachers' perceptions and practices in the classroom, including: teaching and learning environments for smart learning in schools, expected outcomes of smart learning, perceived obstacles to smart learning in the classroom, and professional development opportunities for smart learning.

In addition, questions were included in the survey that asked about teachers' previous experiences with ICT integrated instructions; personal use of smart technologies and devices; understanding of smart learning-related policies and research; support from school administrators; attitudes toward computers, ICT integrated teaching and learning in the classroom; and teachers' perception on general education. However, the analyses of these questions were not reported in this paper.

4 Results

4.1 Physical Readiness of Smart Learning Environments in the Classroom

We asked teachers whether the following smart devices are equipped in their classroom for smart learning, and how often they use them. Computers (for teacher use), TVs (for projecting the teacher's computer screen), and printers are prevalent in most schools; but computers for student use, including Tablet PC or Smart Pads, are still rare to find in a regular classroom. Technology use in the classroom seems to still be limited to teacher-directed teaching practices. In addition, for the question asking whether teachers perceive that their classroom is ready for smart learning, 66.5% (n=278) of respondents answered, “No”.

Smart learning does not necessarily mean 1:1 computing. However, recent smart technologies and smart devices/media can allow self-directed, motivated, adaptive, and resource-rich teaching and learning, i.e. SMART education. In particular, interactive digital textbooks require individual smart devices [3]. Thus, it seems that schools are not quite ready to take full advantage of smart technologies.

Most respondents (97.1%) said there is a computer lab in their school; but more than a half (56.5%) responded that they only use the lab 1~2 times per month. Furthermore, 70.0% of respondents reported that there is a computer lab assistant; but their main role is often limited to maintaining computers (70.0%), and introducing/explaining how to use devices and technologies. Only a small number of teachers (5.6%) reported that their computer lab assistant might help them to support ICT integrated instruction, or the development of instructional materials. It is important for teachers to have technical support in the computer lab; but they also need instructional support from technical experts. This means technical assistants need to be trained, and develop expertise in the instructional use of technologies, to support teachers. Also, if each classroom is to be equipped with individual smart media devices, teachers will need technical support in their classroom, as well as in the computer lab. Schools should be aware of these technical support needs in advance, when they move toward smart learning environments.

Table 1. A list of smart devices available in a regular classroom

Rank	Smart devices	N	%
1	Computers for teacher use	416	99.3
2	TV	410	98.1
3	Printer	393	94.0
4	Electronic Board	13	3.4
5	Computers for student use	9	2.3
6	Tablet PC or Smart Pads	8	2.1

4.2 Professional Development Opportunities for Smart Learning

More than a half of teachers (67.9%) responded that they have never had professional development on smart learning. In Korea, professional development (PD) for elementary teachers is quite systematic; there are many topics teachers can choose from, and there are required hours that teachers should complete. However, it seems that PD on smart learning is not yet readily offered to teachers. Of the respondents, only 22.6 % said the opportunities for smart learning PD that they have been given were sufficient. Specific topics that teachers want for PD include: how to use educational software, programs, and Apps for smart learning (44.4%), how to design smart learning environments (28.7%), how to use and maintain smart devices/media (18.7%), and how to use smart learning for student evaluation and management (8.2%).

Online professional development can be a good way to offer smart learning PDs to vast numbers of teachers across the country. It is important for teachers to experience smart learning by themselves as a learner, especially if teachers are not digital natives.

4.3 Expected Outcomes of Smart Learning in the Classroom

The survey asked to what extent teachers agree on the expected outcomes of smart learning in the classroom, using a 5-point Likert scale (5 being strongly agree). On the total score of the expected outcomes, the respondents gave 3.33 on average ($SD = 0.599$). Items for the expected outcomes of smart learning consist of instructional outcomes, Q&A and feedback between teachers and students, communication, interaction, high-ordered thinking skills, such as problems solving and critical thinking, motivation and satisfaction, and knowledge sharing. Teachers expect smart learning will close the gap between excellent students and underachievers. Also, smart learning will be able to solve the problem of educational gap, as well as digital divide among students.

Group differences were analyzed by gender, level of academic degree, and teaching experience. There was no difference of smart learning expectations between men and women teachers ($t=0.794$, $p>.005$), and between BA and MA/Ph.D degree holders ($t=0.138$, $p>.05$). On the other hand, there was statistically significant difference among groups of different teaching experiences [$F(3, 418)=1.713$, $p<.001$]. Tukey's post-hoc test showed that teachers with less than 3 years of teaching experience (i.e., younger teachers) had higher expectations for smart learning than teachers with more than 6 years of experience.

4.4 Perceived Obstacles to Smart Learning in the Classroom

Teacher-perceived obstacles that hinder the implementation of smart learning in the classroom are as follows. First, the survey results revealed that teachers are busy doing miscellaneous work, which is not directly related to classroom teaching. As a result, teachers did not have much time to research and prepare for their instructional practices. This finding resonates with the earlier studies [7], [10].

Second, there are adequate instructional models, curricula, software, and educational materials for smart learning. These are not readily available to teachers. Therefore, teachers feel that they try to change their teaching and learning methods and materials on their own, without sufficient support and guide from the government or educational offices in a district.

Third, it is not so easy to maintain and update expensive smart learning devices/media in the classroom. In the main, the responsibility for managing smart devices and media in the classroom is up to teachers. However, they are not skillful at mending and fixing the devices and media.

Fourth, not all teachers are willing to implement smart learning in the classroom because of several reasons, such as a lack of instructional support, a lack of time for researching and preparing instruction, a required change of a familiar teaching style, and personal and organizational psychological resistance to adopting new learning methods in the classroom. In particular, whenever a new method comes up, a teacher applying it in the classroom is not assured of whether the new method will positively affect the effectiveness of education, compared to traditional teacher-centered instruction.

Fifth, some teachers felt that they are not ready to use and adapt smart devices and media in the classroom, because they do not have sufficient competencies to use smart technologies, knowledge of smart media functions, prior knowledge on teaching and learning in smart learning environments, and previous experiences of taking full advantage of smart technologies.

Table 2. A list of perceived obstacles to implementing smart learning in the classroom

Rank	Perceived obstacles to smart learning	N	%
1	A lack of time for instructional research and preparation, due to unrelated miscellaneous work	124	30.2
2	A lack of adequate instructional models, curricula, or software for smart learning	87	21.2
3	Difficulties in maintaining and updating smart devices/media	85	20.7
4	A lack of willingness to implement smart learning	57	13.9
5	Teachers' lack of ability to use smart devices/media	37	9.0

There was no difference of perceived obstacles between men and women teachers (χ^2=10.380, p>.05). However, there was a statistically significant difference between BA and MA/Ph.D degree holders (χ^2=12.599, p<.05). BA degree holders felt that a lack of time for research and preparation, and a lack of adequate instructional models are bigger obstacles; whereas, MA/Ph.D degree holders saw a skill-shortage of teachers as a bigger obstacle than others.

5 Conclusion

Korea is well known for its strong IT infrastructure across the nation and advanced smart technology workforce. A recent national survey showed that 69% of students of all age (85% of middle and high school students) in Korea possessed their own smart phone [12]. Nevertheless, the results of this study showed that schools are not quite ready for smart learning or SMART education, as defined by the government, and by research. As for all other reforms in education, smart learning innovations cannot be achieved by a single part of the educational system. All key stakeholders, including students, teachers, parents, administrators, community members and the government, should share a common vision for smart learning, and have the chance to freely discuss the pros and cons of smart learning and education in the school. This study has only tapped into the bigger question, by asking teachers what they think and perceive about smart learning. We believe in the high potential of smart learning for better learning and teaching. Classroom-based practical research, as well as theoretical research, should therefore be carried out on topics such as the development of good smart learning materials, instructional models, strategies, methods; PD for teachers and administrators; evidence that shows the effectiveness of smart learning on students' cognitive, affective, and motivational level compared to traditional instructions, and so forth. The implementation of smart learning in the classroom does not simply mean the utilization of smart devices and media. In order for students to experience smart learning, teachers need to design smart learning environments which include not only physical environment but also instructional and emotional learning experiences.

References

[1] Ertmer, P. A., Ottenbreit-Leftwich, A. T.: Teacher Technology Change: How Knowledge, Confidence, Beliefs, and Culture Intersect. Journal of Research on Technology in Education, 42(3), 255 – 284 (2010)
[2] Ministry of Education, Science and Technology.: Smart Education Driving Strategies and Action Plans, Republic of Korea (2011)
[3] National Center for Digital Textbook, Korea Education and Research Information Service, http://dtbook.edunet.net (Korean site) ; http://www.edunet4u.net/engedunet/bs_01_01.html (English site)

[4] Barron, A. E., Kemker, K., Harmers, C., Kalaydjian, K.: Large-scale research study on technology in K-12 schools: Technology integration as it relates to the National Technology Standards. Journal of Research on Technology in Education, 35, 489-507 (2003)
[5] Norris, C., Sullivan, T., Poirot, J., Soloway, E.: No access, no use, no impact: Snapshot survey of educational technology in K-12. Journal of Research on Technology in Education, 36(1), 15-27 (2003)
[6] Ertmer, P. A.: Teacher pedagogical beliefs: The final frontier in our quest for technology integration? Educational Technology Research and Development, 53(4), 25-39 (2005)
[7] Hew, K. F., Brush, T.: Integrating technology into K-12 teaching and learning: Current knowledge gaps and recommendations for future research. Educational Technology Research and Development, 55, 223-252 (2007)
[8] van Braak, J.: Individual characteristics influencing teachers' class use of computers. Journal of Educational Computing Research, 25(2), 141-157 (2001)
[9] Becker, H. J., Ravitz, J.: The influence of computer and internet use of teachers' pedagogical practices and perceptions. Journal of Research on Computing in Education, 31(4), 356-384 (1999)
[10] Cuban, L., Kirkpatrick, H., Peck, C.: High access and low use of technologies in high school classrooms: Explaining an apparent paradox. American Educational Research Journal, 38(4), 813-834 (2001)
[11] Sandholtz, J. H., Reilly, B.: Teachers, not technicians: Rethinking technical expectations for teachers. Teachers College Record, 106(3), 487-512 (2004)
[12] Ministry of Education: Smartphone Ownership Rate of Elementary, Middle and Highschool Students in Korea. Press release, Ministry of Education (2013.07.29)

Analysis of Problem-Posing Process of Arithmetical Word Problem as Sentence Integration: Viewpoint of First Selected Sentence

Nur Hasanah[1], Yusuke Hayashi[1], and Tsukasa Hirashima[1]

[1] Learning Engineering Dept., Hiroshima University, Japan
{nur,hayashi,tsukasa}@lel.hirashima-u.ac.jp

Abstract. We have developed tablet PC-based software for learning by posing arithmetical word problems named MONSAKUN where several sentences are integrated to pose a problem by a learner. We call this type of problem-posing "sentence integration". Based on collected data by past experimental use, we have been analyzing users' problem-posing process as the selection process of the sentences. As the first step of this analysis, we found that the first sentence selected in the process were different in (1) type of approach, (2) type of story and (3) exercise experience. These results are important to make an elaborate process model of the problem-posing and adaptive support of the process.

Keywords: Problem posing, arithmetical word problems, sentence integration, reverse thinking problem, learning analytics

1 Introduction

Learning by problem-posing is well known as an alternative and important way to promote learners' understanding in solving arithmetic problems [1,2]. To realize learning by problem-posing in a practical way, we developed a computer-based learning environment [3]. The software, named MONSAKUN ("Problem-posing Boy"), provides an interactive support for learning arithmetical word problems solved by one operation of addition/subtraction.

The interface of MONSAKUN is explained in Figure 1. A learner is provided with a set of sentence cards and a numerical expression, and then he/she is required to pose an arithmetical word problem by selecting and arranging appropriate cards. Each card contains a number from the provided numerical expression (first, second, or third number). There are four story types in the exercise: combination, increase, decrease, and comparison. Although learners do not create their own problem statements, they are required to interpret the provided sentences and integrate them into one problem, which is the same as ordinary problem-posing activity in essence. This activity is called "problem-posing as sentence-integration" [4].

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_11

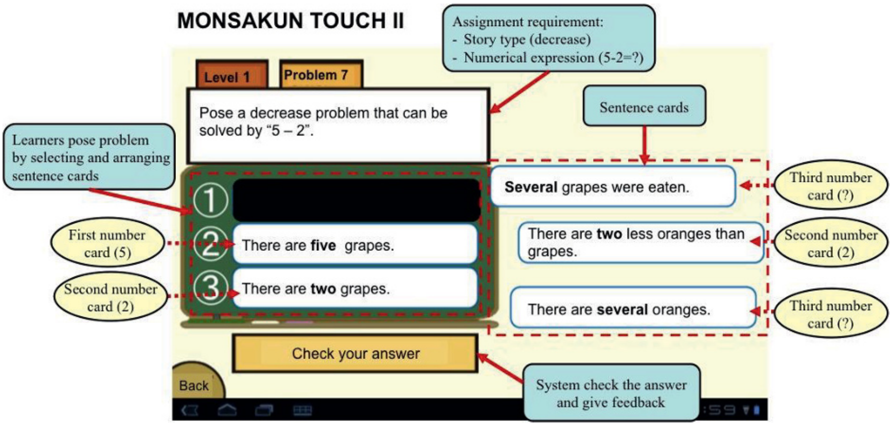


Fig. 1. Interface of MONSAKUN

The practical use of MONSAKUN at several elementary schools has been reported in previous studies [3,4,5]. It has been confirmed that the exercise is effective to improve both problem-posing and problem-categorization abilities. Students and teachers also enjoyed using this system and considered it useful for learning.

While it is difficult to analyze thinking process in a free problem posing activity, we can trace learners' card selection in MONSAKUN which can be considered to reflect their thinking process. In this study, we examine how learners pose arithmetical word problems as sentence integration on MONSAKUN. Our assumption is that learners do not choose sentence cards randomly, but based on some sort of thinking. As the first step toward analyzing problem-posing activity, we especially focus on the type of firstly selected sentence card in each assignment.

2 Analysis of MONSAKUN Log Data

2.1 Difference in First Selected Card between Level 1 (Forward-thinking Problems) and Level 5 (Reverse-thinking Problems)

In this study, the log data of 11 university students using MONSAKUN is analyzed. We focused on subjects' log data in assignments at Level 1 and Level 5 which require them to pose forward-thinking problems and reverse-thinking problems, respectively. In forward-thinking problem, a story represented in the problem has the same structure with the calculation to derive the answer. This type of problem can usually be solved easily by the learners. In reverse-thinking problem, the story and the calculation operation structures are different, so learners are required to understand the problem structure well to pose this kind of problem.

Table 1 shows the proportion of first card chosen by subjects in Level 1 and 5. From the analysis, we found that the proportion of each sentence card to be selected firstly is not even. This shows that subjects did not choose a card randomly, but with some sort of approach.

Table 1 Percentage of first selected card by the subjects

Type of first selected card	Level 1 (%)	Level 5 (%)
First number card	91.8	58.7
Second number card	3.3	16.5
Third number card (question mark)	4.9	24.8

Furthermore, there are different trends between Level 1 and 5. We presume that subjects had different approach to pose either forward-thinking or reverse-thinking problems. In forward-thinking problem, the approach to choose cards by the order of numbers in the numerical expression can be applied easily. However, in reverse-thinking problem they cannot easily pose problem with the same approach. This type of problem requires learners to think about the numerical relation in the given problem and reflect it to the choice of cards.

2.2 Change of Approach through the Exercise

In this section, we would like to explain further how the subjects change their way of thinking during problem posing exercise by looking at the type of story, order of assignment, type of first selected card, as well as the type of sentence.

Table 2 shows the characteristics of first selected card from each assignment at Level 5 that has marginal/significant difference in number of selection from the average. These results were analyzed with binomial test to the amount of each card chosen in each assignment. Based on our assumption that students posed problems by selecting cards through a thinking process, we expect the distribution of first selected card to have a significant difference in comparison with other cards.

During simple forward-thinking problems exercise at Level 1, we found that subjects' initial approach is to simply choose a card with the first number in the required numerical expression. In reverse-thinking problems exercise at Level 5, they firstly did the assignment with the same initial approach. However, this did not work well, and they tend to make more mistakes than in the previous levels. We presumed that the subjects were aware that the previous approach of choosing first number card did not work for reverse-thinking problems, because in the second assignment of Level 5 they tend to choose another type of card. We could observe from Table 2 that subjects changed their approach from the first assignment in a type of story to the second and third assignment in the same type of story.

This leads to two findings about changes in subjects' way of thinking through the exercises. The first one is that subjects change their approach to pose problems after they had experienced posing the same type of story. The next finding is that the change of approach depends on the type of story, as we can see that subjects made different first card selection in different story type.

Table 2. Result of binomial test of first selected card in Level 5 assignments

No	Type of story	Order of assignment	Type of first selected card	Type of sentence	p-value	
1	**Combination**	1st	*First number card*	*Existence*	$7.05*10^{-5}$	**
2		2nd	First number card	Relational	$1.88*10^{-7}$	**
3		3rd	First number card	Relational	$1.97*10^{-3}$	**
4	**Increase**	1st	*First number card*	*Existence*	$1.89*10^{-5}$	**
5		2nd	Second number card	Existence	0.0504	+
6		3rd	*First number card*	*Existence*	0.0504	+
7	**Decrease**	1st	*First number card*	*Existence*	$2.35*10^{-4}$	**
8		2nd	Second number card	Existence	$2.35*10^{-4}$	**
9		3rd	Second number card	Existence	$2.35*10^{-4}$	**
10	**Comparison**	1st	-	-	-	
11		2nd	Third number card	Relational	0.0266	*
12		3rd	Third number card	Relational	0.0266	*

**: significant difference (p<.01), *: significant difference (p<.05), +:, marginal difference (p<.1)

3 Concluding Remarks

In this research, we have conducted analysis of university students' problem posing activity to investigate their way of thinking in posing arithmetical word problems. From the analysis, we found that the first sentence selected in each assignment were different in several ways depending on the type of story and subjects' exercise experience. Furthermore, we infer that users of MONSAKUN were able to recognize the differences in problem structure depending on type of story, as they changed their approach to pose problems for different story types.

For the next step of this research, we plan to perform the analysis to a larger data of MONSAKUN use by elementary school students. The result will be used to make an elaborate process model of problem-posing and adaptive support of the process.

References

[1] Polya, G: How to solve it, Princeton University Press (1957)
[2] Ellerton, N.F.: Children's Made Up Mathematics Problems: A New Perspective on Talented Mathematicians. Educational Studies in Mathematics, Vol.17, 261-271 (1986)
[3] Hirashima, T., Yokoyama, T., Okamoto, M., and Takeuchi, A.: Learning by Problem-Posing as Sentence-Integration and Experimental Use. Proc. of AIED2007, 254-261 (2007)
[4] Hirashima, T., Kurayama, M.: Learning by Problem-Posing for Reverse-Thinking Problems, Proc. of AIED2011, 123-130 (2011)
[5] Yamamoto, S., Kanbe, T., Yoshida, Y., Maeda, K., Hirashima, T.: Learning by Problem-Posing with Online Connected Media Tablets. Proc.HIMI/HCII 2013/III, 165-174 (2013).

Are serious games working as expected?

Borja Manero[1], Javier Torrente[1], Ángel Serrano[1]and Baltasar Fernández-Manjón[1]

[1]Department of Software Engineering and Artificial Intelligence (ISIA) from the Complutense University of Madrid.
borja@sip.ucm.es,{jtorrente, angel.serrano, balta}@fdi.ucm.es

Abstract. This paper reviews "The foolish lady" experiment: a serious game aimed to increment youngsters' interest towards the classical theater play. The article overviews all the phases of the project, from game design to the evaluation in schools, the results obtained and how these have helped us shape our current research in new and innovative ways, such as taking into account players gaming profiles to better adapt the learning approach to the student.

Keywords: Serious games; Gaming profile; Digital Humanities; Theater and videogames.

1 Background and introduction

In the past decade, many studies have been conducted to investigate the effectiveness of educational games, especially in STEM (Science, Technology, Engineering and Mathematics) disciplines, such as mathematics [1], computer science or civil engineering [2], but also in subjects like visuospatial reasoning or business [3]. This is partly a consequence of the strong advocacy for using games to capture more talent into STEM disciplines [4].

Comparatively, the potential benefits of applying serious games in humanities have been less explored, apart from some experiences related to social sciences [5], geography [6], language [7] or history. Literature and scenic arts have not received the same level of attention [8]. We think popularity of videogames can help to bring young people closer to these arts. For example, serious games could be used to motivate students towards classic theater, which is the purpose of this study.

And as this paper is about theater, it is organized following the Aristotle's parts of a tragedy (exposition, conflict, climax and resolution). Act 1 includes the creation of the game and its evaluation in an experimental setup. Act 2 shows the conflict that arouses when the results obtained did not fully met our expectations and how we struggled with data in order to find a plausible explanation. The climax of this paper comes with act 3, as the solution to the riddle is obtained based on the analysis of how students' gaming preferences and habits influenced the results. Finally, Act 4 wraps up the paper and provides the reader with some carry-on thoughts.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_12

2 Act 1: Exposition (Everything the audience needs to know to understand the play)

This study stems from the worrying decrease of interest among young people towards classic theater. Studies from Argentina, Chile, EEUU and Spain [9]–[12] alert that the existing gap between theater and youngsters could put at risk the future of this literary genre in the medium term. We consider that videogames could be an interesting way to motivate young people to attend to classic theater plays and to learn more about the classic stories [13]. We created an educational game called *“La Dama Boba”* (“The Foolish Lady” in English) based on the homonymous classic theater play by Spaniard writer Lope de Vega.

2.1 Creating the game

The game creation process was based in the acting theories proposed by Constantin Stanislavski [14]. Stanislavski’s Method proposes a series of techniques for actors using concepts that have a significant overlap with game design, mainly related to finding motivation and units of action in the dramatic text. The aim of this system is to help actors generate true emotion through action; being actions any human behavior that will be conducive to a change, either in oneself or in another subject.

The actor’s first tool to draw this map is the *objective*. Objective is what a character wants at a particular time. If the objective is what the character wants, motivation answers the question: Why the character wants that? Thus motivation arises before the objective and causes it. Stanislavski argued that to transform a performance into something “interesting to watch” every objective must have a conflict associated to it. The conflict opposes the objective. Characters try to end the conflict to achieve their objectives through actions. So, conflicts generate actions performed to end those conflicts. An actor, according to Stanislavski, should analyze the whole script using this method before playing. In this process he must segment the text into units. A unit is a portion of a scene that contains a unique objective (and conflict) for one character.

Stanislavski also developed the concept of *superobjective*, which provides a character with her main goal in the play as a whole. The superobjective is considered the spine of the performance, with the temporary objectives as different vertebrae.

For example, Hamlet has a superobjective: to avenge his father murder. To achieve it, he has different objectives throughout the play such as convince her mother to abandon his uncle’s bed. The conflict opposing to that objective is that her mother does not want to. The goal of the action is to resolve the conflict. While analyzing a dramatic text, the actor segments the play to find the different units of conflict, focusing on the main events that change the goals of the character throughout the play.

We designed a methodology for applying Stanislavski’s focus on events to drive goals and conflicts into digital game design [15]. The first step is to pick up a character of the play that will be the player’s avatar. In our method, this step means choosing the point of view under the story will be told. The same play could be adapted in as many ways as characters participate in the plot. That choice determines what drives the game and must be made with care. Thereafter Stanislavski provides the guiding principles to find the events and actions that define the space of possibility for the player's avatar, based on the original text.

Stanislavski's acting method facilitated the adaptation process from the classical *The Foolish Lady* theatre play to a game, and helped creating consistent player characters. It provided us with character objectives and conflicts at all times, which allowed us to avoid narrative gaps, achieving character coherence and by extension engaging the player with the game.

The game was implemented using eAdventure, an educational computer game authoring platform that simplifies the game development process by reducing costs and technical requirements [16]. Figure 1 shows the different steps followed to convert a classical script to an educational game.

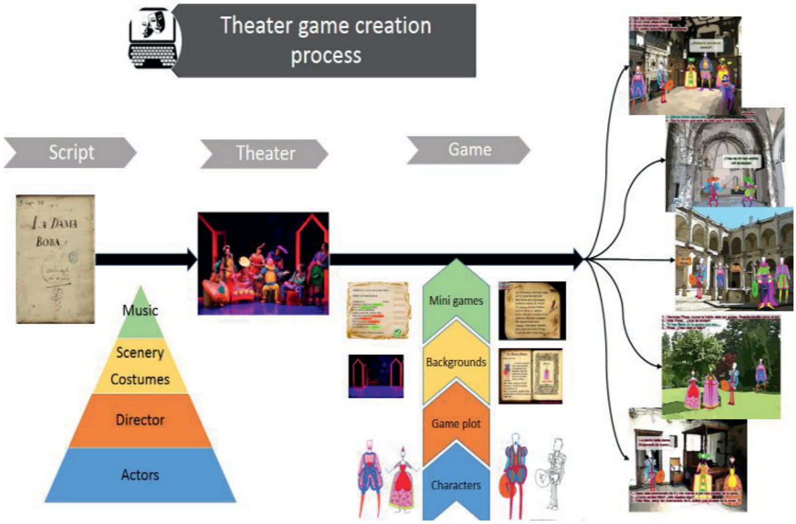


Fig. 1. From a theater script to a serious game.

2.2 Testing the game

The effectiveness of "The foolish lady" game to increase youngsters' interest towards classic theater was evaluated through an experiment run at 8 different schools in the Madrid region (Spain), early 2013. 370 students were given the game about the Foolish Lady to play (Experimental Group, EG). Pre and post tests were conducted to estimate changes in interest towards theater. To have something to compare with, 384 students were given a lecture about the play, covering the same contents than the game, and their interest increment was also measured using the same instruments. From these 384 students, 208 of the students received the lecture from their regular teacher (Teacher Group, TG). The remaining 170 students were given the lecture by the professional actor (Actor group, AG) playing the male main character of the play. We expected the game to be more effective to increase interest than the "teacher lecture" but less effective than the "actor lecture", as having direct contact with a professional actor is usually highly stimulating for youngsters. In short, we expected Actor (AG) > Experimental (EG) > Teacher (TG).

At the beginning, all the students completed the same pre-test questionnaire, containing instruments to measure their interest towards theater. After that, students attended the type of instruction they were assigned to on separate classrooms for 40 minutes (the standard duration of a high school class is 50 minutes). Students in the EG were allowed to play as many times as desired during the class. Students in TG and AG attended a talk of similar content and length leaded by their regular teacher or the actor respectively. After receiving instruction, 5 minutes before the end of the session, the students completed a post-test questionnaire with the same instrument included in the pre-test (to determine gain).

We also collected data for measuring the students' gaming preferences and habits using a self-developed instrument [17]. Figure 2 illustrates the population's distribution attending to the three different learning approaches.

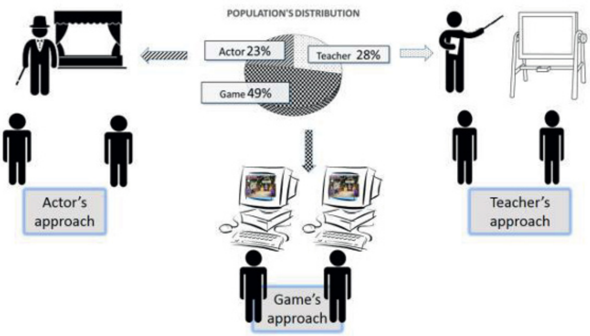


Fig. 2. Population's distribution in The Foolish Lady experiment.

3 Act 2: Conflict (the clash of opposing forces)

3.1 Results of the experiment

As shown in Figure 3, the self-produced serious game was able to increase students' interest on classic theater on the participants. As expected, the actor-driven approach demonstrated to be more effective than the game. However, actor lecturing is a very complex and expensive to deploy educational approach, being even unfeasible to bring an actor to each school. The game could be a much more cost-effective approach, as it is still able to increase students' motivation and it can be easily distributed to as many places as desired.

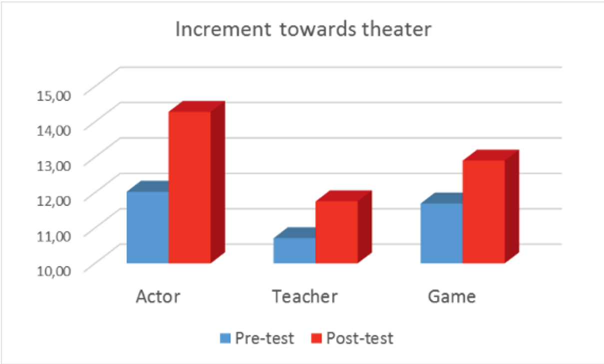


Fig. 3. Results obtained in the increment of the interest towards theater by learning approach.

However, the comparison with the teacher group did not fully meet our expectations. Before the experiment our hypothesis was that game's approach would be better than teacher's approach. While the EG achieved higher final interest scores than TG, the total gain (post-pre) was not significantly different. This fact leaded us to dig into the factors that could have lessened the game's effectiveness.

3.2 Could students' gaming habits and preferences explain the results?

The first thing that captured our attention was that the dispersion of the results obtained was much higher in EG than in the other two groups. This meant results in EG were more variable than in the other two groups. We decided to research whether students' gaming preferences and habits could be the cause of this high variability.

Students' gaming preferences and habits are variables that can be observed or measured directly. Therefore, we developed an instrument to classify students according to their self-reported gaming preferences and habits. We collected information about how often students used to play videogames and what types of videogames they liked most [17]. This instrument was consistent with the game genre classifications described in the literature reviewed in both academic and marketing studies [16] [17]. The resulting instrument had 10 items in 7-point Likert scale.

We used the information collected in these 10 variables to group students according to their gaming preferences and habits. We first run a Principal Component Analysis for data reduction (2 components were extracted), and the results were used to feed a K-means clustering algorithm. The output of this process was a classification of students in four different groups. We examined the characteristics of each group, resulting as follows:

- **Group 1: "All gamers"**. This group plays with a very high frequency to almost every type of videogame (only Musical games are slightly under the general mean), while often preferring FPS (First Person Shooter), Fighting and Strategy.
- **Group 2: "Hardcore"**. This group plays with the highest frequency, but mainly to FPS, action and Sports Games. They do not like the rest of the games.
- **Group 3: "Casual".** This group plays moderately, and mostly prefers Social, Musical, and Thinking Games.
- **Group 4: "No gamers".** This group does not play videogames often.

4 Act 3: Climax (the point at which events must turn in one direction or another)

Taking into account only the experimental group, we compared the increment of students' interest towards theatre between the four gaming profiles, finding significant differences. The game worked much better for Casual (13.50) and Allgamers (13.14) than for Nogamers (12.90) and Hardcore players (12.22). Therefore, we can argue that gaming habits and preferences played a key role in enhancing interest towards theatre by using *"The Foolish Lady"* game.

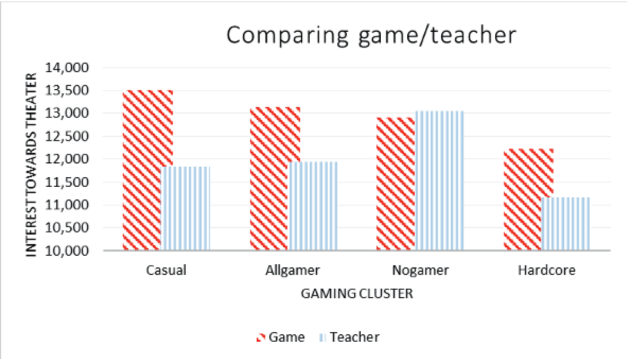


Fig. 4. Results obtained in the increment of the interest towards theater by learning approach (teacher and game)

Figure 4 shows one of the most interesting findings of this study: teacher and game approaches worked in a different way depending on the cluster that the students belong to. In other words, while game worked better for Casual, Allgamer and Harcore students, the teacher resulted in a better learning approach for Nogamer students.

One factor that could explain those differences is *"The foolish lady"* game's nature. It was designed as a graphical adventure, a game genre closer to what Casual gamers tend to prefer. Hardcore gamers do not have these games among their preferences which may decrease the performance of the game in motivating this kind of player. Therefore, these results show that the performance of the game is directly related to whether the game genre is included or not among the player's gaming preferences.

5 Act 4: Resolution. Conclusions and Lessons Learned (whatever comes after the climax)

The main finding of this study is the influence of players' gaming habits and preferences over learning outcomes using serious games. The game proved effective, but less than expected. It could be explained by the gaming profile of the students. The game developed was a great learning approach for students within the Casual cluster, while for Hardcore players it was less effective than teacher lecturing.

Therefore, to achieve a better performance using serious games, it may be necessary to have a better understanding of the targeted population's gaming preferences and habits before the starting of any game development.

On the other hand, the traditional learning approach worked better for the student who do not use to play videogames. This lead us to argue that learners gaming profile could affect not only their learning outcomes using serious games but also through different learning approaches. Nevertheless, more research in this field is needed to confirm this finding.

Our results are consistent with Veronica Zammitto's [20] findings, who argues that gamers' personality is directly linked to their gaming preferences. This statement leads us to think that students with different personalities would achieve different results by using different learning strategies. Nevertheless, we would point out to Zammitto's work that gaming preferences and habits may be good indicators on which learning approach will work better in an educational process.

Finally, we argue that once that the game's effectiveness has been proved, it can also be used by the teacher as a supplementary motivational content. According to some teachers involved in the experience, the game could be an excellent starting point for promoting a further discussion about the theater play to achieve a deeper and more enjoyable knowledge about the play.

Also from this motivational perspective, and even if it does not have scientific validity, after the experiment, the students of one of the schools theater group decide to change the planned end of school year theater play to *The Foolish Lady* even when this play was far more complex than the initially planned (*The Foolish Lady* is written in verse and has complex vocabulary). They played *The Foolish Lady* in June 2013.

Acknowledgments. The next sponsors have partially supported this work: the Spanish Ministry of Science and Innovation (grant no. TIN2010-21735-C02-02), the Ministry of Education (FPU12/04310); the European Commission, through the

Lifelong Learning Programme ("SEGAN Network of Excellence in Serious Games" - 519332-LLP-1-2011-1-PT-KA3-KA3NW) and the 7th Framework Programme (project "GALA - Network of Excellence in Serious Games" - FP7-ICT-2009-5-258169); the Complutense University of Madrid (research group number GR35/10-A-921340) and the Regional Government of Madrid (eMadrid Network - S2009/TIC-1650).

References

[1] N. Bos and N. S. Shami, "Adapting a face-to-face role-playing simulation for online play," Educ. Technol. Res. Dev., vol. 54, no. 5, pp. 493–521, 2006.
[2] N. E. Cagiltay, "Teaching software engineering by means of computer-game development: Challenges and opportunities," Br. J. Educ. Technol., vol. 38, no. 3, pp. 405–415, May 2007.
[3] K. Kiili, "Foundation for problem-based gaming," Br. J. Educ. Technol., vol. 38, no. 3, pp. 394–404, 2007.
[4] M. J. Mayo, "Video Games: A Route to Large-Scale STEM Education?," Science (80-.)., vol. 323, no. 5910, pp. 79–82, Jan. 2009.
[5] J. M. Cuenca López and M. J. Martín Cáceres, "Virtual games in social science education," Comput. Educ., vol. 55, no. 3, pp. 1336–1345, 2010.
[6] H. Tüzün, M. Yılmaz-Soylu, T. Karakuş, Y. İnal, and G. Kızılkaya, "The effects of computer games on primary school students' achievement and motivation in geography learning," Comput. Educ., vol. 52, no. 1, pp. 68–77, Jan. 2009.
[7] A. Ravenscroft, "Promoting thinking and conceptual change with digital dialogue games," J. Comput. Assist. Learn., vol. 23, no. 6, pp. 453–465, 2007.
[8] C. Chou and M.-J. Tsai, "Gender differences in Taiwan high school students' computer game playing," Comput. Human Behav., vol. 23, no. 1, pp. 812–824, Jan. 2007.
[9] U. de Palermo, "Los adolescentes y los hábitos culturales," 2009.
[10] D. Aucoin, "Phantom of the theater: Audience is getting older," Boston, 2012.
[11] Sociedad General de autores y editores, "Anuario de las artes escénicas, musicales y audiovisuales 2012," 2012.
[12] C. cultural de la cultura y las Artes, "Reporte estadístico de teatro," 2011.
[13] B. Manero, C. Fernández-Vara, and B. Fernández-Manjón, "E-Learning Takes the Stage: From La Dama Boba to a Serious Game," IEEE Rev. Iberoam. Tecnol. del Aprendiz., vol. 8, no. 4, pp. 197 – 204, 2013.
[14] C. Stanislavski, Building a character. A&C Black, 2013.
[15] B. Manero, C. Fernández-Vara, and B. Fernández-Manjón, "Stanislavky's System as a Game Design Method: A Case Study," in Proc. of DiGRA, DeFragging Game Studies, 2013.
[16] J. Torrente, Á. Del Blanco, E. J. Marchiori, P. Moreno-Ger, and B. Fernández-Manjón, "<e-Adventure>: Introducing Educational Games in the Learning Process," in IEEE Education Engineering (EDUCON) 2010 Conference, 2010, pp. 1121–1126.
[17] B. Manero, J. Torrente, Á. Serrano, and B. Fernández-Manjón, "Development and preliminary validation of an instrument to classify students according to their gaming profile (gaming preferences and habits...)," Submitted, 2014.
[18] J. B. Funk, "Reevaluating the impact of video games," Clin. Pediatr. (Phila)., vol. 32, no. 2, pp. 86–90, 1993.
[19] A. Rollings and E. Adams, Andrew Rollings and Ernest Adams on game design. Indianapolis: New Riders, 2003.
[20] V. L. Zammitto, "Gamers' personality and their gaming preferences." Communication, Art & Technology: School of Interactive Arts and Technology, 2010.

Automatic Generation of Valid and Equivalent Assessment Instruments

Shilpi Banerjee and Chandrashekar Ramanathan

International Institute of Information Technology, Bangalore
shilpi.banerjee@iiitb.ac.in,rc@iiitb.org

Abstract. Assessment is an integral part of the student's learning process. It is essential to design good quality assessment instruments. Traditional assessment instruments rely on blueprints and random selection of items from the item bank. In this paper, we propose a method of generating valid assessment patterns automatically that satisfies the constraints provided by the instructor. Moreover, we generate a large item bank by using automatic item generation, which helps in designing equivalent, multiple assessment instruments to keep a check in plagiarism. We present an assessment instrument for a course on Design of Digital Systems that is developed using the above approach. The effectiveness of the assessment instrument is ensured by considering the validity of items.

1 Introduction

The essential factors for designing a good quality assessment instrument are -
Validity - A valid assessment is one which measures what it is intended to measure[1]. To ensure the validity aspect, it is essential to design assessments in alignment with the stated aims for a course.
Assessment specification - It is a detailed description for the instrument, often called a blueprint, that specifies the number of proportion of items that assess each content, skill, etc[2].
Alternate(Equivalent) forms - Two or more versions of a assessment that are considered interchangeable(equivalent), when they measure the same constructs in the same ways and are intended for the same purpose[2]. For large scale assessments, having equivalent forms of instrument helps in preventing plagiarism.

The conventional way of designing an assessment instrument, that satisfies the above discussed factors demands devotion of enormous time and energy for the instructor as the process is highly labour-intensive and error-prone. With growing usage of technology for teaching and learning process, there is a need to explore the development of automated methods in the area of assessment. This paper discusses a unique approach to generate a good quality assessment instrument automatically. Section 2 presents the related work and the concepts related to the proposed approach used in this paper, Section 3 presents the proposed approach, Section 4 shows the result for an example and Section 5 summarizes with concluding remarks.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_13

2 Research Background and Related Work

The existing systems for automatic generation of instrument can be categorised broadly into two categories based on pattern generation and item generation, respectively. The following sub-sections contain additional information on these two categories. Some of the terminology used in these sections is defined in Table 1.

2.1 Automatic Assessment Pattern Generation

Assessment blueprints[3] guide the development of instrument by ensuring the right distribution of number of items for all the attributes by creating a pattern for the assessment instrument. The effort related to the creation of blue prints does not remain manually feasible for large number of assessments for a course. Several methods[4][6] have been designed to address this issue for two attributes. If the number of attributes are more than 2, the generation of assessment instrument starts becoming unmanageably complex if done manually. Out of various approaches used to automate the generation of instrument when the number of attributes are more than 2, random extraction and retrospective testing are mostly used these days by the existing software tools[5]. Each of these approaches lacks an important component of assessment, that is alignment of assessment items with the competency and the validity of assessment items is not taken into consideration while creating the assessment pattern.

2.2 Automatic Assessment Item Generation

The systems designed in [5][6] uses a database of items for creating instrument and focus was on the composition of only one instrument. [8] uses randomization technique for organising multiple sets of assessment instrument, but it does not guarantee their equivalence. Because of limited size of item bank, creating alternate forms of instrument is challenging. Large scale assessments demands multiple sets of equivalent instrument. The size of item bank can be increased by using automatic item generation.

3 Proposed Approach

In this paper, we have discussed a way of designing an assessment instrument using three dimensional matrix from the assessment pattern generator and the database of items generated by using automatic item generation. The assessment instrument generation comprises of three essential blocks as discussed in subsequent sections.

3.1 Alignment Pattern Generation

This module takes care of **validity** aspect of the instrument. The correct estimate of student's learning can be estimated by including assessment items in the assessment instrument which are aligned with the competency[1]. Each and every competency focuses over one or many cognitive levels. The assessment item for any competency should be taken from the same or lower cognitive level to which it is aligned. The items are termed to be valid only if it satisfies the alignment constraint(ac). Alignment constraint is provided by the instructor as a input to this module. We get a two dimensional matrix($matrix_{ac}$) at the output which shows the relation between the competency and the cognitive level it belongs to. The instrument will use this matrix for selecting valid items.

3.2 Assessment Pattern Generation

Assessment pattern generation provides the functionality to fulfil a given **assessment specification** and gives a three dimensional matrix that shows the marks allotted to items belonging to each of the attribute categories. The maximum possible number of categories is equal to product of number of competencies(m), number of cognitive levels(n) and number of assessment item types(p). Invalid combinations of competency and cognitive level are filtered out by the alignment pattern generator. Total marks(M_T) for the instrument and weight constraints(wc= $\{W_C,\ W_{CL},\ W_{AT}\ \}$) for competency, cognitive level and assessment item type are given by the instructor as a input to this module. If W_C, W_{CL}, W_{AT} are given by $W_C = \{W_{C_1} \cdots W_{C_m}\}$, $W_{CL} = \{W_{CL_1} \cdots W_{CL_n}\}$, $W_{AT} = \{W_{AT_1} \cdots W_{AT_p}\}$, then

$$\sum W_C = \sum W_{CL} = \sum W_{AT} = M_T \tag{1}$$

The real challenge is to select appropriate number of assessment items from each of these sub categories of assessment item attributes such that equation(1) get satisfied always. **Algorithm 1** presents the pseudo code for assessment pattern generation. As a first round of explanation for the pseudo code of the algorithm, we mention the following points: **satisfy** is designed as a *depth-first state-space* search and **satisfy** uses a *branch and bound* approach to limit search along infeasible paths in the *search tree.*The size of the state space is a function of m, n and p. State space denotes the set of all the candidate assessment patterns. If there are 5 competencies, 6 cognitive levels and 3 assessment item types, the maximum number of possible categories are $5 * 6 * 3 = 90$ and the state space will have an upper bound of 3^{90}, if number of allowed values for every cell of assessment pattern is 3. As the number of these attributes increases, the state space starts becoming unmanageably large. The algorithm discussed in [6][7] explores all possible states in any case. In our approach, we have used branch and bound algorithm which searches the state space in such a way that there are early evidences available, if exploring in any particular direction is not effective in producing result. The search space for assessment pattern is reduced with the help of intermediate and final constraint. **Intermediate constraint** is checked for all cell positions except the last one. The sum of values placed in the cells populated so far should be equal to or less than the weight constraints. **Final constraint** is checked for the last cell position. The sum of values placed in the cells populated so far(all the cells in the matrix, since this is the last cell) should be equal to the weight constraints. For a partially filled matrix, the sum s of values in all cells populated so far should be less than or equal to the weight constraint wc. If $s < wc$, then the remaining cells can be populated with appropriate values so as to make the final $s = wc$. If $s = wc$, then the remaining cells may be filled with zeros. However, if $s > wc$, then there cannot be any values with which the remaining cells could be filled so as to make the final $s = wc$. Hence, for all cells except the last one, we use intermediate constraint.For the last cell of the matrix, s must be equal to wc as there are no cells left to make $s = wc$, in case $s < wc$.

3.3 Automatic Item Bank Generation

Automatic item generation(AIG) was developed to address the increasing demand for assessment items for creating **alternate forms** of the instrument. In the item bank, item templates instead of items are stored along with respective tags for competency, cognitive level and assessment item types. The item templates are written in a manner indicating the integration of cognitive level associated with the competency. Item templates are constructed by using two essential elements, stem and variables. By varying the variables of an item in a systematic manner, AIG can be used to create multiple items in an iterative way as discussed in **Algorithm 2**. All the items generated from the same template are equivalent in nature as the value set for the variable have similar characteristics. Two different values are considered to be equivalent if they addresses the same content domain. The similarity of values for generating equivalent items can be decided by the instructor. We can design different difficulty item templates in a single cognitive level by selecting variable with different characteristics.The algorithm for generating assessment instrument is discussed in **Algorithm 3**.

4 Result - Example Generation

We have developed item templates for the course, Design of Digital Systems. A formative assessment instrument is generated for first two competencies and the sample is included in the paper. The competencies considered are as mentioned in Table 2. The assessment items are validated by using the alignment pattern generator. Table 3 shows valid set of assessment items($\{$AI$\}$) and their tags. The assessment item types which were considered are selection type and supply type. All selection type items are of 1 mark while supply type items were designed for 1 and 2 marks. Total marks(M_T) for the instrument is 20 while the weight constraint for 2 competencies, 3 cognitive levels and 2 assessment item types are $W_C = \{W_{C1}, W_{C2}\} = \{8, 12\}$, $W_{CL} = \{W_{CL1}, W_{CL2}, W_{CL3}\} = \{8, 8, 4\}$, $W_{AT} = \{W_{AT1}, W_{AT2}\} = \{6, 14\}$. The maximum possible number of categories for this combination is $2 * 3 * 2 = 12$. Assessment pattern finds the number of items chosen from each of these categories. Table 4 shows an assessment pattern for the weight constraints mentioned above. Table 5 shows an instance for automatic generation where a template is used to design 8 equivalent items. The tag $C_1CL_2AT_2$ denotes that the item template belongs to the first competency, second cognitive level(understand) and second assessment item type(supply type item). Table 6 and 7 gives assessment instruments for the above mentioned assessment specification.

5 Conclusion

The proposed assessment instrument provides generalization related to alignment question[1] which discusses about the importance of alignment of competency with assessment. Alignment pattern generator ensures the validity of items for assessment which helps in providing the evidence of how well students have learned what the instructor intends them to learn. Assessment specification pattern is automatically developed using depth first branch and bound search algorithm. This algorithm helps in finding the first solution that meets the weight constraint. The complexity of this algorithm increases exponentially as a function of the number of attributes. Equivalent sets of assessment instrument can be designed using the optimized assessment pattern. Our future work will focus on evaluating alternate form reliability and looking for evidences of valid assessment, when the instrument is offered to students.

Table 1. Definition Of Terminology Used

Term	**Definition**
Assessment instrument	Assessment instrument is used for summative or formative assessment. It is designed for specified maximum marks and it addresses a chosen set of competencies.
Assessment item(AI)	A general term referring to a single statement, question, exercise, problem, or task on a assessment or evaluative instrument for which the assessment taker is to select or construct a response, or to perform a task. [2].
Competency(C)	It is a detailed description of what students will be able to do when they complete a unit of instruction[4].
Cognitive level(CL)	Bloom's taxonomy divides the cognitive domain into 6 levels which are remember(CL_1) understand(CL_2), apply(CL_3), analyse(CL_4), evaluate(CL_5) and create(CL_6) [4]
Assessment item type(AT)	The assessment items can be selection type or supply type.
Attribute	It is used to characterize an assessment item for various competency, cognitive level and assessment item type.

Algorithm 1 satisfy - For Creating Assessment Pattern

satisfy(pos, $matrix_{ac}$, $matrix_{wc}$) {pos- cell position, $matrix_{ac}$- 2D matrix(size = len({S_C})*len({S_{CL}})), $matrix_{wc}$- 3D matrix(size = len({S_C})*len({S_{CL}}) *len({S_{AT}})}
if $matrix_{ac}[pos] = -1$ **then**
  Evaluate all possible values for $matrix_{wc}$ [pos]{valid cell position}
  if $pos \neq lastcell$ **then**
    if intermediateConstraint($matrix_{wc}[pos]$) = $True$ **then**
      satisfy($nextcellpos$, $matrix_{wc}$)
    end if
  else if $pos = lastcell$ **then**
    if finalConstraint($matrix_{wc}[pos]$) = $True$ **then**
      return $True$ {solution that satisfies wc can be found in $matrix_{wc}$}
    end if
  end if
else if $matrix_{ac}[pos] = 0$ **then**
  $matrix_{wc}[pos] = 0$ {invalid cell position}
end if
return $matrix_{wc}$

Algorithm 2 generateItems - For Creating Item Bank From Item Templates

generateItems(tag-template file, variable-value file)
for all templates in {T} **do**
  {{T} ← Set of templates for a item template bank}
  Extract {Var_T} {{Var_T} ← Set of variables for a template}
  for all variables in {Var_T} **do**
    {{Val_{var}} ← Set of values for a variable}
    Extract {Val_{var}}
    Find cross product of values present for each of the variable
    Create all items for template by replacing variables by the values found by cross product
    Write created items with associated tags in item-bank file
  end for
end for
return item-bank

Algorithm 3 createInstrument - For Creating Assessment Instrument

createInstrument ($matrix_{wc}$, item-bank, $matrix_{ai}$) {$matrix_{ai}$ - 3D matrix(size = len({S_C})*len({S_{CL}}) *len({S_{AT}})}
list ← empty list for storing items per index
for all index of $matrix_{wc}$ **do**
  T_n ← value in the index {index- tag for items} {value- marks allotted to that index}
  list[index] ← Randomly choose items from item-bank having the same index such that marks allotted to all of them sum to T_n
  $matrix_{ai}$[index] ← list[index]
end for
return $matrix_{ai}$

References

1. Lorin W. Anderson, David R. Krathwohl: A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives, Pearson,(2000)
2. Joint Committee on Standards for Educational and Psychological Testing of the AERA,APA, and NCME, Standards for educational and psychological testing. Washington DC: American Educational Research Association, (1999)
3. Chan Kan Kan "Using Test Blueprint in Classroom Assessments: Why and How", International Association for Educational Assessment, (2010)
4. Dimple V.Paul, Shankar B.Naik, Priyanka Rane, Jyoti D.Pawar,"Use of an Evolutionary Approach for Question Paper Template Generation",IEEE, Fourth International Conference on Technology for Education, (2012).
5. Song Yan, Yang Guoxing, "A Genetic Algorithm of Test Paper Generation", IEEE, Eighth International Conference On Computer Science and Education, (2013).
6. Vaibhav M. Kale, Arvind W. Kiwelekar, "An Algorithm for Question Paper Template Generation in Question Paper Generation System", IEEE, International Conference on Technological Advances in Electrical, Electronics and Computer Engineering, (2013)
7. Vijay Krishan Purohit, Abhijeet Kumar, Asma Jabeen, Saurabh Srivastava, R H Goudar, Shivanagowda, Sreenivasa Rao, "Design of Adaptive Question Bank Development and Management System", IEEE, International Conference on Parallel, Distributed and Grid Computing, (2012)
8. Nor Shahida bt Mohd Jamail, Abu Bakar Md Sultan, "Shuffling Algorithms for Automatic Generator Question Paper System", Computer and Information Science, (2010)

Table 2. Competencies

SNo	Competencies	Cognitive level
C_1	Understand the nature of logic expressions written in terms of logical functions(AND, OR, NOT, NAND, NOR, X-OR, X-NOR)	Understand
C_2	Simplify logical expressions using Boolean theorems.	Apply

Table 3. Valid Set Of Assessment Items

	Remember	Understand	Apply	Analyse	Evaluate	Create
C_1	$\{\mathrm{AI}\}_{C_1CL_1}$	$\{\mathrm{AI}\}_{C_1CL_2}$	-	-	-	-
C_2	$\{\mathrm{AI}\}_{C_2CL_1}$	$\{\mathrm{AI}\}_{C_2CL_2}$	$\{\mathrm{AI}\}_{C_2CL_3}$	-	-	-

Table 4. Automatic Assessment Pattern Generation- Output From Algorithm **satisfy**

		Assessment Pattern		
		CL_1	CL_2	CL_3
C_1	AT_1	$\{AI\}_{C_1CL_1AT_1} = 2$	$\{AI\}_{C_1CL_2AT_1} = 1$	$\{AI\}_{C_1CL_3AT_1} = 0$
	AT_2	$\{AI\}_{C_1CL_1AT_2} = 3$	$\{AI\}_{C_1CL_2AT_2} = 2$	$\{AI\}_{C_1CL_3AT_2} = 0$
C_2	AT_1	$\{AI\}_{C_2CL_1AT_1} = 1$	$\{AI\}_{C_2CL_2AT_1} = 1$	$\{AI\}_{C_2CL_3AT_1} = 1$
	AT_2	$\{AI\}_{C_2CL_1AT_2} = 2$	$\{AI\}_{C_2CL_2AT_2} = 4$	$\{AI\}_{C_2CL_3AT_2} = 3$

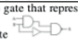
Table 5. Automatic item generation using item templates- Output from algorithm **generateItems**

Tag	AI template	Variable	Value set	Assessment items
$C_1CL_2AT_2$	A logic circuit has three input and one output variables. The output variable is at $C_1CL_2AT_2$_a when two or more inputs are at $C_1CL_2AT_2$_b. Write the truth table and realize using only $C_1CL_2AT_2$_c gates.	$C_1CL_2AT_2$_a	{logic 1, logic 0}	A logic circuit has three input and one output variables. The output variable is at logic 1 when two or more inputs are at logic 1. Write the truth table and realize using only NAND gates.
		$C_1CL_2AT_2$_b	{logic 1, logic 0}	A logic circuit has three input and one output variables. The output variable is at logic 1 when two or more inputs are at logic 1. Write the truth table and realize using only NOR gates.
		$C_1CL_2AT_2$_c	{NAND, NOR}	A logic circuit has three input and one output variables. The output variable is at logic 1 when two or more inputs are at logic 0. Write the truth table and realize using only NAND gates.
				A logic circuit has three input and one output variables. The output variable is at logic 1 when two or more inputs are at logic 0. Write the truth table and realize using only NOR gates.
				A logic circuit has three input and one output variables. The output variable is at logic 0 when two or more inputs are at logic 1. Write the truth table and realize using only NAND gates.
				A logic circuit has three input and one output variables. The output variable is at logic 0 when two or more inputs are at logic 1. Write the truth table and realize using only NOR gates.
				A logic circuit has three input and one output variables. The output variable is at logic 0 when two or more inputs are at logic 0. Write the truth table and realize using only NAND gates.
				A logic circuit has three input and one output variables. The output variable is at logic 0 when two or more inputs are at logic 0. Write the truth table and realize using only NOR gates.

Table 6. Automatically generated assessment instrument- Set 1- Output from algorithm **createInstrument**

Number of marks allotted per category of {AI}	Tag	Item	Marks
$\{AI\}_{C_1CL_1AT_1} = 2$	$C_1CL_1AT_1$	A circuit containing only AND and NOT gates must be a Combinational circuit. (A) True (B) False	1
	$C_1CL_1AT_1$	The Boolean expression for a 3-input AND gate is (A) X = (ABC)' (B) X = ABC (C) X = A + B + C (D) X = (A + B + C)'	1
$\{AI\}_{C_1CL_1AT_2} = 3$	$C_1CL_1AT_2$	What is positive logic?	1
	$C_1CL_1AT_2$	Draw the logic symbol, write the boolean expression and construct the truth table for the X-OR gate.	2
$\{AI\}_{C_1CL_2AT_1} = 1$	$C_1CL_2AT_1$	Choose the gate that represents the function of the logic gate system below. (a) NAND gate (b) X-OR gate (c) NOR gate (d) X-NOR gate 	1
$\{AI\}_{C_1CL_2AT_2} = 2$	$C_1CL_2AT_2$	A logic circuit has three input and one output variables. The output variable is at logic '1' when two or more inputs are at logic '1'. Write the truth table and realize using only NAND gates.	2
$\{AI\}_{C_2CL_1AT_1} = 1$	$C_2CL_1AT_1$	Identify the correct statement for Demorgan's theorem (A) (X+Y)'= X'Y' (B) (X+Y)'= X'+Y' (C) (XY)' = X'.Y' (D) (XY) = X'.Y'	1
$\{AI\}_{C_2CL_1AT_2} = 2$	$C_2CL_1AT_2$	State Commutative law.	1
	$C_2CL_1AT_2$	Write the truth table for the following boolean expression Y=A + B'C	1
$\{AI\}_{C_2CL_2AT_1} = 1$	$C_2CL_2AT_1$	When simplified with Boolean Algebra (x + y)(x + z) simplifies to (A) x (B) x + x(y + z) (C) x(1 + yz) (D) x + yz	1
$\{AI\}_{C_2CL_2AT_2} = 4$	$C_2CL_2AT_2$	Implement boolean expression for Ex-NOR using NAND gates.	2
	$C_2CL_2AT_2$	Complement the expression (AB)'+ A'+ AB	2
$\{AI\}_{C_2CL_3AT_1} = 1$	$C_2CL_3AT_1$	Evaluating x = A'B + C(AD)' using the convention A = False and B = False gives (A) CD' (B) 0 (C) 1 (D) C'D	1
$\{AI\}_{C_2CL_3AT_2} = 3$	$C_2CL_3AT_2$	Prove the following Boolean identity using the laws of Boolean Algebra and implement the simplified equation using basic gates. (z + xy') + xy + x(y' + z)	3

Table 7. Automatically generated assessment instrument- Set 2- Output from algorithm **createInstrument**

Number of marks allotted per category of {AI}	Tag	Item	Marks
$\{AI\}_{C_1CL_1AT_1} = 2$	$C_1CL_1AT_1$	A circuit containing only OR and NAND gates must be a Sequential circuit. (A) True (B) False	1
	$C_1CL_1AT_1$	The Boolean expression for a 3-input NAND gate is (A) X = (ABC)' (B) X = ABC (C) X = A + B + C (D) X = (A + B + C)'	1
$\{AI\}_{C_1CL_1AT_2} = 3$	$C_1CL_1AT_2$	What is negative logic?	1
	$C_1CL_1AT_2$	Draw the logic symbol, write the boolean expression and construct the truth table for the NAND gate.	2
$\{AI\}_{C_1CL_2AT_1} = 1$	$C_1CL_2AT_1$	Choose the gate that represents the function of the logic gate system below.(a) NAND gate (b) X-OR gate (c) NOR gate (d) X-NOR gate 	1
$\{AI\}_{C_1CL_2AT_2} = 2$	$C_1CL_2AT_2$	A logic circuit has three input and one output variables. The output variable is at logic '1' when two or more inputs are at logic '0'. Write the truth table and realize using only NOR gates.	2
$\{AI\}_{C_2CL_1AT_1} = 1$	$C_2CL_1AT_1$	Identify the correct statement for Demorgan's theorem (A) (X+Y) = X'Y' (B) (X+Y)'= X'+Y' (C) (XY)' = X'.Y' (D) (XY)' = X'+ Y'	1
$\{AI\}_{C_2CL_1AT_2} = 2$	$C_2CL_1AT_2$	State Associative law.	1
	$C_2CL_1AT_2$	Write the truth table for the following boolean expression Y=AB'+A'C	1
$\{AI\}_{C_2CL_2AT_1} = 1$	$C_2CL_2AT_1$	When simplified with Boolean Algebra x(x + y)(x + z) simplifies to (A) x (B) x + x(y + z) (C) x(1 + yz) (D) x + yz	1
$\{AI\}_{C_2CL_2AT_2} = 4$	$C_2CL_2AT_2$	Implement boolean expression for Ex-OR using NOR gates.	2
	$C_2CL_2AT_2$	Complement the expression (A'+ B + C')(A'+ B+ C)	2
$\{AI\}_{C_2CL_3AT_1} = 1$	$C_2CL_3AT_1$	Evaluating x = A'B + C(AD)' using the convention A = True and B = False gives (A) CD' (B) 0 (C) 1 (D) C'D	1
$\{AI\}_{C_2CL_3AT_2} = 3$	$C_2CL_3AT_2$	Prove the following Boolean identity using the laws of Boolean Algebra and implement the simplified equation using basic gates. (x' + y'z')(yz' + x')(y' + z')[x' + (y'*z')]	3

College Students' Attitudes and Preferences of Mobile Newspaper Reading: A Comparison between Printed and Web Page Layout

Lin-Chao Fu[1], Ming-Hsin Lu[1], Hsin-Ying Wu[1], Weijane Lin [2], Hsiu-Ping Yueh[1]

[1] Dept of Bio-Industry Communication and Development, National Taiwan University, Taipei, Taiwan
[2] Dept of Library and Information Science, National Taiwan University, Taipei, Taiwan
{r01630010,r01630002, vjlin, yueh}@springer.com

Abstract. The purpose of this study is to understand college students' attitudes and preference of newspaper reading. The two page layout of an app provided by a leading publisher of Chinese newspaper, United Daily News, was selected as the target product of the usability evaluation. The preliminary results showed that college students had no significant preference of either kind of page layout, however reading with the Web page layout demanded more cognitive and physical loading than reading printed one. And students' performance of reading newspaper with the printed page layout was better.

Keywords: Newspaper, Layout, Reading attitude, Reading preference.

1 Introduction

Newspaper reading, as a form of informal learning [1], served as a critical vehicle of information for college students to collect up-to-date facts and status in the society, however the current devices were not preferred [2] due to several interface problems such as the lack of visibility, discoverability, reliability, affordance and inconsistent feedback that led to mistouch or erroneous manipulation [3]. An increasing number of newspapers and publishers went digitization to use online media to overcome the issues of timeliness and interactivity of printed newspapers. It is suggested that more consideration should be taken in order to make the design decisions on interface elements such as the page layout. Whether users' preferences of the page layout transferred [4,5], and whether users' reading performance would be affected [6] required further investigation. Motivated by the aforementioned issues, the purpose of this study is to understand college students' attitudes and preference of newspaper reading.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_14

2 Methods

The two page layouts provided by a leading publisher of Chinese newspaper, United Daily News, was selected as the target product of the usability evaluation. One is the UDN App that adopted the page layout of printed newspapers. The other is the website of UDN that adopted Web page layout. 18 college students were invited to take part in the user experiments, they were asked to search and read the assigned news stories with the two different page layouts.

3 Preliminary Results

The preliminary results showed that college students had no significant preference of either kind of page layout, however reading with the Web page layout demanded more cognitive and physical loading than reading printed one. And students' performance of reading newspaper with the printed page layout was better. When the participants read the printed newspaper, they looked for navigation guide such as the headlines, briefs, photos and drop quotes. However for Web page layout these elements were missing. Also it was likely that the inconsistent segments of the Web page layout led to users' unfamiliarity and confusion, that affected their performance of searching. Continuously more participants of college students will be recruited, and their previous experiences with the newspaper reading and mobile device using will be further investigated to construct more integrative understanding of their mobile newspaper reading behaviors.

References

[1] Meyers, E. M., Erickson, I., & Small, R. V. Digital literacy and informal learning environments: an introduction. Learning, Media and Technology, 38(4), 355-367 (2013)
[2] Institute for Information Industry. *Report of Taiwan digital reading behavior survey*. http://www.magazine.org.tw/ImagesUploaded/news/13418257221870.pdf
[3] Budiu, R. & Nielsen, J. iPad App and Website Usability. http://s3.amazonaws.com/media.nngroup.com/media/reports/free/iPad_App_and_Website_Usability_2nd_Edition.pdf (2011)
[4] Holmqvist, K., Holsanova, J., Barthelson, M., & Lundqvist, D. Reading or scanning? A study of newspaper and net paper reading. Mind, 2(3), 4 (2003)
[5] Lu, H. Y. & Chen, Z. B. The factors affecting willingness to seek news through the Yahoo! Portal. NTU News Forum, 8, 3-30 (2009)
[6] Liu, P. L. The influence of the way of web present and the characteristics of information present on student reading performance. Teacher's Friend. 48(3), 34-41 (2007)

Competing in Cultural Arena: New Design of Career Guiding Application

Hang Guo
SAP Research and Innovation
01 Create Way, #14-01, Singapore 138602
hang.guo01@sap.com

Abstract. Web based career guiding applications have emerged as a new means of organized skill training, knowledge acquisition and career decision making. Most current career guiding applications operate on assumptions of individual capacity to make career decisions and implement a guided process which encompasses two general phases: 1. personality and skill assessment; 2. job recommendations based on assessment result. In this paper, we turn to Pierre Bourdieu's thinking of social, economic and cultural capital to highlight deficiencies in the current career guiding applications. We then discuss a new embedded approach to the design of career guiding application which re-situates individual career decision-making in the real life contexts and brings the non-linear and disruptive nature of career decision-making into the spotlight. Design guidelines illustrating the important characteristics of this new approach will also be presented.

Keywords: Career Guiding System, Bourdieu, Cultural Capital, Career Decision-Making, Design

1. Introduction

In the career guidance field there exist a variety of competing theories of career decision-making and career development. Some based on matching personal traits to job characteristics [3] and others, such as Krumboltz's work focuses on social learning [2] and Roberts emphasizes the social structural aspect of individual career decision making [7]. Each theory sheds light on a particular aspect through which career decision making can be understood.

However, from the stand point of practical career guiding applications, most contemporary web based career guiding applications operate almost entirely on the assumption of individual rational decision-making by seeing individual as the only agent involved in making career decisions and seeing that individual as separate from his/her social context within which the decision is made. A typical career guiding application workflow starts with personality, physical and mental capacity assessments, which are commonly found in psychological research facilities [6]. Based on scores received from such assessments, current applications in this domain would

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_15

provide ‘matching’ services, which presents users with recommended jobs or training opportunities. Despite this seemingly logical flow, we believe current career guiding applications have largely overlooked the complexities involved in real life career decision-making. Treating career decision-making as a rational and linear process imposes presumed mental model of application behavior on users. Most such applications emphasize on providing end-to-end wizard-like guidance to both new and returned user groups. Meanwhile, the importance of application flexibility, adaptability and tolerance to interruption is largely ignored.

Hodkinson’s investigation of a government schema to train young people which involved 12 participants for 18 months revealed two major failures of the individual decision-making model:

1. Individual decision making was not rational in the ways assumed by rational decision making theory.
2. Career progression was often non-linear and was strongly influenced by actions, events and circumstances that lay beyond the control of the young person. [2].

Hodkinson’s study highlights individual’s limited capacity in making rational choices due to constrains in logical analysis and information evaluation. The study also points to the importance of bringing consideration of individual’s social and cultural context into the analysis of career decision-making that career decision-making is an embodied process that takes place in the interactions between the person and the environment they inhabit. The challenge to underlining theory of established career guiding application design points us to develop a framework to rediscover individual career decision-making process and to understand its implications for the design of next generation career guiding applications. We turned to Pierre Bourdieu’s thinking to shed light on the current puzzle.

2. Pierre Bourdieu: Habitus and Cultural Capital

Bourdieu’s thinking resonates with Weber’s account of social class and status but elaborates the contrast between class and status in terms of a distinction between economic, social and cultural capital [1]. Bourdieu proposes that culture is an arena of competition and is itself a marketplace which is related to and always interchangeable with what we conventionally called job market. Schooling and career development, in this view, work to equipment individuals with a fund of culture capital which, if it is worth enough on the existing cultural market, gives them entry to particular occupations and social circles.

Bourdieu's theory leads us to a new and more embedded understanding of individual career decision-making as well as the life context within which such decisions are usually made. Viewing "careership" as a marketplace where skills and knowledge are being exchanged together with embedded culture norms and social connections in the form of a bundled commodity liberates us from taking the tunnel vision of individual career decision-making as a linear process based on rational choice. In Bourdieu's thinking, career decision-making is a form of situated activities which take place in a cultural, economic and social marketplace. Because of the embedded nature of this marketplace, exchanges of cultural, economic and social capital will happen at every social interaction the individuals would go through in his or her everyday lives. Career choice, under this light, is the ultimate outcome of an array of exchange activities that happened in this marketplace, no single means of exchange will determine this outcome, and individuals always make career choice within an embedded life context through a chain of exchanging activities.

We sketched a conceptual image of this embedded career exchanging marketplace with various "exchange points" where cultural, economic and social capital transfers from one individual to another or from one capital form to another.

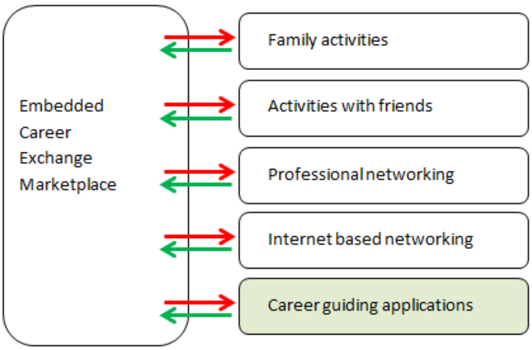


Figure 1: Career marketplace of various "access points" conditioned by strength of social ties

Career decision-making is a collective outcome of the interplay between every "access point", i.e. one's decision to adopt a particular career track can be seen as the accumulative result of his or her interactions with surrounding environment at dinner table, bar, conference, workplace -- any social occasions that individuals go through in their everyday lives. Our challenge is to identify where career guiding applications will fit in this process so embedded in one's life context.

Conditioned by the strength of social ties associated with each "access point", we believe there will be two forms of social ties on top of which next generation of career guiding applications could find fertile ground: 1. Career guiding applications which facilitate information exchange between very weak social ties 2. Applications that support relationship based on specialized social ties such as manger-employee relationship. In fact, we found most existing career guiding or career development applications such as SAP SuccessFactors, belonging to the second category and have already established user rapport within organizational boundaries.

3. Design Suggestions

Bourdieu's thinking creates new dimensions in the design of software application which aims to support individual career decision making. The shift is mainly an internal one, which moves our focus back to lives of users and re-situates our work – the creation of career guiding software application into the lives of people who are embedded in their particular life contexts [2] and make decisions within the boundaries define by their own possession of economic, social and cultural capital. Seeking to find a deeper connection between theoretical understanding and the development of career guiding applications, here we listed a few design guidelines inspired by this new understanding of "careership":

1) To make no assumption of user knowledge and impose no mental model on users. Career decision-making is both complex and subtle. Instead of assuming a linear process and gives user single access point to application functionalities, application should consider situational actions of users [9] by enabling flexible access points in a 'walk-up-and-use' design approach.

2) On top of current "hard and factual" features such as job search, skill development, learning assistance etc. , the next generation of career guiding applications will more likely to find breakthroughs on the soft side of the

problem domain by inventing novel mechanisms to facilitate growth of cultural and social capital in the form of pervasive and longitudinal learning [10].

3) Switching our stereotypical thought of career decision making from a one-shot decision-making process into a more embedded and gradual developmental process allows us to find the right position for career guiding applications in the overall picture of individual career decision-making by fostering specialized relationship unique to the properties of this channel [11].

4. Conclusion

In this brief discussion of career guiding application design, we highlighted major deficiencies in underlying assumptions of contemporary application in this domain, which reply exclusively on individual’s ability to make career decision. We turned to Bourdieu’s thinking and positioned career decision-making in an embedded market exchange of social, economic and cultural capital. In our analysis of the new framework, we proposed new design guidelines for the next generation of career guiding applications, which we believe will find amble growth opportunities by fostering development of social and cultural capital in additional to instrumental abilities and skills.

References

1. Bourdieu, Pierre, and Jean-Claude Passeron. Reproduction in education, society and culture. Vol. 4. Sage, 1990.
2. Dourish, Paul. Where the action is: the foundations of embodied interaction. MIT press, 2004.
3. Hodkinson, Phil, and Andrew C. Sparkes. "Careership: a sociological theory of career decision making." British Journal of Sociology of Education 18.1 (1997): 29-44.
4. Holland, John L. Making vocational choices: A theory of vocational personalities and work environments . Psychological Assessment Resources, 1997.
5. Jansen, Christoph, et al. "Knowledge Portals for Business Engineering: A Reference Architecture." Proceedings of the Third International Conference on the Practical Application of Knowledge Management. 2000.
6. Krumboltz, John D., Anita M. Mitchell, and G. Brian Jones. "A social learning theory of career selection." The Counseling Psychologist (1976).
7. Powell, Darrell F., and Darrell Anthony Luzzo. "Evaluating factors associated with the career maturity of high school students." The Career Development Quarterly 47.2 (1998): 145-158.
8. Roberts, Kenneth. "The developmental theory of occupational choice: a critique and an alternative." People and work (1975).

9. Suchman, Lucy. "Plans and situated actions." New York, Cambridge University(1986).
10. Super, Donald E. "A life-span, life-space approach to career development."Journal of vocational behavior 16.3 (1980): 282-298.
11. Zelizer, Viviana A. The purchase of intimacy. Princeton University Press, 2009.

Design Tutoring Feedback to Increase Online Learners' Satisfaction

Yuhui Ma[1], Ronghuai Huang[2], Xiaoying Zhang[2], Jiong Guo[3]

[1]Educational Technology Research Institute, Bohai University, Liaoning Province, China
shixiaoran@163.com

[2]R&D Center for Knowledge Engineering, Beijing Normal University, Beijing, China
{huangrh, zhangxy-bnu}@bnu.edu.cn

[3] Educational Technology College, Northwest Normal University, Gansu Province, China
guoj72@163.com

Abstract. Online learners' persistence and high dropout rate is a crucial problem in online learning context. Online learners' satisfaction is a major factor affecting persistence. How to design feedback strategies to promote learners' engagement is a problem that needs to be solved. In this paper, the factors affecting online learners' persistence is analyzed. Based on these results, feedback strategies for promoting online learners' persistent and decreasing dropout are presented from three perspectives: cognition, metacogntion and motivation. These strategies would direct to design feedback in the online learning context.

Keywords: Tutoring Feedback. Online Learning. Online Learners' Satisfaction.

1 Introduction

Online learning recently has become the focus of educational practitioners and researchers. More and more people register online learning, especial MOOC, which provide students the opportunities to study from excellent teachers around the world at anywhere and anytime if they want. However, high dropout rates have

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_16

been the central crisis for online learning[1]. So, one of the most difficult challenges of for online learning researches is to find out the factors influencing the students dropout, or to find out the methods to contain the completeness. Researches have proved that students' satisfaction is a major factor in students' decision to complete or drop from online learning. Persistent students or completers often had significantly higher satisfaction with online learning than dropout students[2].Meanwhile, students' satisfaction is also a key indicator of online learning performance. Students who reported higher levels of satisfaction with learning reported higher levels of learning than students who rated their satisfaction level as lower[3]. If students are satisfied, they are more likely to be successful.

Feedback is recognized one of the most powerful tools to promote learning in various instruction contexts, especial in online learning environments[4]. Online learners may incline to discourage or frustrate whenever the problems could not be solved by themselves, and discouragement and frustrating would directly lead to dropout. So feedback is very important to persist the students and promote students' satisfaction.

The strategies of feedback have been studied on how to promote the students' performance in the classroom or online environments. But few of researchers focus on how to design tutoring feedback to persist online learners or decrease dropout in online environments. In this paper, online learning feedback strategies for online environments is presented. These strategies would be directed to design or predict the persistence of online learning environments. In the following sections, we firstly summarized the factors influencing online learners' satisfaction. Based on these analysis, the online feedback strategies were presented. The final section presents the conclusion and some future relative researches.

2 The Factors affecting Online Learners' Satisfaction

Students' satisfaction with online learning is very complex, and it has been found to be correlated with a number of variables. Sun(2008) presented an integrated model with six dimensions to find out the critical factors affecting learners' satisfaction in e-learning. The six dimensions are learners, instructors, courses, technology, design and environment[5]. Sun analyzed the factors from macro point of view, there are others researchers who studied from micro point of view to identify the factors affecting learners' satisfaction. These factors are motivation, computer anxiety, self-regulated skill, cognitive strategy, metacognitive skill, family or organization support, prior experiments of online learning etc al [6],[8].

According to Piccoli(2001) and Sun(2008), computer anxiety significantly affects online learners' satisfaction. Learners must access materials and study by computer, so fears of information technology would certainly hamper satisfaction[8],[3]. Self-regulation is another factor of success in online learning. In online learning environments, learners must regulate the time, control learning pace and strategies by themselves. So self-regulation may be more important for learners in online learning environments than in the traditional environments[3],[4],[5]. Cognitive strategies are the strategies employed by a learner to in the learning process. Specific strategies are rehearsal, elaboration, and organization. The research found that students who reported using cognitive strategies were likely to do better than those who reported less using cognitive strategies[3],[6]. Metacognitive skill, such as help-seeking skill is also important for learners in the context of online learning. Proper help-seeking skill would reduce the time of self-solving problems, and finally decrease the frustrating.

3 The Strategies of Tutoring Feedback to Increase Online Learners' Satisfaction

Proper feedback mechanisms are important to online learners because feedback provides a virtual bridge between learners and instructors, which will improve the learners' satisfaction. With the factors that contribute to students' satisfaction in online learning, we can intentionally design appropriate feedback strategies to improve students' satisfaction and engagement, decrease the rate of drop out[7]. According to the content, feedback can be classified into three dimensions: cognitive feedback, metacognitive feedback, and motivation feedback. Therefore feedback strategies of increasing online learners' satisfaction can be made from these three perspectives.

3.1 Cognitive feedback strategies

Cognitive feedback strategies of increasing learners' satisfaction can direct to design feedback presentation. There are three types of feedback to present, static text or pictures, audio, video. Researches showed that learners preferred to audio or video feedback instead of text feedback. There is an important evidence that audio or video feedback can have an impact on student engagement and strengthening learning motivation[10]. Audio or video feedback is very understandable, clear and fit to explain the complicated knowledge, so learners would more easily get the emphasis from the tone and facial expression of video by watching and listening video than reading feedback. Besides, the feedback about cognitive strategies that can remind learners to apply cognitive strategies such as rehearsal, elaboration, and organization would be taken in the online context.

3.2 Metacognitive feedback strategies

Metacognitive feedback is defined as feedback that triggered by learners' learning behavior (e.g., waste lots of time to think, avoid necessary help). Based on detecting learners' error learning behaviors, metacognitive feedback conveys the information to remind learners the desired learning behavior(e.g., advising the student to ask for a hint). Roll(2011) reported that immediate metacognitive feedback on learners' help-seeking errors can help students acquire better help-seeking skills[11], which would save the wasting time and decrease frustration.

3.3 Motivated feedback strategies

Motivation is a critical factor affecting learners' satisfaction in the online context. It is important to design feedback to promote learners' motivation. Researchers also reported that many learners ignore feedback completely or in some extent. Therefore, it is important to design feedback to promote motivation and engage learners. Embodying an agent that delivers feedback is a good manner. But embodying an agent is not always effective. Lin(2013) reported that the feedback provided by an agent or non-agent is not difference, but the difference is significant when the feedback provided by an agent with elaborate verbal feedback compared to the same agent providing simple verbal feedback. During the process of learning with an agent delivering elaborated feedback, learners' social-interaction schema and meaningful learning are more evoked by the agent providing elaborate verbal feedback than the agent providing simple verbal feedback[9].

4 Conclusion

There are many factors that affect learners' satisfaction in the online learning context. Designing feedback strategies based on these affecting factors would persist online learners and decrease dropout. In this paper, several feedback strategies from cognitive, metacognitive and motivation perspective are presented for increasing online learners' persistence. We propose that these strategies will be taken in the online learning systems.

Reference

[1]Hart, Carolyn.: Factors Associated With Student Persistence in an Online Program of Study: A Review of the Literature. Journal of Interactive Online Learning 11.1 (2012).

[2] Levy, Yair.: Comparing dropouts and persistence in e-learning courses. Computers & education 48.2 (2007): 185-204.

[3] Fredericksen, E., Pickett, A., Shea, P., Pelz, W., & Swan, K. (2000).: Student satisfaction and perceived learning with on-line courses: principles and examples from the SUNY learning network. Journal of Asynchronous Learning Networks, 4(2), 7–41.

[4] Gikandi J W, Morrow D, Davis N E.: Online formative assessment in higher education: A review of the literature[J]. Computers & Education, 2011, 57(4): 2333-2351.

[5] Sun, Pei-Chen, et al. What drives a successful e-Learning? An empirical

investigation of the critical factors influencing learner satisfaction.: Computers & Education 50.4 (2008): 1183-1202.

[6] Shih, C., T. Ingebritsen, J. Pleasants, K. Flickinger, and G. Brown, G. 1998.: Learning strategies and other factors influencing achievement via Web courses. Proceedings of the 14th Annual Conference on Distance Teaching and Learning (359–363). Madison, WI. (ED 422876).

[7] Palmer, Stuart R., and Dale M. Holt. :Examining student satisfaction with wholly online learning. Journal of computer assisted learning 25.2 (2009): 101-113.

[8] Piccoli, Gabriele, Rami Ahmad, and Blake Ives. :Web-based virtual learning environments: A research framework and a preliminary assessment of effectiveness in basic IT skills training. MIS quarterly (2001): 401-426.

[9] Lin, Lijia, et al.: Animated agents and learning: Does the type of verbal feedback they provide matter?. Computers & Education 67 (2013): 239-249.

[10] Crook, Anne, et al.: The use of video technology for providing feedback to students: Can it enhance the feedback experience for staff and students?.Computers & Education 58.1 (2012): 386-396.

[11] Roll, Ido, et al.: Improving students' help-seeking skills using metacognitive feedback in an intelligent tutoring system. Learning and Instruction 21.2 (2011): 267-280.

Acknowledgements

This work was supported by Chinese National Education Science Planning Primary and Secondary School Mathematical Subject: E-textbook Design and Applying for Junior High School Students (GIA117015). This work was also supported by Liaoning Province Social Science Fund: Based on Evidence Pretention and Control Research for Middle Students Overuse Internet (L13DSH020).

Developing the PETAL e-Learning Platform for Personalized Teaching and Learning

Kelly Liu[1,*], Victoria Tam[2,*], Phoebe Tse[1,*], Edmund Y. Lam[3] and Vincent Tam[3]

[1] Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA 02139, U.S.A.
{kellyliu,phoebet}@mit.edu

[2] Department of Mechanical Engineering, Massachusetts Institute of Technology, 77 Massachusetts Ave, Cambridge, MA 02139, U.S.A.
vtam@mit.edu

[3] Department of Electrical and Electronic Engineering, The University of Hong Kong, Pokfulam Road, Hong Kong
{elam,vtam}@eee.hku.hk

Abstract. Mobile devices significantly reshape our various aspects of livings. Yet prolonged contacts with mobile devices may cause eye and/or muscle fatigues especially for young children. In this paper, we consider the integration of web cameras as image sensors available on most tablets or smartphones with an interesting tracking algorithm to continuously monitor and analyze the learners' responses through their facial orientations and eye movements to build the ***PE***rsonalized ***T***eaching ***A***nd ***L***earning, namely the PETAL, platform for nurturing the academic development of our young learners while protecting their eyesight. Through the in-depth studies of various Android programming toolkits with the Open Source Computer Vision library, we explore many possible ways to detect the viewers' responses to educational videos as a mean of self-learning. With the capability of notifying learners of their, possibly unconscious, reactions to such educational videos, our platform is targeted to promote a truly personalized approach for developing the next-generation e-learning systems.

Keywords: Eye Tracking Algorithms · Facial Recognition Techniques · Mobile Devices · Personalized Learning · Smart Sensors.

1 Introduction

As mobile and sensor technologies advance extremely fast each day, the usage of mobile devices, smartphones and tablets proliferates. Children of the new generation especially find themselves being engaged in various activities, possibly

* The concerned authors contributed equally to this work.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_17

be playing games on a mobile phone, exercising with the Microsoft Kinect [7], or even learning through a video playing on a tablet, in such a fast-changing world of technological ubiquity. Given the frequent use of technology, especially in the classroom, we find an ever pressing problem: e-Learning [1, 2] seldom tailors itself to each individual child, thus making it more difficult to determine each individual's true grasping or understanding of the taught material. However, at the same time, we find that Computational Intelligence [5], specifically the facial feature detection and recognition techniques [3, 4], is advancing very rapidly. With the availability of relevant computing and sensing technologies, we hereby propose a possible solution to that challenging problem of determining each learner's actual progress and/or real-time response to any involved online learning materials possibly delivered through the next-generation e-learning systems [2].

Up to our understanding, none of the existing e-learning systems can satisfactorily address our concern. Therefore, in this paper, we explore the applications of the Android programming libraries and the Open Source Computer Vision (OpenCV) software to develop the ***PE****rsonalized* ***T****eaching* ***A****nd* ***L****earning* (***PETAL***) e-Learning system that can help to detect and also continuously monitor each individual student's real-time reaction to any online material, especially the downloaded or streaming video clips, for personalized learning or self-revision through the PETAL e-Learning system. Essentially, through the integration of web cameras as smart image sensors available on most tablets or smartphones with a simple-yet-efficient tracking algorithm run on the mobile devices to continuously monitor and analyze the learners' responses through their facial orientations and eye movements, the PETAL e-learning platform can provide a truly personalized learning experience to nurture the academic development of our young learners while protecting their eyesight. When any learner is facing too close to view the concerned online material or video, the PETAL system will quickly alert the learner with a pop-up message being displayed. While bringing in many technical challenges to more accurately analyze the individual learner's "real-time" response through his/her facial orientation and eye movements, it is obvious that the PETAL e-Learning system imparts new opportunities for many potential applications in e-learning or other areas.

This paper is organized as follows. Section 2 considers the prototype implementation and its empirical evaluation results. Lastly, Section 3 will summarize our work and shed light on many possible directions for future investigation.

2 Our Prototype Implementation and Empirical Evaluation

To demonstrate the feasibility of our proposed e-learning system, a prototype of the PETAL platform was carefully developed on the Android system (Version 4.3) with the OpenCV library (Version 2.4.5) and thoroughly tested in 6 man-months. Figure 1 gives the different diagrams showing the pupil detection and its use to determine the learner's distraction in various scenarios. There were some initial and positive students' feedbacks collected on our initial prototype and reported by a voluntary student group in HKU. For detail, refer to [6]. In addition, a more detailed evaluation and analysis will be carefully conducted in some selected courses in our Faculty of Engineering in the later part of 2014.

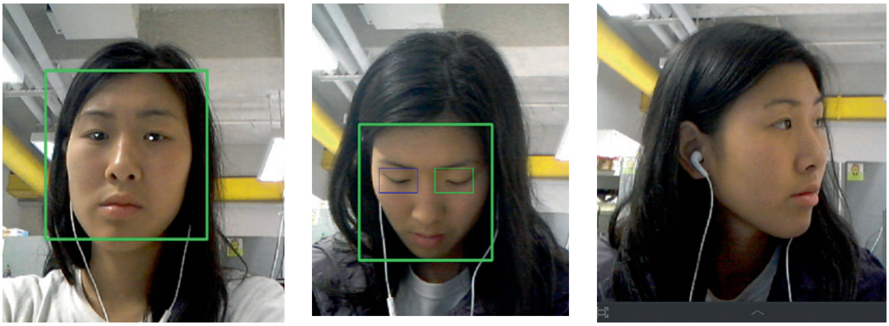


Fig. 1. Diagrams Demonstrating the Pupil Detection and Its Use to Determine the Learner's Distraction.

To provide more personalized learning experience to the user, our application also tracks at what time during the video the user was distracted, sleepy, or zoning out. At the end of the educational video, a summary will be generated for the user to view. The student can then use this summary to determine at what points of the video they were least focused and hence possibly most confused or uninterested in the presented material. At the bottom of the screen, the number of times the concerned learner was distracted, sleeping, or zoned out will be displayed to promote the self-evaluation of attentiveness after viewing each video.

3 Concluding Remarks

Mobile and sensor technologies advance so fast each day to continuously reshape the way we live and learn. In this paper, we consider an effective and interesting development framework of the PETAL e-learning system to build an interactive video player application fully integrated with sophisticated image processing techniques for detecting eye movement and head orientation on mobile devices enabling a new and personalized way of learning experience anytime and anywhere. In particular, our PETAL mobile application can alert any learner when his/her eyes are detected as being 'too close' to the mobile devices for protecting the eyesight. Furthermore, as Android tablets are becoming more popular in the global market of mobile devices, our PETAL application can potentially reach an incredibly large number of learners, thus very influential.

There are many possible directions for future investigations. Examples include the porting of our current implementation to the *iOS* platform, and a thorough analysis on the pedagogical impacts of our proposed PETAL e-learning system on different learners both inside and outside of the classroom. Furthermore, future enhancements in both hardware, such as any further increase in the speed of image frames captured by the underlying camera, and software with more powerful versions of the *OpenCV* library or more accurate facial detection methods should be considered. Last but not least, further cascade training and enhancement in the pose detection algorithms may help to promote the capability of our PETAL system to detect other relevant types of student responses like their confusion or frustration.

Acknowledgements. The support of MIT International Science and Technology Initiatives (MISTI) is gratefully acknowledged.

References

[1] S. Asteriadis, P.Tzouveli, K. Karpouzis and S. Kollias, "Estimation of behavioral user state based on eye gaze and head pose—application in an e-learning environment", Multimedia Tools Application (2009), 41:469–493, the Springer.

[2] V. Cantoni, M. Cellario and M. Porta, "Perspectives and challenges in e-learning: towards natural interaction paradigms", Journal of Visual Languages and Computing, 15 (2004), pp. 333–345, the Elsevier Ltd.

[3] C. Hennessey, B. Noureddin, P. Lawrence, "A single camera eye-gaze tracking system with free head motion.", In: Proceedings of the Symposium on Eye Tracking Research and Applications (ETRA '05), San Diego, CA, USA, pp 87–94, 2006.

[4] S. Ioannou, G. Caridakis, K. Karpouzis, S. Kollias, "Robust feature detection for facial expression recognition.", Int J Image Video Process 29081, 2007.

[5] J. Jang, "ANFIS: adaptive-network-based fuzzy inference systems.", IEEE Trans Syst. Man Cybernetics 23(3):665–685, 1993.

[6] T. Sabih, "PETAL: Learning the Android Way", The HKU Journal of Technology (TecHKU), URL at: http://www.engineering.hku.hk/tecHKU/2013/11/11/petal/, last visited in November, 2013.

[7] The Microsoft Kinect Development Team, "Kinect for Windows", URL at: http://www.microsoft.com/en-us/kinectforwindows/, last visited in April, 2014.

[8] The OpenCV Development Team, "The OpenCV", URL at: http:// http://opencv.org/, last visited in March, 2014.

Development of Weather Monitoring System based on Raspberry Pi for Technology Rich Classroom

Yongbin Hu[1], Ronghuai Huang[1,*]

[1] Collaborative & Innovative Center for Educational Technology , Beijing Normal University, China
Dochuyb@gmail.com
Huangrh@bnu.edu.cn

Abstract. The popularity of weather sensors has encouraged the advance of campus weather station, which helps to automatically or manually measure temperature, humidity, wind speed and direction, pressure, solar radiation and soil temperatures. Technology rich classroom, as the most important smart learning environment, need the weather data from campus weather station to provide comfortable environment. Most of weather monitoring systems (WMS) are implemented with high-cost sensing devices for detecting weather data of schools or colleges. In this study, we proposed a WMS which uses Raspberry Pi and weather Sensor to support weather monitoring. This system is a low-cost portable weather data collection system which allows collecting, storing and transmitting data.
Keywords: Raspberry Pi, Campus Weather Station, physical environment, classroom environment

1 Background and Motivation

Students spend up to 20,000 hours in classrooms by the time they graduate from university[1]. As an important learning space, the classroom serves for not only daily learning activities, but also health and security of the teacher and student. Since 1990s, researchers have regarded ICT as an effective way to enhance teaching and learning, and a variety of technologies, such as laptop computer, interactive whiteboard, projector, Internet access, productivity and curriculum-related software, and printer were gradually employed in the classroom to support teaching or learning with the implementation of school ICT programs.

The classroom equipped with various technologies is always called Technology Rich Classroom (TRC), which has enabled the emergence of a true

*Corresponding author: Ronghuai Huang
Email: huangrh@bnu.edu.cn

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_18

synchronous/asynchronous and virtual/physical matrix of learning opportunities for which our existing learning environment infrastructure is not well suited for children learn[2]. The emerging models of “technology enhanced learning environments” (TEAL) – first introduced at MIT in 2003 – proposed that acoustics, furniture, lighting (both natural and artificial), mobility, flexibility, air temperature and security must support the educational technologies being designed for those spaces[3]. At now, the rapid advances in technology have revolutionized the way in which the children learn, play communicate, and socialize[4].

However, majority of the technologies were employed to support teaching process, such as presentation, organization and integration of learning content, evaluation of students’ learning performance, mutual interaction between the student and the teacher, etc. The physical factors, such as temperature, humidity, noise, thermal, air pressure, ventilation, air quality, acoustic, dust, vibration, lighting, radiation were taken insufficient account. Additional, considerable evidence shows that there is an explicit relationship between the physical characteristics of school buildings, and the spaces within them, and educational outcomes[3]. Recently, more and more researchers have seen the importance of physical environment in the TRC, and providing the students with comfortable physical environment has cause concern of the academic community.

Based on the demands of new generation of students for the reform of learning environment and the analyzing of challenges for both the online learning environments and classroom former environments, Huang et al proposed the concept of “smart” learning environment which is the high level of digital learning environment with the aim at facilitating “easy, engaged and effective” learning for learners[5]. This concept of “smart” learning environment covers not only the devices and instructional software, but also the physical aspect of learning environment. To build an easy, healthy and comfortable environment is one objectives of the “smart” learning environment. As one of the most important component of smart learning environment, campus weather station is a kind of school or college facilities with the function of automated or manual measurements of temperature, humidity, wind speed and direction, pressure, solar radiation and soil temperatures updated every 10 minutes[6].

This paper is the further study of smart learning environment, which focuses on physical environment. The aim is to develop the WMS based on Raspberry Pi to collect weather data of the campus, and transmit to TRC which equipped with indoor environmental systems.

2 Relevant Works

In the past decades, various issues concerning weather monitoring have attracted the attention of researchers from both the fields of meteorology, computer science and education[7]. But the installation cost is still high, so their design optimization is desirable. In the following, we shall briefly introduce several well-known WMSs.

2.1 City Center Photovoltaic Monitoring Station

Wilshaw et al described the installation of a photovoltaic monitoring station in a city center in the north-east of England is described. [8]Weather monitoring instruments were installed to measure ambient temperature, wind speed and direction, relative humidity and solar irradiance. Four types of photovoltaic modules are mounted on the rig in typical building orientations in order to assess their performance with respect to photovoltaic cladding applications. Preliminary investigations have shown that the electricity generated by photovoltaic cladding on vertical surfaces experiences much less seasonal variation than that on a horizontal surface.

2.2 Silicon-cell Microcontroller-based Solar Radiation Monitoring System

Mukaro et al demonstrates the operation of a low-cost silicon pyranometer in combination with a self-designed low-power microcontroller-based data acquisition system for monitoring global horizontal solar radiation. [9] An A/D converter interfaced to a microcontroller-based unit records a set of sensors' signals, while the collected data are stored in a local EPROM. The data collected by the microcontroller are transmitted to a PC, with an RS-232 serial connection, where they are stored for further processing. The same architecture has been implemented for solar irradiation and ambient temperature measurements.

2.3 Photovoltaic-diesel Hybrid Energy Systems

Wichert et al developed and proposed in system in a different approach. [10] A commercial data logging unit has been used to measure a set of meteorological and operational parameters of a hybrid photovol- taic–diesel system. The collected data are transmitted to a PC through an RS-232 serial interface, where they are processed using the LabVIEW data acquisition software. However, a data logging unit lacks flexibility compared with a data acquisition card approach, while, in addition, it cannot be used for renewable energy system control.

2.4 Multi-tiered Portable Wireless System in Wildland Fire Environments

Hartung et al proposed FireWxNet, a multi-tiered portable wireless system for monitoring weather conditions in rugged wildland fire environments[11]. FireWxNet provides the firefighting community the ability to safely and easily measure and view fire and weather conditions over a wide range of locations and elevations within forest fires. This previously unattainable information allows fire behavior analysts to better predict fire behavior, heightening safety considerations. Our system uses a tiered structure beginning with directional radios to stretch deployment capabilities into the wilderness far beyond current infrastructures.

3 Description of weather monitoring system based on Raspberry Pi

3.1 What is Raspberry Pi

The Raspberry Pi is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation with the intention of promoting the teaching of basic computer science in schools[12]. Designed as an introduction to science, technology, engineering, and math for UK grade students, its $35 price tag has made it appealing to hobbyists all over the world. However, it was originally designed to get kids interested in computing, it has also developed a following among programmers looking for a smaller, cheaper medium for projects.

Fig. 1. A Raspberry Pi Model plugged in (Source: readwrite.com)

Despite its diminutive device, Raspberry Pi is powerful enough to process many of the same programs as PCs, from word processors to games. Its small size also makes Raspberry Pi ideal for programming connected home devices—like the aforementioned print server, which has given us the power to make every computer, laptop, and cell phone in our network printer-compatible[13], as is show in Fig.1.

Raspberry Pi owes its low price tag to advances in integrated chips. Instead of having a CPU, a GPU, a USB controller, and memory each on their own individual chips, Raspberry Pi uses a system-on-a-chip with all those components on a single chip. Without a lot of chips to take up space, the Pi itself can consist of a printed circuit board which boots up from an SD memory card.

3.2 Structure of Weather Monitoring System based on Raspberry Pi

WMS is the most important part of campus weather station. The system designed to collect and transmit weather data, including rainfall, wind speed & direction, outdoor temperature & humidity and barometric pressure. Requirements for the system are: (1) Measure weather-related data; (2) Capable of wireless transmittal of data; (3) Weather resistant; (4) Solar or battery powered. Therefore, the weather monitoring system consists of four parts: Internet access, solar or battery feed, weather sensors, gas sensors, screen is optional. The structure of the system is shown in Fig.2.

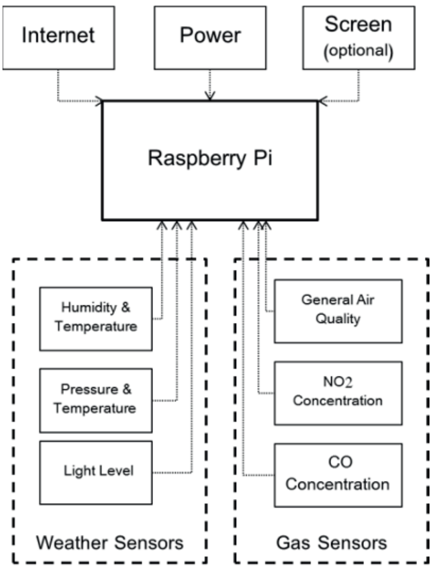


Fig. 2. Structure of WMS based on Raspberry Pi

The system is a low-cost portable weather data collection system which allows collecting, storing and transmitting data.

Internet. An internet connection can be supplied either via an Ethernet cable or a simple USB WiFi adapter which could be plugged directly into the Pi. To avoid the risks of disconnection by break of the cable, wireless connection is recommended.

Power. Solar and batteries are integrated into one cycle energy system, which is use to power the weather monitoring system.

Weather sensors. Weather sensors are a set of weather measuring instruments operated by a campus weather station. The quality and number of instruments can vary widely, and do not adhere to any standards, but normally includes four or more measured parameters. Most weather stations provide readouts of the data being collected.

Gas sensors. A gas sensor is a device which detects the presence of various gases within an area, usually as part of a safety system. Gas detectors can be used to detect air quality, NO2 concentration and CO concentration.

Screen. Screen in this system is optional. With the help of web application develop by PHP, the readout of weather data is shown on the screen from time to time.

4 Conclusion and Future Work

In this study, we propose a new approach on WMS, which uses low-cost portable Raspberry Pi equipped with weather sensors and gas sensors to collect, store and transmit weather data. The use of these low-cost and popular technologies makes WMS more available than most of the previously developed WMS. In addition to the consideration of availability, WMS provides a web application to show real-time weather data.

The system has been developed and piloted in several schools, the teacher and student from that schools very satisfied with this system. However, a deep research on its effectiveness is still in the air. To evaluate the effective of WMS, the indicator and approach would be the most important issue. We will make it a priority to evaluation the effectiveness of WMS.

References

[1] Fraser, B.J.: Twenty thousand hours: Editor'introduction. Learn. Environ. Res. 4, 1–5 (2001).

[2] OECD: OECD 21st Century Learning Environments, http://www.oecd.org/education/innovation-education/centreforeffectivelearningenvironmentscele/21stcenturylearningenvironments.htm.

[3] Barrett, P.S., Zhang, Y.: Optimal learning spaces: Design implications for primary schools. (2009).

[4] Mouza, C., Lavigne, N.: Introduction to Emerging Technologies for the Classroom: A Learning Sciences Perspective. Emerging Technologies for the Classroom. pp. 1–12. Springer New York (2013).

[5] HUANG, R., YANG, J., HU, Y.: From Digital to Smart: The Evolution and Trends of Learning Environment [J]. Open Educ. Res. 1, 75–84 (2012).

[6] Fort Collins weather station: About the Fort Collins Weather Station.

[7] Benghanem, M.: A low cost wireless data acquisition system for weather station monitoring. Renew. Energy. 35, 862–872 (2010).

[8] Wilshaw, A.R., Pearsall, N.M., Hill, R.: Installation and operation of the first city centre PV monitoring station in the United Kingdom. Sol. energy. 59, 19–26 (1997).

[9] Mukaro, R., Carelse, X.F., Olumekor, L.: First performance analysis of a silicon-cell microcontroller-based solar radiation monitoring system. Sol. Energy. 63, 313–321 (1998).

[10] Wichert, B., Dymond, M., Lawrance, W., Friese, T.: Development of a test facility for photovoltaic-diesel hybrid energy systems. Renew. energy. 22, 311–319 (2001).

[11] Hartung, C., Han, R., Seielstad, C., Holbrook, S.: FireWxNet: A multi-tiered portable wireless system for monitoring weather conditions in wildland fire environments. Proceedings of the 4th international conference on Mobile systems, applications and services. pp. 28–41 (2006).

[12] Cellan-Jones, R.: A £15 computer to inspire young programmers, http://www.bbc.co.uk/blogs/thereporters/rorycellanjones/2011/05/a_15_computer_to_inspire_young.html.

[13] Lauren Orsini: Raspberry Pi: Everything You Need To Know, http://readwrite.com/2014/01/20/raspberry-pi-everything-you-need-to-know#awesm=~oBoMwREEhm3Gof.

[April 14, 2014]

Digital Signage System for Learning Material Presentation Based on Learning Continuum

Hiroyuki Mitsuhara and Masami Shishibori

Institute of Technology and Science, The University of Tokushima, Japan
{mituahra, bori}@is.tokushima-u.ac.jp

Abstract. This paper describes an approach to presenting learning materials (videos) effectively through digital signage (DS) installed in public spaces on university campus. The authors propose Learning Continuum (LC), which means that students can view the learning materials from the beginning to the end. A prototyped DS system presents learning materials satisfying LC for a student by means of a high-power RFID reader.

Keywords: digital signage • learning material presentation medium • RFID • smart learning environment on campus

1 Introduction

Technology has changed people's activities. For example, ICT (information-communication technology) has enabled them to distribute and receive digital information anywhere at any time. While people recognize ICT's power and benefit, ICT is being hidden from people's eyes. In other words, ICT is being united with environment. The unification can be called "ambient computing/intelligence" or "smart environment". There have been many concepts, systems, and practices of smart environment (e.g., [1] and [2]).

Smart environment can be applied to learning support—smart learning environment (SLE). García et al. [3] proposed an SLE model focusing on collaborative e-Learning, where the network between students and learning communities supported by teachers are created and the students can share learning resources and collaborate (communicate) with others. Scott et al. [4] developed a context-aware learning support system, which recommends learning resources based on learners' location, schedule, device (e.g., smartphone), etc.

The first author's group launched a learning support project called "Niche-Learning" and developed a digital signage system [5]. "Niche-Learning" is a coined term from "niche" representing the break time between lectures and "e-Learning". This project aimed at promoting university students to learn outside of lecture rooms—enlarging learning environment on campus with digital signage.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_19

During the break time between lectures, the system presents learning materials (e.g., slideshow and video) through computer displays installed in public spaces on university campus. To catch students' eyes, as the second step, the system had the interactivity that superimposed the viewers (students) on a quiz slideshow and enabled them to answer the quiz by body movement. To present learning materials suitable for students, as the third step, the authors extend the system to SLE. The extension is based on the concept of Learning Continuum (LC), which means that students can view learning materials from the beginning to the end.

2 Niche-Learning

The break time between lectures can be regarded as a potential learning opportunity on campus even if it is short. The Niche-Learning (NL) project focuses on digital signage (DS), which is an information presentation medium using computer displays for public spaces and many unspecified people, as a learning material presentation medium. The NL project provides students with a short-time learning opportunity in public spaces on campus during the break time. In other words, the NL project provides DS-based learning environment.

Students often spend their break time together with friends in a lounge area. Or, they walk out of a lecture building soon after the lecture ends. If a DS system is installed in the lounge area or the entrance hall, they can learn from learning materials presented on the public display.

In the NL environment, they happen to notice a NL material and decide whether to view the material based on time, place, and their various conditions (e.g., interest, activity schedule, and accompanying friends). Although the NL environment does not ensure that they learn from the material, it can provoke accidental group learning (e.g., discussion) by enabling them to view the same material at the same time and place.

The DS system presents NL materials according to a schedule set by an administrator. When a presentation (delivery) time comes, the system opens the corresponding NL material (file) on a video player or a slideshow viewer. The schedule is partially illustrated in Fig.1. In many cases, the break time is less than 15 minutes except for the lunch break. Therefore, NL materials are less than 15 minutes and concise in terms of content.

```
<content><file><path>C:\Users\nl\001.mpg</path></file>
<delivery><minute>1</minute><second>30</second><start><hour>9</hou
r>
<minute>0</minute><second>0</second></start></delivery></content>
```

Fig. 1. A partial example (XML file) of NL material presentation schedule: 001.mpg is opened at 9 a.m. and is played for 90 seconds.

The DS system was installed in a lounge area and an entrance hall on campus at the University of Tokushima. Then, for the past 4 years, it presented NL materials about English conversation, disaster prevention, etc. However, it was found that many students did not view the NL materials—they passed by the system without stopping. The authors felt the major causes as follows.

(1) In the break time, students do not have enough time to view a NL material being presented.
(2) If having enough time but no interest in the NL material, they do not view it.
(3) If having interest in the NL material, they view it for a second. If viewing it from the middle, however, they do not continue to view it.

Concerning (1), fundamental solutions including expansion of the break time may be desired. Concerning (2) and (3), the system can remove the causes by realizing smart NL material presentation.

3 Learning Continuum

For the realization of smart NL environment, it is necessary to define what ideal learning in the NL environment is. If it is ideal that students can frequently learn from NL materials, they should be given on-demand learning environment available for their personal terminals (e.g., smartphone) rather than DS-based learning environment.

Currently, this study focuses on how they can continue to view NL materials only through the DS system, while understanding the availability of such an on-demand learning environment. As the ideal learning, the authors propose the concept of Learning Continuum (LC). LC is defined as follows: *"In the NL environment, a student views NL materials from the beginning to the end discontinuously but accordingly."* Furthermore, LC is divided into the following two definitions (conditions).

- LC1 (for one NL material): *"Within a certain time of viewing a NL material partially, the student views the NL material from the beginning to the end."*
- LC2 (for more than one NL material): *"Within a certain time of viewing a NL material fully (from the beginning to the end), the student views another NL material partially."*

According to the definitions, LC1 is prerequisite for LC2. In other words, LC1 should be preferentially satisfied. Therefore, it is important that the DS system enables the student to restart viewing the NL material smoothly before he/she forgets its partial content. Based on LC1 and LC2, the ideal learning—satisfying LC—in the NL environment means that a student views NL materials fully through divergent steps from one NL material.

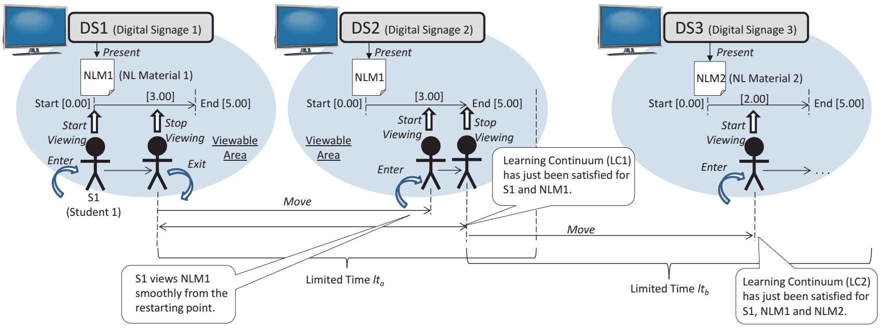


Fig. 2. An example of satisfying LC

Fig. 2 illustrates a case of satisfying LC. In this figure, a student (S1) views two NL materials (NLM1 and NLM2) through DS1, DS2, and DS3. Through DS1, S1 starts viewing NLM1 from the beginning and then stops viewing after 180 seconds. Within a limited time (lt_a), through DS2, S1 happens to restart viewing NLM1 from the restarting point he/she stopped viewing and then views it to the end. At this time, LC1 is satisfied for S1 and NLM1. Within another limited time (lt_b), through DS3, S1 views NLM2 from the middle. At this time, LC2 is satisfied for S1, NLM1, and NLM2.

4 Extended System

Although students pass between lecture rooms and public spaces on campus, they do not necessarily pass in front of the DS systems. Therefore, as the required setting for satisfying LC, the DS systems have to be installed in many public spaces and connected for data exchange. As the required function for satisfying LC, the DS systems have to identify the students. The extended (prototyped) DS system aims at intentionally providing each student with such a case like Fig. 2.

4.1 Design Overview

To satisfy the requirements, the extended system has a client-server architecture (centralized architecture) shown in Fig. 3. There are more client systems than one on campus. Each client system, which has a large display, communicates with the server system via the Internet and stores NL materials in its local disk. The server system, implemented in the LAMP software combination, works as data server for satisfying LC.

Client System. For the student identification, each client system has a high-power RFID reader—the area covered by the RFID reader is called "viewable area" and forms an irregular fan with about a 5-meter radius in front of the display. This means that students have to carry their passive RFID tags in the smart NL environment. The client system receives IDs of the students being inside the viewable area from the RFID reader and sends viewing data (student ID, NL material ID, etc.) to the server system.
Server System. The server system, which has software interface between the client system and the internal database consisting of student data, viewing data, and NL material data, selects a NL material to be presented for the student identified by the client system.

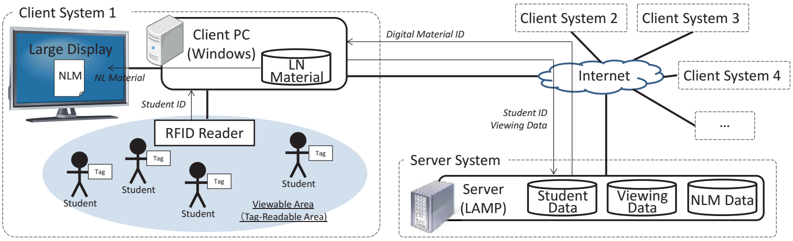


Fig. 3. The architecture of the extended system

4.2 Behaviors

Fundamentally, the client system presents NL materials according to the schedule—NL material presentation like this is called "fundamental mode". When a student enters the viewable area in the fundamental mode, the client system sends the received ID (his/her student ID) to the server system.

NL Material Selection. When receiving the ID from the client system, first the server system selects a NL material that satisfies LC1.
Satisfying LC1. The server system gets his/her viewing data from the database and selects a NL material according to the following steps.

i. Searches for NL materials that he/she viewed from the beginning to the middle.
ii. Selects the NL material with the highest value of p (priority for selection) calculated by the following formula when some NL materials are found. The NL material with $p<0$ is out of selection.

$$p = (te_i - ts_i) \times \{lt_a - (ct - te_i)\}$$

i: NL material's ID, ts_i: starting time of viewing, te_i: ending time of viewing, ct: current time, lt_a: limited time for LC1, te_i-ts_i: viewing time, ct-te_i: elapsed time from the ending time of viewing
iii. Sends the selected NL material's ID and his/her restarting point (time) of the selected NL material to the client system. [Occasionally End]

iv. If a NL material is not selected through the above steps, the server system searches for NL materials that he/she viewed from the middle to the middle.
v. Selects the NL material with the highest value of p in the step iv.
vi. Sends the selected NL material's ID and "0" (second) as the restarting point to the client system. [End]

Satisfying LC2. When a NL material that satisfies LC1 is not selected, the server system searches for NL materials related to the current NL material (being presented in the fundamental mode) in order to satisfy LC2. The NL materials are tree-structured in the NL material data. The server system, which currently adopts breadth first search, selects the first one of NL materials that the student has never viewed, as the related NL material to be presented.

NL Material Presentation. If receiving the selected NL material's ID and the restarting point from the server system, the client system immediately stops presenting the current NL material and (re-)starts presenting the NL material corresponding to the received ID from the restarting point―NL material presentation like this is called "interrupt mode".

In the interrupt mode, even if other students enter the viewable area, the client system does not send their IDs to the server system. This means that the current NL material is not switched continuously like multiple interrupt. When another student enters the viewable area, the client system records his/her student ID, the current NL material's ID, and the current time as ts_i. When he/she exits or the current NL ends, the client system additionally records the current time as te_i and sends the recorded data to the server system―the server system stores the received data as the viewing data. Table 1 shows an example of the viewing data.

Table 1. An example of viewing data.

Student ID	NL material ID	Starting time of viewing	Ending time of viewing
1	2	2014.1.15 10:16.18	2014.1.15 10.16.22
2	2	2014.1.15 10:16.05	2014.1.15 10.16.12
3	2	2014.1.15 10:16.20	2014.1.15 10:16.27
4	2	2014.1.15 10:16:00	2014.1.15 10:19.00
5	2	2014.1.15 10:18.00	2014.1.15 10:19.00
4	3	2014.1.15 10:19.00	2014.1.15 10:21.00
5	3	2014.1.15 10:19.00	2014.1.15 10:24.00
5	4	2014.1.15 10:26.00	2014.1.15 10:27.00
5	5	2014.1.15 10:30.00	2014.1.15 10.31.00

4.3 Example

Fig. 4 shows an example of NL material presentation for satisfying LC1, linking the viewing data shown in Table 1. In this example, when a student (S4) enters the viewable area of DS1 in the fundamental mode, DS1 presents NLM2 for S4. After that, DS1 presents NLM3 related to NLM2. When another student (S5) enters the viewable area in the interrupt mode, DS1 records his/her student ID (=5), NLM3's ID (=3), and his/her ts_i (=10:19.00). When S5 exits, DS1 sends his/her te_i (=10:24.00) and the recorded data to the server system. When S5 enters the viewable area of DS4, DS4 restarts presenting NLM3 from the elapsed time (=5.00) as his/her restarting point. S5 views NLM3 to the end. At this time, LC1 is satisfied for S5 and NLM3. Immediately after that, DS4 presents NLM5 related to NLM3. At this time, LC2 is satisfied for S5, NLM3, and NLM5.

When S5 enters the viewable area of DS4, the server systems searches for NL materials that he/she viewed from the beginning to the middle and three NL materials (NLM3, NLM4, and NLM5) are found. Concerning NLM3, the calculated value of is p is $3,240,000$ (te_i-ts_i=300, ct-te_i=$7,200$, and lt_a=$18,000$). Concerning NLM4 and NLM5, the values are p=$658,800$ and p=$673,200$. Therefore, NLM3 is selected.

Fig.5 shows the extended system installed into two public spaces. The RFID reader (antenna) is set under the larger display. Currently, video is only available for the smart NL material presentation.

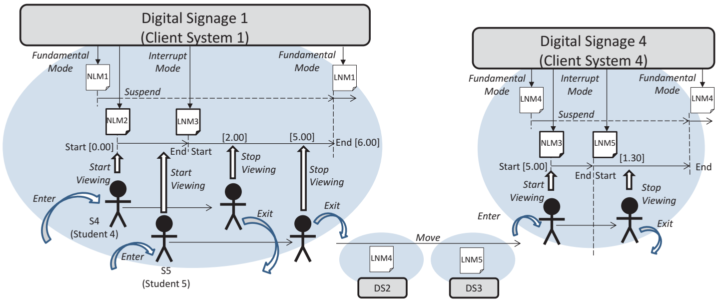


Fig. 4. An example of NL material presentation for satisfying LC1 and LC2

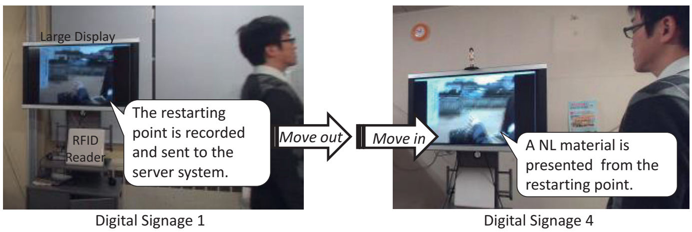


Fig. 5. Example snapshots of smart NL material presentation

5 Conclusion

This paper described a smart learning environment using digital signage (DS), proposing the concept of Learning Continuum (LC) so that students can continue to view learning materials (videos) in public spaces on campus.

There have been many issues in the smart learning environment. The fundamental issue is whether the extended DS system based on LC is necessary—how many students receive the benefit by the system. If an on-demand learning environment is available, students can view learning materials on their personal terminals and do not have to rely on a limited number of public displays. Understanding the extended system's limitations, this study explores how DS can contribute to smart learning environment and then integrates on-demand learning environment and DS. Although currently focusing on learning material presentation for one student, the extended system should focus simultaneously on some students. Concerning this, the authors optimistically think that the current learning material presentation covers not only one student but also his/her friends. This is because students often spend their break time together with friends who have similar characteristics (e.g., interest and registered lectures) and it may be easy to select learning materials that they want to view commonly. As a matter of course, the extended system has to be evaluated through large-scale practical use on campus.

Acknowledgement

This study was supported in part by Grant-in-Aid for Young Scientists (A) No. 24680079 from the Japan Society for the Promotion of Science. Thanks are expressed to Mr. Sumikawa, T. and Mr. Kangawa, H. for their efforts in extending the system.

References

[1] Gouin-Vallerand, C., Abdulrazak, B., Giroux, S., Dey, A.K.: A Context-aware Service Provision System for Smart Environments Based on the User Interaction Modalities, *Journal of Ambient Intelligence and Smart Environments*, Vol. 5, pp. 47–64 (2013)

[2] Borrego-Jaraba, F., García, G.C., Ruiz I.L., Gómez-Nieto, M.Á.: An NFC Based Context-aware Solution for Access to Bibliographic Sources in University Environments, *Journal of Ambient Intelligence and Smart Environments*, Vol. 5, pp. 105–118 (2013)

[3] García, Ó., Tapia, D.I., Alonso, R.S., Rodríguez, S., Corchado, J.M.: Ambient Intelligence and Collaborative E-learning: a New Definition Model, *Journal of Ambient Intelligence and Humanized Computing*, Vol.3, Issue 3, pp.239-247 (2011)

[4] Scott K., Benlamri, R.,: Context-Aware Services for Smart Learning Spaces, IEEE Transactions on Learning Technologies, Vol.3, No.3, pp.214-227 (2010)

[5] Matsumoto, J., Mitsuhara, H., Uosaki, N., Teshigawara, M., Yano, Y.: Learning Material Creation by Student Participation for Niche-Learning, *IADIS International Journal on WWW/Internet*, Vol.7, No.2, pp.31-46 (2009)

[6] Mitsuhara, H.: An Interactive Digital Signage System Using Live-video Superimposing and Quiz Slideshow, *The Journal of Information and Systems in Education*, Vol.11, No.1, pp.62-68 (2012)

Dividing Learning Process in Classroom with One-to-One Technology into Small Segments: Accurately Locating Students' Learning Status

Guangde Xiao[1], Ronghuai Huang[2,*]

Collaborative & Innovative Center for Educational Technology,
Beijing Normal University, Beijing, China
[1] xiaoguangde@163.com
[2] huangrh@bnu.edu.cn

Abstract. In order to provide suitable support for students, the first thing is to locate the status of student and know about what problem the student might encounter. Dividing learning process into small segments, each of which represents a knowledge unit or a small learning objective, can reduce the complexity of the learning process and make the locating of students' learning status more precisely. In the classroom with one-to-one technology, dividing learning process into small segments can be used to build automatic tracking and recording system of students' learning status.

Keywords: Learning process • Learning status • One-to-one technology

1 Introduction

In modern learning theory, learners are active constructors of knowledge and play an active role in the learning process [1].When learners encounter difficulty in the learning process, teachers should respond to the learners' difficulty in time and provide suitable guidance or learning resources for remediation [2]. In fact, for the sake of providing suitable support for student, the first thing is to know about which student and what problem the student might encounter. In another word, accurately locating the status of students is the prerequisite for the realization of this purpose. In an ordinary classroom, it is very difficult for teacher to grasp each student's situation in time. But in circumstance with one-to-one technology, every student owns and regularly uses a personal computing device [3], such as tablet. Majority of the important information reflecting student's learning situation can be recorded via the interactive multimedia instruction system running on the computing device. Based on the data recorded, teacher can know about each student's learning status in time after class even during the class time.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_20

The purpose of this paper is to propose the idea of dividing learning process into several small segments so as to accurately locating learners' status in the classroom with one-to-one technology.

2 Learning Process in Classroom with One-to-One technology

2.1 Definition of Learning Process

For the sake of implementing course objective, based on learning theories, such as behaviorism, cognitivism or constructivism, teacher will design various learning activities according to characteristics of students and features of learning content. The learning of each class is ordinarily composed of several learning activities. From the perspective of a course, the learning process consists of all of the class time in a semester. But for precisely analyzing the situation of every student's learning, we would rather choose the learning process of per class time than of learning process of a semester. So learning process can be defined as the combination of a serial of learning activities in a class time. As shown in the figure 1, the length of each rectangle represents the duration of each learning activity. The patterns filled in each rectangle represent the types of learning activities.

Fig. 1. Leaning process is composed of serial learning activities

2.2 Complexity of Learning Process

As there are many differences in learning content, learning objective, and etc., teacher usually takes combination of different learning activities. The learning process of each class time is different compared with others. Learning process is full of complexity.

Firstly, there are many types of learning activities such as listening, reading, writing, practicing, executing experiment, discussing within group, communicating among teacher and students, cooperating to complete a task, making project plan, and so on. Secondly, there is no fixed order of various learning activities. Teacher usually takes the predesigned sequence of learning activities. Even facing the same course content, teachers also might take different instructional strategies according to their teaching philosophy. It will lead lots of huge differences between the different sequences of learning activities. Thirdly, the duration of various learning activities is also not fixed. Although the teacher has detailed plan beforehand, the implementation of learning activities may be adjusted according to the feedback of the students.

In fact, there are still a lot of uncertain factors in learning process. For example, students often engage in many roles in the learning activities. Kolb argued that in the process of learning one moves in varying degrees from actor to observer, from specific involvement to general analytic detachment [4]. The complexity has caused great difficulties to accurately grasp the situation of students. Although Flanders Interaction Analysis System (FIAS) is successful in analyzing the interactive content between teacher and students [5], it can not apply to all types of learning activities in the classroom.

2.3 Characteristics of learning Process in Classroom with One-to-One technology

When classroom is equipped with one-to-one technology, the learning process show characteristics which is different compared with the learning process in ordinary classroom. The implementation of many learning activities will be carried out on the support of information technology device and digital learning resources. Teacher will use interactive multimedia instruction system, such as eClicker, to present learning content, raise question, arrange exercises, and etc. Students use one-to-one device to read learning content, answer question, do exercise, take peer instruction and peer evaluation, and so on. Students can take advantage of one-to-one technology to fully participate in various learning activities.

Depending on whether or not use information technology equipment, learning activities can be divided into two categories. One is without information technology device, the other need the support of digital resources of software and hardware. In this way, learning activities can be listed in a table like table 1 in accordance with the sequence of their appearance in the learning process.

Table 1. List of learning activities in learning process

NO.	Title	Participants	Duration	IT
01	Read the definition of Ohm's Law	Each student	2:30	Yes
02	Discuss the phenomena of the heat generated by an incandescent	Group	3:30	No
03	Execute exercise of Ohm's Law	Each student	4:00	Yes
…				

3 Principles of Dividing Learning Process

The purpose of dividing learning process into small segments is to accurately locating what content the students has learnt [6] and what problem students has encountered. Each segment should represent a small learning objective which usually need students to grasp a knowledge unit, such as a concept, a formula, a rule, or a paragraph of text. The learning in classroom is to implement the course objective under the organization of teacher and school. Each learning activity is carried out for implementing part objectives of the whole course. Within the same temporal and spatial relationship, students learn in the same pace. Based on these conditions, it is possible for teacher to divide the learning process into small segments and necessary to follow principles described below:

- In most instances, every learning activity will be considered as a segment, unless it is too long or it includes too much learning content. When the duration of learning activity exceeds three minutes, it should be divided into two segments. If the learning activity needs students to do more than one exercise, each exercise should be regarded as a segment. Every segment should contain a single atomic knowledge unit. That means the learning content embraced in each segment or its learning objective can not be divided again.
- When learning activity is too short and doesn't represent an entire knowledge unit, two learning activities or more can be seen as a segment.
- For the frequent interaction between students and teachers in a period, the segment can be defined according to the topic of the communicate content.
- The learning activity finished just by one student should be regarded as a segment.
- For the collaborative learning activities among a group, despite of doing different thing each student, it also can be regarded as a segment that every student participates in.

According to these principles, learning process can be redefined as the combination of a serial of segments in each of which students usually need to learn a small knowledge unit. Figure 2 shows a comparison of the relationship between learning activities and segments. LA represents learning activity. S represents segment. One-to-one technology is used in the segment marked with bold black line. The data of students' learning status in these segments should be tracked and recorded.

Fig. 2. Comparison of the relationship between learning activities and segments

4 Locating System Based on One-to-One Technology

As most of learning activities are carried out based on interactive multimedia instruction system (IMIS) in the classroom with one-to-one technology, the function of locating learning status should be integrated into it. As shown in the figure 3, the locating system (LS) for tracking and recording students' status is a component of IMIS based on one-to-one technology and is running on the server. Using IMIS running on teacher's device, teacher sends a command to LS to initiate a learning segment via Internet/Intranet. The learning resources of the segment will be delivered to each students' device by LS and the relative information concerning with the learning contents and learning objectives will be recorded by LS. When students finish a segment, the relative data reflecting students' status will be transmitted back to LS and recorded in the database of learning status.

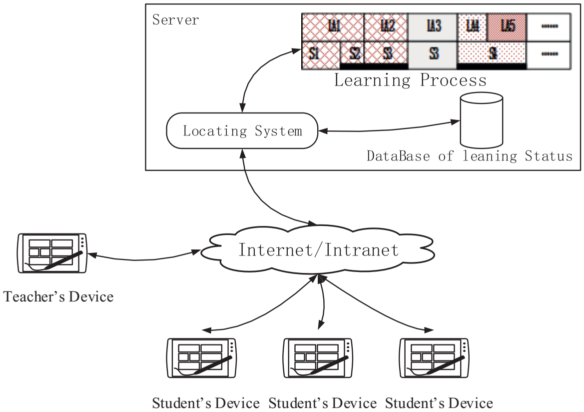


Fig. 3. Locating System in IMIS

For the sake of implementing accurately locating student's learning status, teacher will design the learning process and divide it into small segments according to the principles described above in advance. The learning contents will be organized in accordance with the learning activities and distributed to each segment. The design of the learning process and related learning resources are stored on the server.

5 Discussion

Tracking students' learning status so as to provide appropriate guidance or remediation in time for student who has problem in the learning process can effectively improve learning performance. Dividing learning process into small segments makes the automatic tracking and collecting data of students' learning status based on interactive multimedia instruction system more detailed and more purposeful. Furthermore, some learning activities do not use any information technology and are very difficult to be automatically tracked. Sometimes, the design of learning activities should be redesigned in order to automatically keep abreast of the students' mastery of knowledge. For example, appropriate exercises or tests are added in the learning activity based on one-to-one technology.

In order to obtain students' learning status, some information, such as issues encountered in learning process, answer of question, duration of finishing task, works of a task, notes on e-textbook, results of test, will be recorded in the locating system. But it needs more research to determine what kind of information should be recorded.

6 Conclusion

As learning process is full of complex, it is very difficult to accurately know about the students' learning status. Dividing learning process into small segments makes the locating of students' learning status more precisely. Because each segment represents a knowledge unit or a small learning objective which students should master. In the classroom with one-to-one technology, it is possible to take advantage of technology and devices to track and record data of students' learning status. Dividing learning process into small segments can be used to build automatic tracking and recording system which will cooperate with interactive multimedia instruction system and automatically suggest teacher in time to provide guidance or remediation for student who has difficulty.

References

[1] Gamoran, A, Secada, W.G., Marrett, C.A.: The organizational context of teaching and learning: changing theoretical perspectives, in Hallinan, M.T (Eds),Handbook of Sociology of Education (1998)

[2] Jonassen, D.: Designing constructivist learning environments. Instructional design theories and models: A new paradigm of instructional theory, 2, 215-239 (1999)

[3] Chan, T. W., Roschelle, J., Hsi, S., SHARPLES, M., Brown, T. O. M., PATTON, C., ... & HOPPE, U.: One-to-one technology-enhanced learning: an opportunity for global research collaboration. Research & Practice in Technology Enhanced Learning, 1(1), 1-32 (2006)

[4] Kolb, D. A.: Management and the Learning Process. California Management Review, 18(3), 21-31 (1976)

[5] Flanders, Ned.: Intent, Action and Feedback: A Preparation for Teaching. J. Teach. Educ. 3(14), 25-260 (1963)

[6] Howard, L., Remenyi, Z., & Pap, G. : Adaptive blended learning environments. In International Conference on Engineering Education, 23-28 (2006)

Educational Dashboards for Smart Learning: Review of Case Studies

Yesom Yoo[1], Hyeyun Lee[1], Il-Hyun Jo[2], and Yeonjeong Park[2,*]

[1] Department of Educational Technology, Ewha Womans University, Seoul, Korea
{aettom77.hyeyun521}rr@naver.com
[2] Department of Educational Technology, Ewha Womans University, Seoul, Korea
{ijo, ypark78}@ewha.ac.kr

Abstract. An educational dashboard is a display which visualizes the results of educational data mining in a useful way. Educational data mining and visualization techniques allow teachers and students to monitor and reflect on their online teaching and learning behavior patterns. Previous literature has included such information in the dashboard to support students' self-knowledge, self-evaluation, self-motivation, and social awareness. Further, educational dashboards are expected to support the smart learning environment, in the perspective that students receive personalized and automatically-generated information on a real-time base, by use of the log files in the Learning Management System (LMS). In this study, we reviewed ten case studies that deal with development and evaluation of such a tool, for supporting students and teachers through educational data mining techniques and visualization technologies. In the present study, a conceptual framework based on Few's principles of dashboard design and Kirkpatrick's four-level evaluation model was developed to review educational dashboards. Ultimately, this study is expected to evaluate the current state of educational dashboard development and suggest an evaluative tool to judge whether or not the dashboard function is working properly, in both a pedagogical and visual way.

Keywords: Dashboard, Evaluation Criteria, Educational Data mining, Smart Learning

1 Introduction

Given the number of institutions using Learning Management Systems, namely Blackboard or Moodle, there have been various attempts to utilize educational data, which is automatically tracked from the system for students' teaching and learning process. Examples of applications are widely ranged from predicting drop-out or academic success to providing personalized and proper recommendations for successful online learning [1-4]. However, in order for the raw data, such as log files, to be meaningful for educators, students and decision

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_21

makers of institutions, appropriate data mining process is inevitable and more importantly, it needs to be based on the understanding about the education environment. Consequently, Educational Data Mining (EDM) has been recognized as an emerging area and therefore required an interdisciplinary approach, including computer science, education and statistics [5]. Until now, due to the diverse challenges and practices, data mining techniques, such as prediction, classification, modeling, association and so forth, have been involved to solve educational issues and to improve the quality of education-related services. As the extension of such previous works, this study deals with developing an evaluation criteria for educational dashboard which is a collective outcome produced by the data mining process and visualization technologies.

An educational dashboard holds various roles and values. First, it allows teachers to know students' learning status at real time and in a scalable way. In particular, in the online learning environment, where the teachers and learners are physically separated, students' learning activity pattern reported in the dashboard is useful. Second, it helps students themselves to improve self-knowledge by reviewing their learning status and history [6]. Students can monitor their learning patterns through visualization of quantified information and refer to them as they modify their learning related plans and behaviors. Above all, as data mining technologies are advanced, the information displayed in the dashboard can lead to making more intelligent decisions. For example, a dashboard enables to identify at risk students or predict high performers as well as suggest proper feedbacks and guidelines to students. In a pedagogical approach, the dashboard may play a role to motivate students, improve their self-directed learning ability and help them achieve their learning goal effectively.

In the current study, we reviewed 10 major educational dashboards that have been introduced through academic journals and international conferences: Loco-analyst [7], Student Inspector [8], Students Success System [9], Course Signal [10], Gismo [11], GLASS[12], SNAPP [13], Narcissus [14], Step-up [15], and SAM [16]. These cases provide an overview of the presented dashboards and offer insights on the technology employed on the basic features they provide as well as their limitations. It should be noted that our review of these cases is conducted based on the information provided through literatures and additional web sites or resources in the cases the authors indicate. As we review case studies mentioned above, an evaluation framework was developed based on Kirkpatrick's four-level model and Few's principles of dashboard design. Because the background of this study is to design and develop an effective educational dashboard, we focused on discovering the effective presentation method of pedagogically useful information and to present the best way to deliver to those who need the information.

In the following sections, we will first provide the theoretical background of the design of educational backgrounds by reviewing the design principles presented in the previous literature on information visualization. We carry on to focus on the criteria for creating an evaluation framework in order to assess the existing educational dashboards, and then provide the conclusions and contribution of the present study.

2 Theoretical Backgrounds

2.1 Definition of Educational Dashboard

In looking at the original meaning of the word, “dashboard” is a board or panel placed on the front of a horse-drawn carriage to protect mud or dirt from being splashed into the interior. After that, it has evolved to a control panel in front of the driver in automobiles, showing information to support driving, such as speedometer, tachometer, odometer, fuel gauges, gearshift position, seat belt warning light, etc. (Wikipedia). In a business community, a dashboard is recognized as an emerging performance management system, for example, to monitor productivity, analyze cost-effectiveness and improve customer satisfaction [17]. That is, key performance indicators (KPIs) are displayed at a glance in a dashboard such that decision-makers can receive alerts as to whether the performance is deviated from predefined targets [18]. For the past decades, with the exponential growth in data volume and the applications of big data, enterprise dashboards, similar to a dashboard in an aircraft (which is even more complicated than that of automobiles and requires a large number of indicators), came to be SMART (synergetic, monitor KPIs, accurate, responsive, and timely) and IMPACT (interactive, more data history, personalized, analytical, collaborative, and traceability) [19].

Due to the influence of information technology, dashboards received more attentions from both the professional world and our daily lives. Although the term, educational dashboard, is yet unfamiliar to instructors and students, there have been several applications of dashboard-like reporting tools that present students’ learning patterns in the online environment. Each cases utilize different expressions, such as learning analytics dashboard [6] and learning dashboard [20], or unique metaphors, such as student activity meter [16], student inspector [8] and course signals [10]. However, the common role of such tools is to display the prompt status of students learning progress and to provide alerts or feedbacks for their learning facilitation in several cases.

The dashboards consist of visual elements with charts, graphs, indicators and alert mechanisms [18]. The visualization of data is importantly considered in the data-mining process because it converts the abstract and complex to the concrete and visible by amplifying human cognition [21]. Ultimately, data-mining aims to find the unknown and implicit, but useful, information based on the patterns of relationship in data sets, which is somehow large, noisy and messy [22]. Thus, visualizing the results of data-mining is important and is also the last step in the broad perspective of data-mining and knowledge discovery. Considering the aforementioned concepts, including the dashboard, data-mining and data visualization, an educational dashboard, as an umbrella term including other terminologies such as learning analytics dashboard, can be defined as a visualized and intuitive display derived from the results of educational data-mining for the purpose of supporting students’ learning and performance improvement.

2.2 Principles of Dashboard Design

Due to the recent emergence of the dashboard, studies on the design principles for this specific output are very rare. However, Few [23], based on his practical experiences and theoretical foundations, introduced many dashboard examples with good or bad cases in terms of design principles. Above all, in defining a dashboard as “a visual display of the most important information needed to achieve one or more objectives that has been consolidated on a single computer screen so it can be monitor at a glance” (p. 26), the essential characteristics of the dashboard were identified: 1) dashboards are visual displays; 2) dashboards display the information needed to achieve specific objectives, 3) a dashboard fits on a single computer screen, and 4) dashboards are used to monitor information at a glance. Also, in understanding the dashboards as a communication means, effective design is related to several theoretical foundations, such as human cognition and perception, situation awareness and visualization technologies. More specifically, effective design of a dashboard should be based on an understanding of how we see and think[24].

In regard to the visual perception, three considerations are remarkable from the literature [23]. First, humans have limited working memory; thus, only three or four chunks of visual information can be stored at a time. Thus, to design a dashboard, well-designed graphical patterns, such as graphs rather than individual numbers, are better for efficient perception and memory retention. Second, for rapid perception, pre-attentive attributes, such as color, form, spatial position and motion, should be properly utilized. Third, by following Gestalt’s principles, design elements such as proximity, similarity, enclosure, closure, continuity, connection should be considered in designing a dashboard.

Situational awareness is another important concept that relates to the dashboard design. Situational awareness is defined in terms of “what information is important for a particular job or goal” and works on three levels [25]: level 1: perception of the elements in the environment, level 2: comprehension of the current situation, and level 3: projection of future status. That is, in order to conduct specific jobs, for example, driving a car, treating a patient, operating an aircraft, etc., people need to be consistently aware of what is going on, in order to predict what will be happening as well as to prepare what must to be done.

The implications from Few’s design principles for dashboard are as follows: 1) the most important information should stand out from the rest in a dashboard, which usually has limited space fit into a single screen; 2) the information in a dashboard should support one’s situated awareness and help rapid perception using diverse visualization technologies, 3) the information should be deployed in a way that make sense, and elements of information should support viewers’ immediate goal and end goal for decision making.

3 Evaluation Criteria for Educational Dashboards

3.1 Evaluation Criteria

The previous section mostly dealt with effective dashboard design in the aspect of information visualization and communication. However, because this study is interested in the educational dashboards that should play a treatment role to promote students' learning and performance, another framework to evaluate them in a performance perspective is necessary. In particular, in the realm of instructional design, evaluation is positioned at the center of the process and an educational program that pursues continuous improvement usually requires conducting a formative evaluation in an iterative way [26, 27]. Kirkpatrick's four-level model is one of the most influential frameworks for the evaluation of training program, including e-learning courseware [28-30]. The four levels include reaction to the learning event, learning (acquisition) of intended knowledge, skills and attitudes, behavior change back on the job and context, and the impact of programs.

As a related work to evaluate such a dashboard, Verbert, et al. [6] introduced a learning analytics process model based on personal informatics applications, which supports people to improve their self-knowledge by reviewing and analyzing their personal history and to foster self-control and positive behavior. The four stages included 1) awareness: people are aware of visualized data, 2) reflection: people reflect data on themselves and ask questions to assess their past behavior, 3) sense-making: people attempt to answer the questions and create new insights, and 4) impact: people induce new meaning and change behavior. This framework presents a possible stepwise process, where dashboard users move from the initial reactions to the final goal-achievement. Because this framework attempted to illustrate such procedural usefulness and affordances of dashboard, it is similar to the Kirkpatrick's four level evaluation model, as shown in Table 1.

Table 1. Resources to build an evaluation framework for educational dashboards.

Levels	Learning Analytics Process Model[6]	Kirkpatrick's Four-level evaluation model [31]	Blocks of Information Visualization [24]
4	Impact	Result	Goal achievement
3	Sense-making	Behavior change (Transfer)	Decision making
2	Reflection	Learning	Quantitative reasoning
1	Awareness	Reaction (satisfaction)	Visual Perception

In our study, we built an evaluation structure for effective educational dashboards using Kirkpatrick's four-level evaluation model and Few's design principles for dashboards based on the understanding of information visualization. Also, we considered the pedagogical affordances that educational dashboards can provide by referring to the learning analytical process model that Vertbert et al. [6] incorporated. Appendix 1 presents the output of the evaluation structures for educational dashboards. As we structured the criteria of evaluation, detailed indexes were developed based on MECE (mutually exclusive and collectively exhaustive) principle so that each index supports the criteria.

3.2 Previous Case Studies

Although all of the existing dashboards cannot be introduced in detail due to page limitation, a summary of ten dashboards is presented in Table 2. A summary of our evaluation is provided in Table 3, which assess each model's performance of the level 1 (reaction), 2 (learning), 3 (behavior), and 4 (result) evaluations.

Table 2. Summary of ten educational dashboards

Tool Name	Overview of Dashboards		
	Target Users	Information	Visualization Techniques
LOCO-Analyst	teacher	Login trends, performance results, content usage, message analysis	Bar graph, pie chart, table matrix, tag cloud
SAM	Teacher & student	Login trends, performance results, content usage, message analysis	Line chart, bar graph, tag cloud
Student Inspector	Teacher & student	Performance results, content usage	Bar graph, pie chart
Student Success System	Teacher	Performance results, social network, at-risk student prediction	Risk quadrant, scatterplot, win-lose chart, sociogram
SNAPP	Teacher	Content usage, social network, message analysis	Sociogram
GLASS	Teacher & student	Login trends, performance results, content usage	Timeline, bar graph
Blackboard Analytics	Teacher & student	Login trends, performance results, content usage, social network	Bar graph, line graph, win-lose chart, scatterplot
Course Signal	Student	Login trends, performance results, content usage, at-risk student prediction	Signal lights

Narcissus	Student	Content usage, social network	Wattle tree
Step-Up!	Teacher & student	Login trends, content usage, online social network	Bar graph, table matrix, line chart

Table 3. Evaluation of ten educational dashboards

Tool Name	Evaluation Criteria			
	Reaction	Learning	Behavior	Result
LOCO-Analyst	○	△	-	-
SAM	○	△	-	-
Student Inspector	○	○	○	△
Student Success System	-	-	-	-
SNAPP	-	-	-	-
GLASS	-	-	-	-
Blackboard Analytics	-	-	-	-
Course Signal	△	△	△	△
Narcissus	○	○	○	○
Step-Up!	△	△	△	○

Symbols: (○) indicates evaluations based on the Kirkpatrick 4 level model; (△) indicates evaluation was partially conducted; (-) indicates evaluation was not conducted, or it could not be found.

4 Conclusion

Since we depended on the literatures, there was a lack of resources to evaluate each dashboard. However, in reviewing their literatures, we could learn important design implications. First, we found that each dashboard has contributed to help students and teachers become informed of the online learning activities with several data-mining and visualization techniques.

Second, remarkably, social network, at-risk student prediction and message analysis were attempted in a few cases. Social network involves the targets' social interaction, including discussion behavior and content or message exchange. At-risk student prediction is a function of alerting students who are highly possible to fail in the course semester. Message analysis involves text data analysis, often summarized as a tag cloud form.

Third, the dashboards incorporate visualization techniques in order to best present the information; however, only a few case studies consider designing such visualizations based on dashboard design principles. Further, no case attempted to review the relationship between visualization information and users' reactions. As further research, it might be necessary to investigate how users react to and understand such visualized information, for example, by using an eye-tracking machine.

Lastly, in using the framework, as a lens to review each dashboard, while some case studies have conducted an evaluation at the four levels fairly well, some cases did not try to evaluate; thus, the effectiveness of the dashboard was not investigated and proved.

For future research, the evaluation structures developed in this study need to be verified through experts' review and actual usages in real-world context. Nevertheless, using this evaluation framework suggests that educational dashboards need to be evaluated through further experiments in the real field in order to verify the impact of dashboards in education by considering all of the four aspects. Also, the information in the dashboard, which is derived from data-mining of LMS, was various in its kind -- ranging from the basic login information to complex analysis results. (1) Login trends, (2) performance results and (3) content usage were the most popular items. Login trends include all data tracking involving the target's login activity, such as login frequency and duration time. Performance results include students' academic achievement, such as quiz result or grade. Therefore, to properly utilize suggested evaluation tool and ultimately figure out the pedagogical effect of educational dashboards, along with developing educational dashboards, it is critical to confirm which information of student data is valuable to show. This involves finding out expectative variables for student success when acknowledged by students.

References

[1] J. Bayer, H. Bydzovská, J. Géryk, T. Obšıvac, and L. Popelınský, "Predicting drop-out from social behaviour of students," in *Proceedings of the 5th International Conference on Educational Data Mining-EDM 2012*, 2012, pp. 103-109.

[2] C. Romero, P. G. Espejo, A. Zafra, J. R. Romero, and S. Ventura, "Web usage mining for predicting final marks of students that use Moodle courses," *Computer Applications in Engineering Education,* vol. 21, pp. 135-146, 2013.

[3] E. J. Lauría and J. Baron, "Mining Sakai to Measure Student Performance: Opportunities and Challenges in Academic Analytics."

[4] N. Thai-Nghe, L. Drumond, A. Krohn-Grimberghe, and L. Schmidt-Thieme, "Recommender system for predicting student performance," *Procedia Computer Science,* vol. 1, pp. 2811-2819, 2010.

[5] N. Bousbia and I. Belamri, "Which Contribution Does EDM Provide to Computer-Based Learning Environments?," in *Educational Data Mining*, ed: Springer, 2014, pp. 3-28.

[6] K. Verbert, E. Duval, J. Klerkx, S. Govaerts, and J. L. Santos, "Learning Analytics Dashboard Applications," *American Behavioral Scientist,* 2013.

[7] L. Ali, M. Hatala, D. Gašević, and J. Jovanović, "A qualitative evaluation of evolution of a learning analytics tool," *Computers & Education,* vol. 58, pp. 470-489, 2012.

[8] O. Scheuer and C. Zinn, "How did the e-learning session go? The Student Inspector," *Frontiers in Artifical Intelligence and Applications,* vol. 158, p. 487, 2007.

[9] A. Essa and H. Ayad, "Student success system: risk analytics and data visualization using ensembles of predictive models," in *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, 2012, pp. 158-161.
[10] K. E. Arnold and M. D. Pistilli, "Course signals at Purdue: Using learning analytics to increase student success," in *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, 2012, pp. 267-270.
[11] R. Mazza and C. Milani, "Gismo: a graphical interactive student monitoring tool for course management systems," in *Technology Enhanced Learning Conference, Milan*, 2004.
[12] D. Leony, A. Pardo, L. de la Fuente Valentín, D. S. de Castro, and C. D. Kloos, "GLASS: a learning analytics visualization tool," in *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, 2012, pp. 162-163.
[13] S. Dawson, A. Bakharia, and E. Heathcote, "SNAPP: Realising the affordances of real-time SNA within networked learning environments," in *Proceedings of the 7th International Conference on Networked Learning*, 2010, pp. 125-133.
[14] K. Upton and J. Kay, "Narcissus: group and individual models to support small group work," in *User Modeling, Adaptation, and Personalization*, ed: Springer, 2009, pp. 54-65.
[15] J. L. Santos, K. Verbert, S. Govaerts, and E. Duval, "Addressing learner issues with StepUp!: an Evaluation," in *Proceedings of the Third International Conference on Learning Analytics and Knowledge*, 2013, pp. 14-22.
[16] S. Govaerts, K. Verbert, E. Duval, and A. Pardo, "The student activity meter for awareness and self-reflection," in *CHI'12 Extended Abstracts on Human Factors in Computing Systems*, 2012, pp. 869-884.
[17] W. W. Eckerson, *Performance dashboards: Measuring, monitoring, and managing your business*, 2nd ed.: Wiley, 2010.
[18] V. Podgorelec and S. Kuhar, "Taking advantage of education data: Advanced data analysis and reporting in virtual learning environments," *Electronics and Electrical Engineering,* vol. 114, pp. 111-116, 2011.
[19] S. Malik, *Enterprise dashboards: Design and best practices for IT*: Wiley, 2005.
[20] E. Duval, "Attention please!: learning analytics for visualization and recommendation," in *Proceedings of the 1st International Conference on Learning Analytics and Knowledge*, 2011, pp. 9-17.
[21] S. K. Card, J. D. Mackinlay, and B. Shneiderman, *Readings in information visualization: using vision to think*: Morgan Kaufmann, 1999.
[22] R. Nisbet, J. Elder, and G. Miner, *Handbook of statistical analysis and data mining applications*: Academic Press, 2009.
[23] S. Few, *Information dashboard design: Displaying data for at-a-glance monitoring*, 2nd ed. Burlingame, CA: Analytics Press, 2013.
[24] S. Few, *Now you see it: simple visualization techniques for quantitative analysis*: Analytics Press, 2009.
[25] M. R. Endsley, *Designing for situation awareness: An approach to user-centered design*: CRC Press, 2012.
[26] K. L. Gustafson and R. M. Branch, *Survey of instructional development models*, 4th ed. New York: ERIC Clearninghouse on Information and Technology, 2002.
[27] W. Dick, L. Carey, and J. O. Carey, *The systematic design of instruction*, 6th ed. Boston, MA: Allyn and Bacom, 2005.
[28] W. Horton, *Evaluating e-learning*. Alexandria: ASTD (American Society for Training & Development), 2001.
[29] T. C. Reeves, L. Benson, D. Elliott, M. Grant, D. Holschuh, B. Kim*, et al.*, "Usability and Instructional Design Heuristics for E-Learning Evaluation," 2002.
[30] J. Brill and Y. Park, "Evaluating online tutorials for university faculty, staff, and students: The contribution of just-in-time online resources to learning and performance," *International Journal on E-Learning,* vol. 10, pp. 5-26, 2011.
[31] D. L. Kirkpatrick and J. D. Kirkpatrick, *Evaluating training programs: The four levels*, 3rd ed. San Francisco: Berrett-Koehler, 2006.

[32] O. Scheu and C. Zinn, "How did the e-learning session go? The student inspector," in *13th International Conference on Artifical Intelligence and Education*, Amsterdam: Netherland, 2007.
[33] G. J. Houben, G. McCalla, F. Pianesi, and M. Zancanaro, Eds., *User modeling, adaptation, and personalization* (Narcissus: Group and individual models to support small group work. 2009, p.^pp. Pages.
[34] BlackboardInc. Blackboard & Montgomery County Community College: Solution focus, student analytics.

Appendix 1. An evaluation framework for educational dashboards.

Criteria	Sub-categories	Indexes
1. reaction	Goal-orientation	1. A dashboard identifies goals that present the specific information. 2. A dashboard helps users monitor goal-related activities.
	Information Usefulness	3. A dashboard displays the information that users want to know. 4. A dashboard includes essential information only.
	Visual Effectiveness	5. A dashboard consists of visual elements. 6. A dashboard fits on a single computer screen. 7. A dashboard presents visual information that users can scan at a glance. 8. Visual elements in a dashboard are arranged in a way for rapid perception.
	Appropriation of visual representation	9. A dashboard includes proper graphic representations 10. Graphs in a dashboard appropriately represent the scales and units. 11. A dashboard delivers information in a concise, direct and clear manner. 12. A dashboard uses appropriate pre-attentive attributes, such as form, color, spatial position and motion. 13. A dashboard displays information correctly in both desktop computers and mobile devices.
	User Friendliness	14. A dashboard is easy to access. 15. A dashboard is customized to users' context. 16. A dashboard has intuitive interfaces and menus to use easily. 17. A dashboard allows users to explore more information that are embedded or hidden on the single page.
2. Learning	Understanding	18. A user understands what the visual information in a dashboard implies.
	Reflection	19. A user understands what the statistical information in a dashboard implies.
3. Behavior	Learning motivation	23. A user is motivated to be engaged in learning as he/she reviews the dashboard. 24. A user makes plans for his/her own learning based on the information in a dashboard.
	Behavioral change	25. A user manages his/her learning activities based on a dashboard. 26. A user makes changes in learning patterns as he/she monitors the information in a dashboard.

4. Result	Performance improvement	27. A dashboard helps users to achieve their learning goal.
		28. A dashboard enhances users' academic achievement.
	Competency Development	29. A dashboard enhances users' self-management skill.
		30. A dashboard enhances users' social values and networking competency.

Effects of Social Network-based Visual Feedback on Interaction in Online Discussion

Hana PARK, Hee Joon KIM, Hyo Sun PARK, Kyu Yon LIM*

Ewha Womans University, Republic of Korea
klim@ewha.ac.kr

Abstract. This study aims to explore the effects of different feedback types on learner interaction in online discussion. Sixty-three undergraduate students were randomly assigned to treatment groups, and participated in a 3-week, small group online discussion. Overall, visual feedback of interaction patterns was effective as indicated by generally higher out-degree centrality for the group received feedback of interaction patterns as compared to the group received no feedback.

Keywords: Social Network Analysis, online discussion, visual feedback

1 Introduction

In this study, researchers provided a metacognitive feedback on the status of interaction and participation so learners can monitor themselves during online discussion. Interaction occurs when there are two or more actors, while participation does not. For example, in an online discussion, a message does not necessarily mean an interaction when no one reads or reacts to this post. In this case, a post itself is considered a simple participation rather than an interaction. Based on this idea, researchers designed two different treatment conditions as a feedback to inform the status of online discussion. One was developed using social network analysis (SNA) and the other is based on simple participation frequency.

SNA enables researchers to understand how individual actors are connected within a network by analyzing the pattern of interactions (Jo, 2009). Unlike other approaches, SNA focuses on the patterns of collective relationships among learners and provides visual representations of the connections (Lim et al., 2009; Scott, 2000). This study used NetMiner software to draw a diagram illustrating learners' interaction pattern to inform who is interacting with whom, and who is the member with the strong connection within the network. It is expected to assist learners to intuitively recognize the interaction patterns by themselves and change their interaction action accordingly after all.

This study aims to explore the effects of different feedback types on learner interaction in online discussion. Specifically, the levels of different feedback types

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_22

included feedback of interaction patterns among learners using SNA diagram, feedback of individual participation frequency using text, and no feedback. The dependent variable is out-degree centrality as a measure of individual prominence during discussion.

2 Methodology & Result

Participants were 63 undergraduate students in South Korea. They were randomly assigned to the 8 discussion groups, and provided with an online group discussion board. And then, each group was randomly assigned to 3 conditions: feedback of interaction patterns among learners using SNA diagram (Type A, see Fig 1), feedback of individual participation frequency using text (Type B), and no feedback (Type C). At the end of each week, 3 groups received Type A feedback, another 3 groups received Type B feedback, and 2 groups received no feedback throughout the discussion. Online discussion was conducted for 3 weeks. Regarding dependent variable, out-degree centrality was computed using SNA.

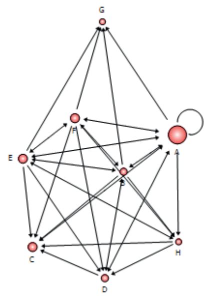


Fig 1. Example of feedback Type A

Results from ANOVA revealed a main effect of feedback types on out-degree centrality (F = 5.928, p = .004). Turkey's post-hoc analysis reported that the average of individual out-degree centrality of the team with visual feedback SNA diagram (mean = 3.07) was significantly higher than that of the team with no feedback (mean = 1.60).

References

Jo, I.-H. (2009). The effect of social network diagrams on a virtual network of practice: a Korean case. *Asia Pacific Education Review, 10*, 525-534.

Lim, K. Y., Heo, H., & Kim, Y. S. (2009). Team leaders` interaction patterns in online team project. *Educational Information and Media, 15*(4), 293-315.

Scott, J. G. (2000). *Social network analysis: A handbook*. Sage Publications.

Enhanced federation and reuse of e-learning components using cloud computing

Sameh Ghallabi[1,*], Fathi Essalmi[2], Mohamed Jemni[3], and Kinshuk[4,#]

[*]The Research Laboratory of Technologies of Information and Communication & Electrical engineering (LaTICE)
[1]gallabi_sameh@yahoo.fr
[2]fathi.essalmi@isg.rnu.tn
[3]mohamed.jemni@fst.rnu.tn
[2]School of Computing and Information Systems Athabasca University, 1 University Drive, Athabasca, ABT9S3A3, Canada
[4]kinshuk@ieee.org

Abstract. Cloud computing is a new model, based on the Internet, to combine several services such as software, platform and infrastructure as a service. It offers the opportunity to store a large amount of information and to reduce the cost of development. In addition, it is used to increase the performance, the flexibility, the scalability and the availability of information systems. Due to these advantages, several researchers have focused on applying cloud-computing environment in learning systems. This research explores cloud computing for federating and combining the e-learning components to achieve the benefits of cloud computing: its low cost, its storage capacity, its high security and its availability. This paper proposes an approach based on the cloud computing technology for the federation of personalization efforts. Through this approach the user can easily access the reusable learning components from anywhere and anytime.
Keywords: Cloud Computing, reuse, personalization, e-learning components.

Introduction

Personalized learning systems enable teachers to provide learning scenarios adapted to the learners' characteristics [1, 2]. Such customization is possible only if the learning content is available in multiple formats to suit the needs of different types of learners. There are a number of mechanisms available to help teachers in finding appropriate learning content [3, 4]; however, the federation of learning components requires significant amount of software and hardware resources. Use of federated learning components also requires the personalized learning systems

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_23

to be open and interoperable. These systems limit the network and the space of their functioning. In addition, the users are not capable of incorporating learning courses from heterogeneous personalized learning systems. Several implemented personalized learning systems; there is not a sharable and interoperable platform capable of integrating the various existing systems. The users perform the mentioned systems from downloaded software on their computers or a physical server situated in their buildings. Cloud computing research has emerged as a possible solution to meet such needs. It is a new model that allows users to access applications through Internet. It also allows interoperability between heterogeneous information resources and services.

Cloud computing brings many advantages such as reduced cost, high availability, scalability, storage capacity, accessibility and so on [5]. The characteristics of the cloud computing make it particularly suitable for integration in personalized e-learning. While there are many examples in the literature regarding the use of cloud computing for the personalization of e-learning, the use of cloud computing for combining various e-learning components has not yet been explored. As a consequence, research is needed to identify how to integrate cloud computing technology for combining personalization efforts.

In this paper, an approach to federate and reuse different e-learning components in cloud computing environment is proposed. The proposed approach will allow the teachers to access e-learning components from anywhere and anytime through various devices. As a result, e-learning components are considered as a collection of services which are going to be used according to cloud computing. These components are hosted on a platform and are used according to the SaaS model.

This paper is structured as follows. Section 2 defines cloud computing. Section 3 discusses related. In section 4, the benefits of personalized learning systems in cloud are described. Section 5 represents the proposed approach that allows federation and combination of e-learning components by using cloud-computing technology. Finally, the concluding remarks are given in section 6.

Cloud computing

Cloud computing [6] is a model which gives the possibility to access data and services on a remote server. It offers standardized and shared resources. These resources are delivered over the internet. Cloud computing is a model of deployed resources such as services and data. Consequently, users can access these resources over Internet. Therefore, they have the possibility to invoke these services by computing devices anywhere and anytime.

Related works

Cloud computing is an on-demand computing model. It is characterized by its scalability, efficiency, flexibility, and reliability. Therefore, thanks to its promising benefits, many works have been done in order to apply them in the e-learning personalization field. For example, Jeong and Hong [7] proposed a service based e-learning system in cloud computing technology. The proposed system performs the e-learning process as a service in the cloud-computing environment. Moreover, Chang et al [8] defined an approach to support a cloud based personalized learning environment. The proposed approach was based on Google App Engine to design software as a service (SaaS). This approach used genetic algorithm (GA) in order to provide the learning resources adapted to the learners' demands. In addition, Jain et al [9] presented a new approach that allows the application of cloud computing in e-learning. Further, Pund et al [10] defined the benefits of cloud computing for e-learning systems. The main objective of the work was to provide a shared pool of the e-learning resources and to increase the availability and the scalability. Zaharescu [11] proposed a new approach that allows the integration of cloud computing in the education field. Furthermore, Kaewkiriya et al. [12] defined a new model of learning management systems using cloud computing with Web services. The approach allowed users to access various e-learning resources with low cost. El-Sofany et al. [13] defined a new approach that applied cloud computing in e-learning environments. They used cloud in order to secure data storage and computing power. Fernandez et al. [14] proposed an approach which integrated e-learning systems into cloud environment. Their approach allowed users to work and find their resources from multiple places anytime. Finally, Liang et al [15] proposed a new approach that enhanced the efficiency within a virtual personalized learning environment. They used the cloud infrastructure as a service and the cloud software as a service for creating a service oriented model.

To sum up, many works in the literature have used cloud computing for personalization of e-learning. However, the usage of cloud computing for the combination of e-learning components has not yet been explored. The research in this paper presents an approach that applies cloud computing technology for the federation and combination of the e-learning components. E-learning components are considered as a collection of services which are going to be used according to the cloud computing. Thus, the proposed approach allows teachers to select learning components and combine them flexibly to create new personalized learning courses.

Benefits of personalized learning system in cloud

In this section, benefits of using cloud computing for the federation of e-learning components are presented. The cloud computing resolves the high development cost and arises the personalized learning systems performance. In addition, it provides the possibility of high e-learning components' storage capacity, availability and scalability. Therefore, this research proposes a solution that allows reuse of e-learning components and models. On the one hand, teachers benefit from the cloud based-federation of e-learning components. Therefore, cloud computing allows teachers to reuse the nearest learning components. Then it gives them the possibility to provide optimal and performance composition. In addition, they can incorporate learning components in a relevant and easy way in a particular learning scenario. On the other hand, the mentioned systems provide many advantages for the learners. For instance, they have the ability to access their lessons in any place and anytime using any media type. There are numerous criteria used in this research in order to facilitate the comparison between personalized learning systems in cloud and classical systems. To compare these approaches, seven criteria of comparison are defined:

Low cost. Cost is a set of expenses supported by a company. Users execute the classical personalized learning systems from software downloaded on a computer or a physical server situated in their buildings. However, they can run systems from cloud through their mobile phones, PCs having minimum configuration with internet connectivity. In addition, organizations have just to pay in time learning cost effective. Therefore, it is cheap and they only need to pay for the needed space. In cloud, users need not to spend much money for large memory data storage in local machines.

Run time. Time put by the systems in order to execute the request. With growth of numbers of learning actors, the answer time for classic personalized learning system service is slow. However, cloud personalized learning service can respond instantly to the user's request, due to the high capacity remote servers.

Networks. Access to resources is provided over the network. Classic personalized learning systems limited network and space of their functioning. Cloud personalized learning systems are eliminating the time restrictions of network and of space.

Scalability. Is the system's capacity to process a large number of operations or transactions during a given period while keeping the same performance. Classic personalized learning systems are characterized by their static and manual scalability. Cloud computing provides an intelligent resource management. Cloud computing provides an intelligent resource management. Therefore, cloud resources can be dynamically delivered in real-time.

Mobile and decentralized. This criterion allows users to access the resources that are provided over the internet anywhere and anytime. Personalized learning systems are centralized. They are not mobile.

Availability. It is used to guarantee a permanent service. Cloud computing provides permanent services with the use of redundant systems.

Storage capacity. Is a storage space of learning information. Cloud computing provides better data storage and virtualization of hardware resources.

Table I presents the difference between personalized learning systems and classic systems through the mentioned criteria. It presents learning systems in the columns and criteria in lines. Each cell includes a notation representing the important of the criterion (presented in the line) in the learning system (presented in the column). The notation *** means that the criterion is considered, ** considered little, * considered rarely and – not considered.

Table 1. Comparison between two types of systems.

Learning systems Different criteria	Classic personalized learning systems	Cloud personalized learning systems
Low cost	**	***
Run time	*	***
Networks	*	***
Scalability	-	***
Mobile and decentralized	-	***
Availability	**	***
Storage capacity	*	***

Cloud computing is characterized by many advantages. Therefore, this research takes into consideration these advantages for federating and combining e-learning components in a low cost and effectiveness.

Proposed approach

In this section, we present our approach for federating of personalization efforts using cloud. E-learning components are considered as a collection of services that are going to be used according to cloud computing. Each learning component represents as a Web service. Some components require complex Web service; it is of composite Web services which are defined as being the composition of several services. For operational use of Web services, these services are hosted on the PaaS platform. These services are used according to the SaaS model. SaaS is a model through which users can acquire e-learning components service via

Internet. This model is composed of a set of services and API (Application Programming Interface). Therefore, PaaS is the execution platform and hosting services. As depicted graphically in figure1, the proposed approach allows teachers to reuse e-learning components via Internet, from anywhere, and anytime by using any device. The proposed approach allows assembling and combining e-learning components with low costs. Therefore, cloud computing meets the need of cost reduction and personalized learning system enrichment through the reuse of e-learning components. The proposed approach allows teachers to reuse and integrate these components in a specific learning scenario.

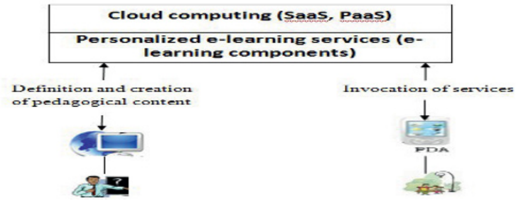


Fig.1. The proposed approach

Each learning component is represented as a Web service. Teachers research and invoke a set of services in order to create a new scenario. In order to exploit the proposed architecture presented in Fig.1, the following different scenarios are presented:

Scenario1. Teacher who wishes to put its components on the Web in order to allow their consultation by other teachers, students or researchers in the domain. This scenario is based on availability and storage capacity criteria. However, classic systems do not guarantee a permanent service. In addition, storage capacity in classic systems is limited.

Scenario2. Teacher who looks for the learning components in order to access or reuse them as a basis of the course that he/she wishes to build. This scenario allows teachers to create the course with low cost.

Scenario3. Teacher who accesses learners' profiles in order to create a course adapted to their needs. This scenario uses run time criterion. Learner profile services can respond instantly to the teacher's request.

Scenario4. Through using cloud computing; teacher can prepare online tests for learners, send his/her feedback and communicate with learners through online forums. This scenario needs many of the mentioned criteria such as networks, availability, etc.

Scenario5. Teacher can invokes statically or dynamically an additional service in his/her learning scenario according to a particular context. Teacher accesses services that combine and assemble the learning components in a reusable and interoperable way. This scenario requires all the mentioned criteria.

Scenario6: Learner can take online courses and exams anywhere and anytime using different media. This scenario is based on the mobile and decentralized criterion.

The following Fig.2 presents the application of cloud computing in personalized learning environment. This figure describes various services that are hosted in cloud computing model. SaaS model provides these services. This research allows realization of the interoperability between different personalized learning systems and reuse of e-learning components.

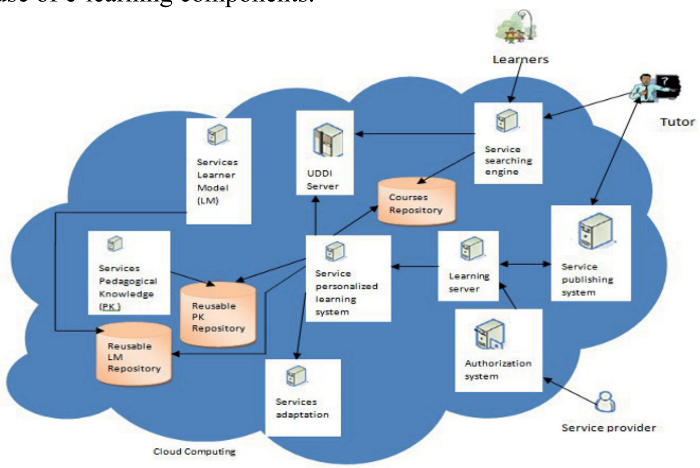


Fig.2. Reuse of the e-learning components in cloud

This figure describes the various services that are hosted in cloud computing model. The SaaS model provides these services. The proposed approach performs the personalized learning scenario as a service in cloud computing. In this approach, all services of e-learning components should be uploaded on the UDDI server. Teachers can access the UDDI server to find the learning components what he/she wants to use.

Conclusions

This research presents a new approach that improves the efficiency within the personalized learning systems. It describes cloud computing as a solution for combining, federating and assembling e-learning components. The first objective of this research is to make these components available anywhere and anytime. Second goal is that these components are represented in a reusable and interoperable way. Thus, teachers are able to easily integrate learning components in a particular learning scenario. There are many benefits from using cloud computing for federating e-learning components and models. In future, we envision to implement and validate the proposed approach. We will implement this approach using one of the cloud-computing providers. We will choose the platform that allows realization of federation of the learning components.

References

[1] Essalmi, F., Jemni Ben Ayed, L., Jemni, M. : An ontology based approach for selection of appropriate E-learning personalization Strategy. Design Centered and Personalized Learning in Liquid and Ubiquitous Learning Places (DULP) Future Visions and PracticalImplementations. In The 10th IEEE international conference on advanced learning technologies (ICALT), Sousse, Tunisia, 724-725 (2010)

[2] Essalmi, F., Jemni Ben Ayed, L., Jemni, M. : A Multi-Parameters Personalization Approach of Learning Scenarios. The 7th IEEE International Conference on Advanced Learning Technologies (ICALT), Niigata, Japan, 90-91 (2007)

[3] Khribi, M. K., Jemni, M., Nasraoui, O. : Toward a Hybrid Recommender System for E-Learning Personalization Based on Web Usage Mining Techniques and Information Retrieval. In Proceedings of E-learn 2007, Quebec City, Canada, October 2007, Volume 7, Issue 1,6136-6145,(2007)

[4] Essalmi, F., Jemni Ben Ayed, L., Jemni, M., Kinshuk, and Graf, S.: A fully personalization strategy of E-learning scenarios. Science Direct, Computers in Human Behavior, Jan.2010, doi:10.1016/j.chb.2009.12.010, 581–591 (2010)

[5] Creeger, M.:CTO Roundtable: Cloud computing. Communications of the ACM, vol. 52, no.8, 50-56 (2009)

[6] Jeong, H.Y., Hong, B.: Service based Personalized Learning System in Cloud Computing Environment. AST/EEC/MMHS/AIA2012 conference program, Beijing, China, 95-102 (2012)

[7] Doelitzscher, F., Sulistio, A., Reich, C., Kuijs, H., Wolf, D.: Private cloud for collaboration and e-Learning services: from IaaS to SaaS. *Computing*, vol. 91, no. 1, p 23-42 (2011)

[8] Chang, Y. C., Li, J.W., Ku, H.H.: A Genetic Algorithm (GA)-Based Personalized Learning Service in Cloud Learning Environments. IEEE Technology and Engineering Education (ITEE), VOL. 7, NO. 2, .28-32 (2012)

[9] Jain, A., Chawla, S.: e-learning in the cloud. International Journal of latest Research in Science and Technology, volume2, Issue1, ISSN (online): 2278-5299, 478-481 (2013)

[10] Pund, B. G., Nair, **S.S.,** Deshmukh**,** P.P.: using cloud computing on e-learning. International Journal of Emerging Trends & Technology in Computer Science (IJETTCS), Volume 1, Issue 2, ISSN 2278-6856, 202-209 (2012)

[11] Zaharescu, E.: Enhanced Virtual E-Learning Environments Using Cloud Computing Architectures. International Journal of Computer Science Research and Application, Vol. 2, Issue. 1 (Special Issue), ISSN 2012-9572 (Online), 31-41, 2012.

[12] Kaewkiriya, T., Utakrit, N.: A Model of an e-Learning Management System Based on Cloud Computing and Web Service**.** Information Technology Journal, Vol. 8, No. 1, 83-87 (2012)

[13] El-Sofany, H.F., Tayeb, A. Al., Alghatani, K.., El-Seoud, S.A.:The Impact of Cloud Computing Technologies in E-learning. iJET – Volume 8, Special Issue 1: "ICL2012," http://dx.doi.org/10.3991/ijet.v8iS1.2344, 37-43 (2012)

[14] Fernandez, A., Peralta, D., Herrera, F., Benıtez, J.M, :An Overview of E-Learning in Cloud Computing. L. Uden et al. (Eds.): Workshop on LTEC 2012, AISC 173, Springer-Verlag Berlin Heidelberg, 35–46 (2012)

[15] Liang, P., Yang, J.: Virtual Personalized Learning Environment (VPLE) on the cloud. In: Gong et al. (Eds) : WISM 2011, part II, LNCS 6988, 403-411 (2011)

Enquiry into a Self-regulated Teaching Assistant Development Program in China: The Yin and Yang of Success

Carlos Vasconcelos-Lopes

University of Saint Joseph, Faculty of Psychology and Education, Macau, China
carlos.lopes@usj.edu.mo

Abstract. This paper presents a qualitative study aimed at identifying the quality of graduate student engagement in a self-regulated teaching assistant development program of an international university in Macau, China. The study also intended to test the relevance of a virtual mechanism, operated asynchronously through the Internet, for keeping both communication and reflection alive within the space of the project. *Grounded Theory* was selected for data analysis. Empirical data was extracted from non-structured interviews and class observation reports. Empirical evidence shows that the participants have primarily been concerned with the meaning of their actions, and only secondarily with criteria situated in the context of that meaning. Implications of this study and suggestions for subsequent efforts to highlight the potential impact of new media in self-regulated teacher education programs are included.

Keywords: higher education; teacher education; 21st century education; teaching assistant development program; professional learning community; community of inquiry; self-regulated learning; smart learning environments; adaptive learning environments; ubiquitous learning environments

1 Aims

This paper presents a qualitative study conducted within a two-year graduate teaching assistant development program of an international university of Macau, China. The program was launched with the intention of confronting a growing number of complaints from students about the poor quality of the instruction delivered by some members of the academic staff. Its design was inspired by teacher education models from the North of Europe, particularly those from Finland. It was expected that it could help set a smarter learning environment, one that would be more responsive to the 21st century learning needs of the students. A "self-effacing" leadership format was adopted, with a teacher-educator performing a coordinating role. He had, essentially, to observe classes in order to evaluate

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_24

student response to instruction and provide the teaching assistants with feedback. The teaching assistants were five voluntary, high-achieving graduates, all of them initiating master's studies at the university.

The research aimed, primarily, at identifying in what ways, how and why these teaching assistant's readings of their participation in the program have evolved. It was assumed that the success of the program would be dependent on having these teaching assistants experimenting and reflecting on the potential of their own selected pedagogic strategies for promoting the intended student learning. That could only happen if that kind of active alignment continued making sense to them, that is, being, meaningful, from the beginning until the end of the project. The research aimed, additionally, at testing a virtual mechanism, operated asynchronously through the Internet, conceived to keep communication and reflection alive within the space of the project. It was expected that this virtual artifact could help disseminating information regarding the outcomes of practice beyond the space/time of their production and that it could autonomously function as an integrative medium, as a "significant symbol" [1]. In short, the study addressed the two following questions related to the genesis of the meaning of participating in the teaching assistant development program:

- How personally involved were the participants in the teaching assistant development program, i.e., how meaningful was that participation for them?
- How instrumental was the technological artifact operationalized through the Internet for keeping communication and reflection "alive" within the space of the project?

2 Theoretical Framework

The design and implementation of the program was deeply influenced by the Finnish teacher education rationale. Educational literature tends to correlate the actual high degree of educational attainment in Finland with teachers' strong competence and preparedness, which, in turn, is attributed to an approach to teacher education that involves a combination of autonomous, research-based, practice and reflection [2,3]. According to Sahlberg [3], the most important factor driving the development of teaching capability in Finland is a dynamic conception of educational knowledge that focus on keeping, at all times, the teaching and learning environment personally meaningful. In the same vein, Andere [2] outlines the critical role played by the personalization of the learning environment.

The transferability of that kind of self-regulated and inquiry-oriented approach to teacher education to a non-Finnish context, particularly to the much more power-distant and teacher-centered educational culture of Macau is, of course, problematic. However, there are reasons to believe that the truth contained in the Finnish educational "miracle" lies at a much higher level of abstraction than that of concrete measures of educational policy. Most probably, as implied by Sahlberg [3], a key aspect lies in the conditions for consensus actually prevailing in the Finnish educational system and in Finnish society in general. The most widespread understanding of the role of standards in education worldwide is, according to Sahlberg [3], primarily concerned with motivating the adoption by the learners of some course of action (or interaction), i.e., with inducing some kind of behavior, believed to be, in the case of teacher education, the most appropriate to handle a specific instructional circumstance. An opposite approach prefers, instead, to fixate on the meaning of behavior, not the behavior in itself—not "what" people are supposed to do or "how", but "why". Behavioral openness is a requirement for operating within this latter rational, which, according to Sahlberg [3], is the general direction in which learning regulation can be found in Finnish teacher education.

That same rational pervaded the design and implementation of the teaching assistant development program. It was assumed that an aspiration for operating in meaning, being a profoundly human trait, had to be highly transferable. How significantly it would be possible to keep the program moving forward within that kind of rational remained an open question.

Key theoretical inspiration was sought in the works of Niklas Luhmann [4,5,6,7], a German social scientist and a prominent thinker on the topic of meaning, with an approach that purposely avoids the subjective, psychological, or transcendental connotations of the term [5]. He is also well known for having imported the concept of autopoiesis from biology to social sciences to characterize the organization of communicative and reflective processes. The concept of autopoiesis, literally meaning self-creation, was first presented as the systemic definition of life by the Chilean biologists Humberto Maturana and Francisco Varela [8]. Luhmann abstracts autopoiesis from life, seeing it as a general form of system building. For him, "there are non-living autopoietic systems" [7].

Drawing on an extensive range of evidence, Luhmann [6] suggests that meaning systems, while servicing their autopoiesis, tend to obscure selected parts of their surroundings, by excluding from consideration environmental facts not immediately relevant to the preservation of their organization or of their identity. It follows that, for these systems, learning is possible only in the eventuality of it not "short-circuiting" identity. By the same rationale, learning must be highly probable in all identity-protecting situations in which it may contribute to individuation, i.e., to distinguish these systems from their surroundings. The teaching assistant development program was intentionally designed to maximize the exposure of participants to this kind of identity protection through learning, situations.

According to Luhmann [6], an interest in acquiring information and, thus, in contextual observation, can only arise via the "irritation" of a self-selected matrix of aspects in relation to which minds are set sensitive to their environments and therefore react. Only in that case can a specific set of surprising developments be taken not as mere undifferentiated noise, but as information, as "difference that makes a difference" [9], thus, leaving behind a cognitive structural effect. The participants in the program were in permanent contact with that kind of reference by sharing online access to an electronic medium, an Excel file containing the coordinator's evaluations of student responses to instruction. Evaluations were systematically computed on learning outcomes operationalized around *Critical Thinking*; *Creativity*; *Communication*; *Cooperation*; *Content Knowledge* and *Attitudes/Values*, the six learning dimensions in which the 21st century educational purpose of the program was internally decomposed.

3 Methodology

Primary empirical data was extracted from open and non-structured interviews conducted in an ongoing, flexible, exploratory way, near the end of the program, with the teaching assistants, who were substantially different in terms of nationality and cultural background (2 Chinese, 1 Portuguese, 1 Brazilian and 1 of mixed origin, Macanese-Filipino). They provided the information necessary to convey an overall picture of their main concerns and how they tried to resolve them at several critical points in time while participating in the program. Additional data was extracted from class observation reports.

Grounded Theory was the methodology selected to conduct the data collection and analysis. Data was coded through the *Constant Comparative Method* [10,11,12,13]. "The overall object of this analysis is to seek patterns in the data" [10]. The analysis occurred simultaneously, in parallel with data collection. Basically, it involved an iterative process of collecting, analyzing, and codifying data running in turns, first the interview of participant A; followed by analysis and theoretical development; then, the interview of participant B; more analysis and more theoretical development; and so on successively until the interview of participant E. Data proceeding from class observation reports were critically compared with data from the interviews in order to identify consonance or incongruity between them. Literature sources were also used in comparisons with data. From the point of view of *Grounded Theory*, "all is data" [11,12,13]. Theory very much helped in digging up the truth contained in the concrete material, as it became apparent, at a certain point in the analytic process, that it lay deep down, out of reach of mere induction.

4 Findings

Enhancement of Self-Descriptions was one of the most significant patterns identified in the analysis. It condenses the most plausible explanation for what was the main concern of the teaching assistants participating in the program. It denotes an unintended improvement in the quality of the TA's evaluations of their own personal characteristics and the characteristics of the other participants in the program, in the former case constituting a development in self-consciousness or I-awareness. Student responses to instruction submitted the teaching assistants' portrayal of themselves and their self-concept as teachers to permanent validation tests. As one of the participants emphasized in her interview, "there was that purpose we had to realize. To deliver that output was almost a matter of survival" (Teaching Assistant A). The amplification of the truth contained in personal theories of self was an emergent form of reality over which no one was totally in control. Illusionary self-deception was hardly sustainable. Extended self-awareness was the obvious consequence of being a central reference to that peculiar communicative process in which one's self is the main topic of the "conversation".

A second core concept, *Complexifying the Domain of Distinctions*, also emerged from the analysis. This refers to a process eliciting the structural growth of the set of references used in meaning processing operations and explains how the main concern was, by the assistants, processed and resolved. Uncertainty about self-evaluations was resolved through the restructuring of self-sensical narratives using a richer and more integrated set of personal attributes. As one of the interviewed teaching assistants recognized, "it is all about the thinking of the individual, the personal thinking, how a person thinks about herself" (Teaching Assistant B). Expanding the repertoire of distinctions used in performing self-evaluations was the key to reducing the level of doubt about their selves induced by the contingent flow of events and circumstances.

A third and, probably, the most significant idea emerging from this study, even though totally unexpected, is related with the virtual artifact devised to assist the autopoiesis of communication and reflection within the space of the program. Despite continually reminding the participants about several aspects of student responses to instruction, in relation to which they were expected to be sensitive, 3 out of the 5 exhibited an inclination to "shut their eyes" to specific parts of that feedback, and to exhibit a lower level of reaction to clear indications that their instruction was not successfully addressing some of the specified learning outcomes. Instead of addressing the purpose holistically, in all of its dimensions, some assistants could be seen unilaterally focusing their instructional effort in only a few of the intended learning outcomes (curiously, the ones normally involved in one form or another of unilateral approach were the non-Chinese teaching assistants). The virtual mechanism, operated asynchronously through the Internet, despite a necessary communicational medium, was apparently insufficient to guarantee that complete justice was paid to the global purpose of the program.

One has to accept the possibility that the several dimensions of a complex educational purpose may be addressed in different ways, but in a 21st century learning environment, one is not anymore in a situation in which it is possible to go far by electing only a few learning outcomes to address unilaterally, neglecting the positive influence of developments elicited in the context formed by the remainder others, that is, disregarding how the Yin gives rise to the Yang, and vice-versa, to use the Chinese philosophy references mentioned in the title of this paper. This last finding deserves deeper scrutiny, because no one could be observed in the interviews advocating a reduction in the dimensional scope of the 21st century teaching purpose of the program.

5 Discussion

The study showed that the initial expectations about the transferability of a self-regulated and inquiry-oriented, Finnish-like, approach to teacher education into a Chinese context were relatively well founded. A very positive answer was elicited in response to the first research question, which sought to determine how meaningful participation was for participants. The analysis of the interviews suggests that, from the beginning until the end of the program, the teaching assistants' actions remained almost radically self-determined and, therefore, invested with personal meaning.

With respect to the second research question, whether or not a technological artifact operationalized through the Internet helped keeping communication and reflection "alive", a definite answer could not be drawn from the analysis. An apparent contradiction between the record of classroom performance and what some teaching assistants' state in the interviews raised an important question. Why was a holistic teaching approach immediately preferred by some teaching assistants and continued being the prevalent one to them while to others, even if eventually selected, it tended to die out and to be replaced by a unilateral one? What can explain the persistent adoption of one or the other of the two different strategies?

One immediately dependable inference is that the two distinct teaching rationales, the holistic and the unilateral, despite not being equally effective from the point of view of the program, were probably functionally equivalent from the point of view of solving the above-mentioned main problem of the teaching assistants, i.e., the uncertainties surrounding the *Enhancement of Self-Descriptions*. Recent psychological research gives support to this hypothesis. People's heightened concern for the stability of their own expectations might diminish a concern for the factual fit of their own self-descriptions. They might suppress the commitment to exploration and function, focusing instead on maximizing routine expertise: "multifinal choices make a great deal of sense, and exemplify the simple rationality of maximizing the returns on one's investments, or increasing the 'bang for one's buck'" [14]. By restricting their attention to a particular teaching strategy, i.e., by adopting a unilateral approach, even if it might be perceived as barely instrumental to achieve all of the several complementary learning goals, some assistants were supposedly reducing the risk inherent in having to identify effective attainment strategies for each of the goals in question. On the contrary, by running the risks of abandoning a valuable teaching strategy in order to explore ways of recursively covering all the other dimensions of the overall goal, i.e., by adopting a holistic approach, some other assistants were benefiting from operating within a stronger functional connection between each of these specific goals and the selected means. Research suggests that individuals will oscillate in their preference for connection strength, versus value, in the relationship between goals and means, depending on their preferred self-regulatory mode [15].

This combination of findings and literature points to uncertainty absorption as the most promising explanation for the selection of the unilateral approach. Too much openness can become a threat to the very autopoiesis of meaning; can raise the complexity of communicative and/or reflective processes to intolerable levels. Some teaching assistants and their students might have been involved, much more than others, in framing the spectrum of possibilities for communication and reflection in order to make these processes less volatile and more certain. The continuation of communication and reflection was unquestionably crucial for all participants in the program. For sure, nobody could afford a communicative halt. The fact that the participants choosing the unilateral approach seemed not to be aware of making that kind of strategic decision makes conceivable the idea that it was not their choice alone. These assistants may have simply followed a pathway of viability in their relationship with students. The unilateral solution was, so to speak, “noise” activated. It was a transpersonal decision, the outcome of innumerable personal decisions circularly activated by meaning processing difficulties. This idea provides some support for the hypothesis that the Chinese teaching assistants may have benefited from the fact that the large majority of students in the program were Chinese. Compensating for losses in meaning was probably easier in their classes, as few of the involved had to face the normal difficulties posed by operating within a multicultural context.

6 Conclusion

This study strongly corroborates the worth of the *Luhmannian* hypothesis concerning the autopoietic nature of communication and consciousness, that is, of the idea that meaning constitutes the circumstances assisting its own reproduction and that is does so autonomously, as if it had a life of its own. The study also brings forth the notion that significant structural differences in the realization of a complex educational purpose can occur without compromising the overall organization of meaning. General self-identification with an educational purpose, however, can continue even in situations where the organization of meaning is partially jeopardized, namely when communication and reflection around specific dimensions of that purpose lose their meaning. Self-identification, in itself, does not seem to be sufficient to prevent the emergence of a gap between what people think and talk about and what is really decisive. Lower forms of realizing the valued educational purpose may well supervene.

Even if the findings are suggestive, one cannot claim that things happened in the program the way they did for general reasons that can be completely understood in terms of the study alone. The hypotheses emerging from the study have to be tested in their capacity to predict similar developments outside the space in which they originated, namely within other comparison groups. Only further investigation will help establishing a greater degree of accuracy on the matter.

The present study, however, already suggests that, from the point of view of learning, it is not teachers, or students, or schools that innovative teacher education efforts and technologies should primarily target to serve. It is meaning. Technological developments that acknowledge circumstantial communication and thinking limitations to the full are the ones that can do self-regulated teacher education programs good. This is, most probably, the direction in which significant innovations in this field can be expected in the coming years.

References

[1] Mead, George H.: A Behavioristic Account of the Significant Symbol. Journal of Philosophy 19 (6), 157-163 (1922)
[2] Andere M., Eduardo: Teachers' Perspectives on Finnish School Education: Creating Learning Environments. Springer, Dordrecht (2013)
[3] Sahlberg, Pasi: Finnish lessons: what can the world learn from educational change in Finland. Teachers College, New York (2011)
[4] Luhmann, Niklas: The improbability of Communication. International Social Science Journal 33 (1), 122-132 (1981)
[5] Luhmann, Niklas: Society, Meaning, Religion: Based on Self-Reference. Sociological Analysis 46 (1), 5-20 (1985)
[6] Luhmann, Niklas: Social Systems. Stanford University Press, Stanford California (1995)
[7] Luhmann, Niklas: The autopoiesis of social systems. Journal of Sociocybernetics 6, 84-95 (2008), p. 84
[8] Maturana, Humberto R., & Varela, Francisco J.: Autopoiesis: The organization of the living. In: H. R. Maturana and F. J. Varela (eds.) Autopoiesis and cognition, pp. 59-138. D. Reidel Publishing Company, Boston (1973)
[9] Bateson, Gregory: Mind and Nature: A Necessary Unity. E. P. Dutton, New York (1979)
[10] Merriam, Sharan B.: Qualitative research and case study applications in education. Jossey-Bass Publishers, San Francisco, California (1998)
[11] Glaser, Barney G.: Theoretical sensitivity: advances in the methodology of Grounded Theory. The Sociology Press, Mill Valley, California (1978)
[12] Glaser, Barney G.: Doing Grounded Theory: issues and discussions. The Sociology Press, Mill Valley, California (1998)
[13] Glaser, Barney G. & Strauss, Anselm L.: Discovery of grounded theory: strategies for qualitative research. Aldine de Gruyter, Chicago (1967)
[14] Kopetz, C., Kruglanski, A. W. Chen, X., & Orehek, E.: Goal systemic effects in the context of choice and social judgment. Social and Personality Psychology Compass 2(6), 2071-2089 (2008), p. 2080
[15] Orehek, Edward, Mauro, Romina, Kruglanski, Arie W. & van der Bles, Anne Marthe: Prioritizing association strength versus value: The influence of self-regulatory modes on means evaluation in single goal and multigoal contexts. Journal of Personality and Social Psychology, 102(1), 22-31 (2012)

Exploring pre-service teachers' acceptance of smart learning

Jeongmin Lee*, Hyunmin Chung, Jiyoon Moon, & YoungRan Yoo

Ewha Womans University, Seoul, Korea
jeongmin@ewha.ac.kr, hm502@ewhain.net, gracemoon626@gmail.com, applenyoo@naver.com

Abstract. The purpose of this study was to investigate the structural relationships among smart learning acceptance factors for pre-service teachers in South Korea. The research model based on the UTAUT2(Unified Theory of Acceptance and Use of Technology) model. The model suggested the determinants of smart learning acceptance including Performance Expectancy, Effort Expectancy, Social Influence, and Facilitating Conditions, Hedonic Motivation and Attitude. For this research, 206 pre-service teachers answered the off-line survey in Seoul, Korea. As the data analysis method, descriptive and correlation analysis were done as well as the structural equation modeling analysis to validate the model and analyze the causal relationship among variables. The implications of this study and suggestions for the future research will be discussed in the conference.

Keywords: UTAUT, smart learning, pre-service teacher, Behavioral Intention.

1. Introduction

According to the recent statistics, almost 67% of population in Korea use smart devices and it is the highest level of smartphone ownership in the world [1]. The wide use of smartphone equipped with not only basic communication function but exploring and searching information has enabled us to get information easily and quickly. The use of various types of applications also gives convenience in life, which are developed to meet the needs of the users worldwide. In addition, the easy way to share information and communicate with other undergoes drastic change through SNS by overcoming the limitation of time and space, which brings about the whole ecology of economy, society and culture [2]. With its pedagogical benefits, active discussion about teaching and learning by smart learning and the educational effect have been increasingly suggested while the perfect consent between the researchers is not achieved for the concrete organized concept and

* Jeongmin Lee, Ewha Womans University, Seoul, Republic of Korea, jeongmin@ewha.ac.kr

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_25

structural characteristics of smart learning[3].According to the previous research, most students already experience smart learning[4].

Following this current movement, Korean MESC (the Ministry of Education, Science and Technology) keep up with the trend, announcing “Smart Education Strategy action plan" in June 2011[5]. The whole paradigm change of the era requires the development of the educational field. However, despite the support of government and requirement of the members of school community, the actual time for smart learning is not sufficient. Also based on the previous studies which are related to the characteristics of teachers affecting the use of ICT in class, such as, the teachers' use of computer experience [6], attitudes toward computer use [7] and the experience of Teacher Training courses [8]. It is necessary to investigate what condition and precursor variables works to increase teachers’ smart device. Moreover, the latest technology and well-designed learning methods are not enough to make good learning [9]. Therefore, studying the casual variables suggested by UTAUT2 would contribute to achieve effective smart learning, except the inappropriate cause related to the environment (i.e., price value, habit). The final structural model included Attitude which significantly affects Behavior Intention. Considering that the moment of this research was in the early stage for smart learning, the age and the degree of experience are unevenly distributed, thus, those were excluded as moderating variables.

With this background, the purpose of this study is to investigate the factors that affect the choices of pre-service teachers on smart learning on the basis of UTAUT2 (Unified Theory of Acceptance and Use of Technology) [10] through an empirical analysis. Based on the findings of the analysis, we suggest the implications about strategic factors for pre-service teachers. Considering the situation that the adoption of smart learning in the classroom is at an early stage, the study focus on the investigation of behavior intention, excluding usage behavior for revising original UTAUT2 model.

The specific Research hypotheses of this study are as follows.

Hypothesis 1: Performance Expectancy has a positive effect on Behavioral Intention.
Hypothesis 2: Effort Expectancy has a positive effect on Behavioral Intention.
Hypothesis 3: Social Influence has a positive effect on Behavioral Intention.
Hypothesis 4: Facilitating Conditions has a positive effect on Behavioral Intention.
Hypothesis 5: Hedonic Motivation has a positive effect on Behavioral Intention.
Hypothesis 6: Attitude has a positive effect on Behavioral Intention.

2. Method

2.1. Participants

For this study, two-week offline survey has performed in 2014. Most of participants are in their early twenties from 17 to 29(average, 21) attending a teachers college located in Seoul. All participants were female and educated to be teachers. After eliminating 210 incomplete responses, 206 data were analyzed.

2.2. Measurement

To measure Performance Expectancy, Effort Expectancy, Social Influence, Facilitating Conditions, Hedonic Motivation, Behavioral Intention, questionnaire items developed by Venkatesh et al.(2012) were revised in order to adapt appropriate situation, with the use of 7-point Likert scale.

Performance Expectancy consisted of 3 test items like 'I would find smart learning useful in my classes '.The reliability records .887 of Cronbach's α. In addition, *Effort Expectancy* measured with 4 items, for example 'It would be easy for me to become skillful at using smart learning in my classes'. The reliability records .943 of Cronbach's α. Also *Social Influence* measured with 4 items by the questionnaire, for example, 'People who influence my behavior think that I should use smart learning'. The reliability recorded .892 of Cronbach's α. *Facilitating Conditions* measured with 4 items by the questionnaire, for example, 'I have the resources necessary (smart devices) to use smart learning'. The reliability recorded .791 of Cronbach's α. And also 3 items for *Behavioral Intention* like 'I intend to use smart learning in my classes' and reliability recorded a Cronbach's α of .923. To measure *Hedonic Motivation*, three items were used and the Cronbach's α of inter-item consistency was .954 (e.g., "Using smart learning for class is interesting").

we used Taylor and Todd[11] instrument to measure *Attitude*. The measurement instrument consisted of 4 items (e.g., "I think using smart learning have some good points"). The Cronbach's α of inter-item consistency was .903 with the use of 7-point likert scale.

2.3. Procedure

For statistical analysis, exploratory factor analysis will be administrated to confirm the validity and descriptive statistics, correlation analysis conducted in order to confirm the normality of the data by using SPSS. After that, structural equation modeling analysis will be performed to test proposed model and the causal relationships among the variables by using AMOS.

3. Results

The variables means ranged from 1.33 to 7.00, standard deviations from .92 to 1.18, skewness from .22 to .77, and kurtoses from .05 to .61. Because the skewness of the measurement variables were less than 3, and the kurtoses were less than 10, the variables satisfied the basic assumptions of a multivariate normal distribution for SEM examination.

Table 1. Fit statistics for the structural Model

(n=206)

	CMIN	df	TLI	CFI	RMSEA (90% confidence interval)
Structural Model	535.25	254	.931	.942	.073(.065-.082)

The correlation coefficients of variables were from .253 to .799.The measurement model had a good fitness, and the fitness of the structural model was TLI = .931, CFI = .942, and RMSEA = .073(.065-.082).Therefore, we confirmed the measurement model has a good fitness.

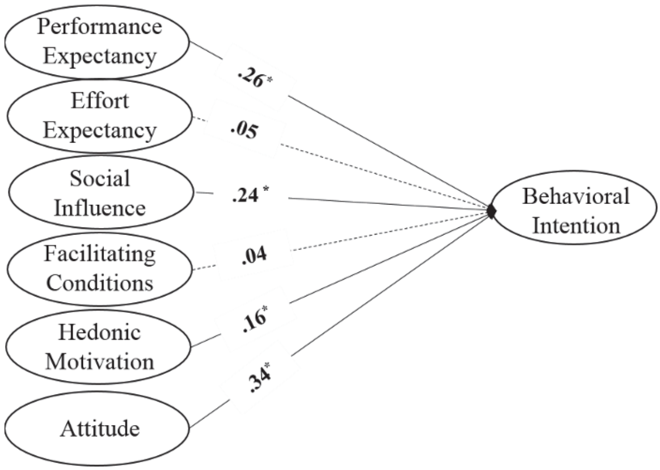


Fig. 1. Structural model with standardized path coefficients

Fit statistics for the structural Model are shown in Table.1. The result of direct effects between predictors and dependent variable, Behavioral Intention as follows: Performance Expectancy on Behavioral Intention was β = .26(t = 2.06, $p< .05$); Effort Expectancy on Behavioral Intention was β = .05(t =.80, $p> .05$); Social Influence on Behavioral Intention was β = .24(t = 4.24, $p< .05$); Facilitating Conditions on Behavioral Intention was β = .04(t = .57, $p > .05$); Hedonic

Motivation on Behavioral Intention was β = .16(t = 2.19, $p < .05$); Attitude on Behavioral Intention was β = .34(t = 2.32, $p < .05$) as shown in Table 2.

Table 2. Effects of the structural model

(n=206)

Variables			Unstandardized coefficient (B)	Standardized coefficient (β)	S.E.	t
Behavioral Intention	←	Performance Expectancy[H1]	.29	.26	.14	2.06*
		Effort Expectancy[H2]	.04	.05	.05	.80
		Social Influence[H3]	.31	.24	.07	4.24*
		Facilitating Conditions[H4]	.06	.04	.10	.57
		Hedonic Motivation[H5]	.16	.16	.07	2.19*
		Attitude[H6]	.39	.34	.17	2.32*

*$p < .05$

Therefore the effects of Performance Expectancy, Social Influence, Hedonic Motivation, and Attitude on Behavioral Intentionwere statistically significant, but the effects of Effort Expectancy and Facilitating Conditions on Behavioral Intentionwere not significant. Moreover, because the total explanation power of Behavioral Intention was 82.0% (.820), we conformed the proposed structured model had validity. The standardized path coefficients of the modified model are shown in Fig. 1.

4. Conclusion

The purpose of this study is to investigate the structural relationships among smart learning Behavioral Intentionand its precursors in the case of pre-service teachers in South Korea.The result of the study is as follows:

First,Performance Expectancy predictsBehavioral Intentionpositively and this result is consistent with the results from previous studies [12]. The findings provided the following implication that the higher Performance Expectancy of using smart learning by pre-service teachers brings about the higher Behavioral Intentionto adopt technology in their class, therefore, the frequent and effective executionof teacher training or sharing well-designed cases of teaching demonstration to raise Performance Expectancyof technology use will facilitate behavior intention.

Second, Effort Expectancy does not predict Behavioral Intentionand the result shows inconsistency with the claims from the previews studies [13]. Given that the data was collected from high percentage of participants in their early twenties, Effort Expectancy is regarded less important. Generally speaking, young generation can utilize the smart device and technology without extra effort and thus their digital literacy or capability to use technology for smart learning bring about this result. Therefore, we need to confirm the cause or relationship between two variables.

Third, Social Influence exerted an effect on Behavioral Intention, consistent with the results from the previous studies [14]. Given that Social Influence is a variable that depends on others, the positive belief of peers or the circles of teachers, surrounding circumstances toward smart learning is a key factor of increasing behavioral Intention.

Fourth, on the other hand, Facilitating Conditions fail to predict Behavioral Intention. The result regarding facilitation conditions are inconsistent with the previous research [15]. The result comes from the pre-service teachers, so this it might reflect unclear expectation for teaching environment. The investigation for causal relationship between Facilitating Conditions and Behavior Intention is needed in specific classroom setting with the teachers in the actual education field.

Fifth, hedonic Motivation exerted significant effects on Behavioral Intention. This result echoes the claims from previous studies related to Hedonic Motivation and Behavioral Intention[16].This result implies that learners with a high level of Hedonic Motivation tend to show positive intention to use smart learning, therefore, designing smart learning to feel fun and entertain when they use technology may increase the rate of Behavior Intention.

To make teacher perceive the entertaining part of smart learning, not only the training programs for functional skills but focusing the purpose of training programs for practical use is meaningfully appealed to teachers in addition to provide huge amount of interesting multimedia and learning contents for the adoption to classroom activities [17]. With this program, teachers would feel fun and it will generate motivation: to know and acquire advanced level of functions for smart learning.

Sixth, Attitude significant effects on Behavioral Intention, and this result is consistent with the results from previous studies [17][18]. In other words, positive attitude toward smart device is a critical determinant behavior intention, as claimed in prior research.

Therefore, it is important to make teachers realize positive functions and aspects to increase positive attitude toward smart learning. Without coercive law or regulation, incentives or inducement strategies for teachers to enhance the use of smart learning is important, with internal motivation to develop their teaching skills as well as external motivation by governmental support.

The limitation of the study and our suggestions for further research studies are as follows. First, the results of this study have a limited generalizability: we used 206 female pre service teachers in South Korea. Future studies should include teachers with educational experience as well as different gender, race, and various types of social backgrounds and culture based on the previous studies related to

UTAUT2[16]. Second, since we only focused on Behavioral Intention, the causal relationship between Behavioral Intention and use behavior needs to be proved on the basis of previous research [19].

References

[1]Yoon, S. (2013.07.02). Korea tops global smartphone penetration in 2012, http://www.korea.net/NewsFocus/Sci-Tech/view?articleId=109715
[2]Oh, K.& Lee, J.: The 'Smart Life'Revolution and Smart Phone Addiction. Internet and Information Security, 3(4). 21-43. (2012).
[3]Lim, K. & Lee, D. Y.: The 'Smart Life'Revolution and Smart Phone Addiction. Journal of Digital Convergence, 10(9), 47-57. (2012).
[4]Jo, K.: The research for the actual use of smart device for elementary and middle school students. Seoul: Korea Education and Research Information Service. (2013).
[5]Kim, D.: Smart learning promotion strategy. Educational development 38(3), 30-37 (2011).
[6]Kang, M., Shin, E. M. & You, J.: A Structural Relationship among Factors Affecting Mobile Learning Acceptance in Foreign Language Learning, 29(3), 637-665 (2013)
[7]William, D., Coles, L., Wilson, K., Richardson, A., &Tuson, J.: Teachers and ICT: Current use and future needs. British Journal of Educational Technology, 31(4), 307-320 (2000)
[8]Shapka, J. D., & Ferrari, M.: Computer-related attitudes and actions of teacher candidates. Computers in Human Behavior, 19(3), 319-334 (2003)
[9]Vannatta, R. A., & Fordham, N.: Teacher disposition as predictors of classroom technology use. Journal of Research on Technology in Education, 36(3), 253-271 (2004)
[10]Venkatesh, V., L. Thong, J. Y., & Xu, X.: Consumer acceptance and use of information technology:Extendingthe unified theory of acceptance and use of technology. MIS Quarterly, 36(1), 157-178.(2012).
[11]Taylor, S. & Todd, P.: Understanding Information Technology Usage: A Test of Competing Models. Information Systems Research, 6(2), 144-176. (1995).
[12]Moran, M., Hawkes, M., &Gayar, O. E.:Tablet personal computer integration in higher education: Applying the unified theory of acceptance and use technology model to understand supporting factors. Journal of Educational Computing Research, 42(1), 79-101. (2010).
[13]Jairak, K., Praneetpolgrang, P., &Mekhabunchakij, K.:An acceptance of mobile learning for higher education students in Thailand. The International Journal of the Computer, the Internet and Management, 17(SP3), 36.1-36.8. (2009).
[14]Pynoo, B., Devolder, P., Tondeur, J., Van Braak, J., Duyck, W., &Duyck, P. : Predicting secondary school teachers' acceptance and use of a digital learning environment: A cross-sectional study. Computers in Human Behavior, 27(1), 568-575.(2011).
[15]Agarwal, R. &Karahanna, E.:Time flies when you're having fun: cognitive absorption and beliefs about information technology usage. MIS Quarterly, 24(4), 665-694. (2000).
[16]Lewis, C. C., Fretwell, C. E., Ryan, J., & Parham, J. B.: Faculty Use of Established and Emerging Technologies in Higher Education: A Unified Theory of Acceptance and Use of Technology Perspective. International Journal of Higher Education, 2(2). (2013).
[17]Kim, M. & Han, K. H.:A Study on Factors Affecting the Satisfaction and Intention to Use ICT in Elementary, Junior and Commercial High Schools. The Journal of korean teacher education, 23(3), 143-166. (2006).
[18]Eom, W. & Yoon, J.:Analysis of Teacher`s Individual Characteristics Affecting ICT Use in the Secondary Classroom Teaching. The journal of educational information and media, 11(2), 29-48. (2005).
[19]Davis, F. D.:Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319-339. (1989).

Exploring students' discussion in face to face and online synchronous learning

Peng Chen[1,4], Jing Xiang[1], Yuting Sun[1], Yi Ban[1], Guang Chen[1,2,3*] and Ronghuai Huang[1,2,3]

[1] School of Educational Technology, Faculty of Education

[2] Collaborative & Innovative Center for Educational Technology (CICET)

[3] Beijing Key Laboratory of Education Technology
Beijing Normal University, Beijing, China

[4] School of Life Science, Capital Normal University, Beijing, China

{pengchbnu,derering0118,sunyt0709,banyi0907,teastick,ronghuai.huang}@gmail.com

Abstract. The aim of this study was to compare class discussion between face to face learning and online synchronous learning. Discussion records containing 311 messages from a similar class in both context were analyzed by content analysis methods. In addition, a questionnaire was given to participants in order to understand their perceptions toward online learning. According to the data, students' discussion about questioning, greeting, greeting and help in online learning were significant higher than in face to face learning. The analyses also revealed that face to face learning may be more suitable for learners to discuss deeply in learning content for judgment, reasoning, explanation, and the teacher should supply proper instructional design and facilitation for class interaction. As a pilot study, the problem is resulted from the lack of massive discussion messages and experiments times, and instructional strategies will take into considered.

Keywords: students' discussion, face to face learning, online synchronous learning

1 Introduction

Synchronous learning refers to the learning environment in which everyone takes part at the same time. Before a technology allowed for synchronous learning environments, most synchronous learning means face to face learning, and online education took place through asynchronous learning methods. Since synchronous tools that can be used for education have become available, many people are

* Corresponding author: Guang Chen
Email: teastick@gmail.com

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_26

turning to online synchronous learning [1]. Online synchronous learning becomes more and more popular because of its convenience, now a number of studies have demonstrated the benefits of online synchronous teaching and learning [2][3][4]. However, changes of the instruction models, accompanied by environment changes, also brought much thinking and challenge.

1.1 Synchronous discussion

Discussion between students and tutors is an necessary part of a class, crucial for supporting negotiation of meaning that leads to knowledge construction, and essentially a social cognitive process [5][6][7]. Learners can fully express their views, opinions, formed mutual tolerance, understanding and helping with interacting learning [8]. Social interaction is a vital factor in cognitive development, and cognitive and value conflicts arising through social discussion and interactions that play an important role in promoting individual cognition [9]. In a face to face environment, discussion is always controlled by teacher. Sometimes when teacher asks a question or assigns a task or the learner has a something want to ask or communicate, the discussion will happen. In online synchronous learning, learners and teacher discuss in a chat room or through a microphone. When the learner has a question, he also can hand up immediately. A growing body of literature has explored the connectivity between technology and collaborative learning by using dialogue as a pedagogical tool to help students engage in online synchronous discussion for idea exchange [10][11][12]. They found some advantages of online synchronous discussion such as immediate feedback, increased level of motivation and an obligation, learn and interact more sufficiently and deeply [2][3][4]. Chen et al. [13] conducted a research about how synchronous online discussion may support quality and success in professional development and teacher education by analyzing online synchronous discussion transcripts. Teng et al. [14] analyzed the message content to explore students' learning experience with cognitive, social, and teaching presence in the Synchronous Cyber Classroom. They found that effective discussion among learners, instructors, and course content, which result in a better understanding of each other and accumulating mutual trust. On the other hand, they also found some limitations include a time constraint, lack of reflection time and difficulty in moderating larger scale conversations [15].

1.2 Research questions

In the previous research, online synchronous learning was used mainly because of its convenience, unrestrained and not limited by time and space. In the campus, it wasn't involved issues of time and space. The teacher can get students together in a classroom easily. However, teachers found students discuss less and lower efficiency in face to face learning, even they were asked to do so. Previous researches didn't compare class discussion between face to face and online synchronous learning, and rarely take college students as participants. Based on the condition of face to face learning, whether online synchronous learning can solve those problems or not? With the development of information technologies, most college students are digital natives. Do they have intention to express and discuss more in the technology rich environment? In this research, we aim to explore the differences of students' participation and discussion between face to face learning and online synchronous learning.

2 Methods

2.1 Data Sources

The participants in this study included 22 students who take part in the course Psychology 101 in Beijing Normal University. They are sophomore students, major in Educational Technology, and are skilled in operating a computer. Every student has a laptop and headset. One teacher and four teaching assistants were responsible for facilitating the course. In the research, we organized two classes. One is a face to face learning (control group), which teacher gave a lecture and asked questions, students answered questions and had some discussion. The other is online synchronous learning using WebEx (experimental group), which is very popular, and well-rounded platform operated by Cisco, and has chat room, raise hand function, grouping function, share screen that facilitate students learning online. The teacher taught in the same approach, and the learning content of two groups has similar property. During the class, we recorded the whole discussion.

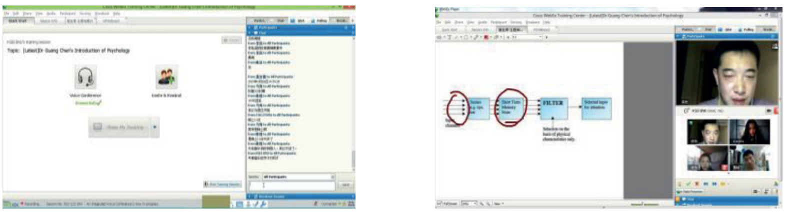


Fig. 1. Snapshots of the online research learning

2.2 Data Collection

We used content analysis as the main methodology to analyze the face to face and online discussion because the present study is more concerned with analysis and categorization of text [16]. The major data source in this study was the synchronous discussion transcripts. In synchronous online learning, we got discussion transcripts from WebEx chat room and WebEx recording forum containing a total of 242 messages. And in the face to face learning, we collected 69 messages of student discussion transcripts extracting from record video. Two researchers did extracting work with confirmation and modification carefully for ensuring the accuracy. In order to understand students' learning outcomes and satisfaction with online synchronous live instruction, a survey was conducted. The students were given a questionnaire, which referred and modified from "Student evaluation of synchronous online courses" in Chen's study[13], to evaluate their learning experience at the end of the course, which using a 5-point Likert scale, ranging from 1 (strongly disagree) to 5 (strongly agree).

2.3 Data Analysis

Coding scheme is the most important part of content analysis, Garrison et al. [17] concluded their extensive investigations on students' learning in computer-mediated asynchronous communication environment and proposed the model of Community of Inquiry for online learning. They identified three key categories for analysis of computer-mediated communication discussion including cognitive, social, and teaching presence [18]. The framework for this study was that of Chen et al. [19] which was modified from Zhu's [20] and Veldhuis' original model. According to important characteristics of the virtual learning community, Zhu [20] designed a collaborative knowledge building code system, considered a good discussion of study activities should include cognitive, social and teaching presence. Chen modified and simplified each dimension of Zhu's model. In this analysis framework, messages were categorized into three major categories: cognitive presence, social presence, and teaching presence. Tables 1 show the information on dimension and explanation of each category.

Table 1. Coding scheme for analyzing interaction content

Dimension	Category	Explanation
Cognitive Presence	Share	Supply or introduce relative fact, resource, information or knowledge
	Questioning	Ask questions associated with activity or task
	Demonstrate	Judge, comment, demonstrate, explain and summarize the conclusion, viewpoint, fact information
	Negotiate	Check, affirm, doubt the viewpoint; agree or disagree and modify the viewpoint.
Social Presence	Positive emotion	Express ore describe personal positive emotion
	Negative emotion	Express ore describe personal negative emotion

	Greeting	Express greeting or introduce each other
	Help	Ask others for help or help others, state something irrelevant with academic tasks.
	Plan	Design activities, determine the time to complete the task and the media, establishing ritual constraints
Teaching Presence	Facilitate	Inspire and guide a talk by asking questions, act as organizer and guide the participation
	Reflect	Reflect the learning process, methods and achievement
	Evaluate	Evaluate others' answers or activities performance

The coding of synchronous discussion messages was performed by two coders using Nvivo (Qualitative Data Analysis software). The coders coded every message based on the analytical framework (show in table 1). Each message was analyzed dimension by dimension (e.g. interaction types) and categorized them into one specific category (e.g. share, questioning, demonstrate, negotiate). Two coders first engaged in the coding processes independently. They discussed their results with each other then. The complete set of data (synchronous discussion messages) was analyzed by both coders. When the coders did not agree on the coding, the following process was used to reach consensus on how to code the messages. First, each coder stated their reasons based on the framework. When the two coders felt it was not clear what category a message should go, they would go over the messages again and make modifications resolve the ambiguities.

3 Results

3.1 Analyses of online messages

In the face to face learning, students contributed 69 messages. Students posted 242 messages throughout the discussion in WebEx. After coding by Nvivo, we conducted discussion statistics. Students didn't talk anything that related with plan and facilitate, so those two categories are not included in the result. Figure 2 shows the quantitative data on participation in 11 categories of the two synchronous discussions. Discussion frequencies in online learning are higher than face to face learning discussion. Greeting and reflecting are the main subject of students' discussion in online learning, and in face to face learning students' discussion is refer to share and reflection. There is a marked increase in some categories, especially in questioning, greeting, and reflect. Paired T test results (Table 2) showed that there were significant differences in the scores of questioning (t=-2.263, p=0.034), greeting (t=-3.765, p=0.001), help (t=-2.347, p=0.029), reflect (t=-4.852, p=0.000), and other (t=-2.935, p=0.008) between face to face learning and online synchronous learning.

Table 2. Coding scheme for analyzing interaction content

category	t	df	Sig.
Sharing	.752	21	.461
Questioning	-2.263	21	**.034**
Demonstrate	1.821	21	.083
Negotiate	.901	21	.378
Positive	.646	21	.525
Negative	-1.821	21	.083
Greeting	-3.765	21	**.001**
Help	-2.347	21	**.029**
Reflect	-4.852	21	**.000**
Evaluate	-1.000	21	.329
Other	-2.935	21	**.008**

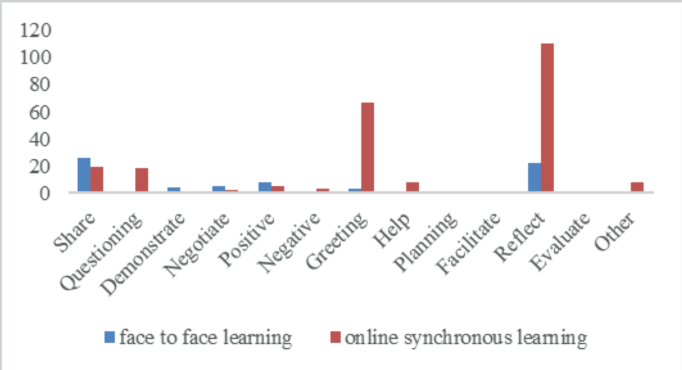


Fig. 2. Statistical distribution of interaction content in 13 category

3.2 Questionnaire results- satisfaction and perceptions of synchronous discussion

In order to understand students' learning outcomes and satisfaction with online synchronous live instruction, students did a questionnaire after class. There were 22 valid questionnaires results, and the mean of scores is 3.77. Most students responded that they were satisfied with the online synchronous learning. They liked online synchronous learning not only because of the new model, but key factor is they thought it supplied more real time feedback and facilitated theirs' motivation.

4 Discussion

In online learning, discussion involved in content questioning, greeting, help, and reflect were significant higher than in face to face learning. Students rarely asked questions spontaneously in face to face learning, even they had questions about learning content. We think it is caused by the traditional teacher-student relationship in China. Students were not encouraged to ask questions during class. In face to face learning, students tended to discuss with classmates or teachers after class. But in online synchronous learning, the gap between teachers and students is not very obvious, and students can ask questions in the chat room by typing at any time they want, which can give them less pressure. Also, in synchronous online learning, when student had some questions about the software, the learning environment, they would ask help and get support in the chat room. Meanwhile, most students rarely greeted in face to face learning, but greeted a lot in online learning. Because no one will do such kind things and teacher wouldn't give time for them to do during face to face learning. But students keep saying "hello" to each other in the chat room during online learning. Some researchers argued that students used too much time on social while learning. Since this is the very first time for those students who study in a new learning environment, we think they might need some time to get used to it. In teaching presence, students talked more on reflecting because they can get immediately feedback from teacher and other students. In a word, as digital natives, students are familiar with online discuss because most of them are using some SNS Apps, such as WeChat, Line, etc.

In face to face learning, there are more demonstrating and negotiating of cognitive presence than in online learning. Students discussed deeply for judgment, reasoning, and explanation when they were in the real classroom environment. In face to face learning, students had few opportunities for asking questions, and they might think and discuss more deeply when they have a chance to do so. If teachers need students to discuss the learning content more deeply in online synchronous learning, they should try a different instructional approach.

Moreover, we found that there are many independent transcripts in online chat room. It turns out the online synchronous learning may also have some disadvantages. It requires more learners' self-control. This is a challenge to teachers as well, because they have to provide guidance to support and control students' discussion and learning in online learning.

5 Conclusions

Three important insights emerged from the findings of this study, including 1) students conduct greeting and reflecting very frequently in online learning; 2) questioning, greeting, help, and reflecting of cognitive, social, teaching presence are significant higher in online learning than in face to face learning; and 3) the teacher should supply proper instructional design and facilitation for class interaction. Because this was a pilot study of our researches in online synchronous learning, we did content analysis in interaction transcripts, comparing property and distributing of interaction content in two kinds of synchronous learning environment. Small sample size of data, short experiment times, and only two researchers were involved to decide these messages were deficiencies of the study. Our follow-up study will take more participants, longitudinal study in one semester. Designing instructional strategies in online synchronous learning to research whether and how instructional strategies might have an impact on the synchronous discussion, such as task-driven, collaboration, flipping etc.

References

[1] Wikipedia for Synchronous learning, http://en.wikipedia.org/wiki/Synchronous_learning
[2] Chen, N.S., Ko, H.C., Kinshuk & Lin, T.: A model for synchronous learning using the Internet. Innovations in Education and Teaching International. 42(2), 181-194 (2005)
[3] Hastie, M., Hung, I-C., Chen, N.S. & Kinshuk.: A blended synchronous learning model for educational international collaboration. Innovations in Education and Teaching International. 47(1), 9-24 (2010)
[4] Wang, Y., Chen, N. S., & Levy, M.: Teacher training in a synchronous cyber face-to-face classroom: characterizing and supporting the online teachers' learning process. Computer Assisted Language Learning. 23(4), 277-293 (2010b)
[5] Baruch Schwarz,Tommy Dreyfus and Rina Hershkowitz.: Transformation Knowledge Through Classroom Interaction. Routledge Teylor & Francis Group (2009)
[6] Asa Wedin.: Classroom interaction: Potential or problem? The case of Karagwe. International Journal of Educational Development. 30, 145-150 (2010)
[7] Wei X. F., Cui G.Z., Li L., Duan Y. M.: Research on classroom interaction analysis based on the learning process. E-education Research.12, 91-97 (2011)
[8] Huang R. H.: Theory and method of CSCL. E-education Research. 6, 25-30 (2009)
[9] Zheng L. Q.: The Method to Interaction Analysis in Col laborative Learning: A Review. Distance Education Journal. 6, 76-82 (2010)
[10] Duemer, L., Fontenot, D., Gumfory, K., Kallus, M., Larsen, J., Schafer, S., et al.: The use of online synchronous discussion groups to enhance community formation and professional identity development. The Journal of Interactive Online Learning. 1(2), 1-11 (2002)
[11] Hsu, S.: Using case discussion on the web to develop student teacher problem solving skills. Teaching and Teacher Education. 20(7), 681-692 (2004)
[12] Shotsberger, P.: The human touch: Synchronous communication in web-based learning. Educational Technology. 40(1), 53-56 (2000)
[13] Chen Y., Chen N.S., and Tsai C.-C.: The use of online synchronous discussion for web-based professional development for teachers. Computer & Education. 53(4), 1155–1166, (2009)
[14] Daniel Chia-En Teng, Nian-Shing Chen, Kinshuk, Tommaso Leo.: Exploring students' learning experience in an international online research seminar in the Synchronous Cyber Classroom. Computers & Education. 58(3), 918-930, (2012)
[15] Branon, R. F., & Essex, C.: Synchronous and asynchronous communication tools in distance education: A survey of instructors. TechTrends. 45, 36-42 (2001)
[16] Schwandt, T. A.: Qualitative inquiry: A dictionary of terms. Thousand Oaks, CA: Sage (1997)
[17] Garrison, D. R., Anderson, T., & Archer,W.: Critical inquiry in a text-based environment: computer conferencing in higher education. The Internet and Higher Education. 2(2-3), 87-105 (2000)

[18] Garrison, D. R.: Online collaboration principles. Journal of Asynchronous Learning Networks, 10(1), Retrieved from. http://www.sloan-c.org/publications/jaln/v10n1/pdf/v10n1_3garrison.pdf
[19] Chen P., Li Y.Y.: Data Mining-Based Role Analysis in CSCL. Modern Distance Education Research. 109, 84-88 (2011)
[20] Zhu L. L.: Research on the design and application of coding system of interactive texts in e-Learning. Beijing Normal University, Beijing (2006)

Facilitating listening and speaking with game-based learning activities in situational context

Wu-Yuin Hwang[1], Zhao-Heng Ma[1], Rustam Shadiev[2],*, Timothy K. Shih[1], Shu-Yu Chen[1]

[1]National Central University, Taiwan
[2] National Cheng Kung University, Taiwan
*rustamsh@gmail.com

Abstract. This study proposed game-based learning activities in situational context to facilitate listening and speaking. To measure the feasibility of learning activities, this study conducted one experiment in which students participated at learning activities by using traditional method (control) and mobile application (experimental). Results revealed that experimental students outperformed control students in the speaking post-test while there was insignificant difference in the listening post-test. Furthermore, most students had positive perceptions toward game-based learning activities supported by mobile application. This paper discusses research findings and implications along with conclusions and several suggestions for future development and research.

Keywords: game-based learning, situational context, EFL listening and speaking, mobile application.

Introduction

Nowadays English has become the most important international language [1]. Thus, English as a foreign language (EFL) is emphasized and commonly taught in countries of the Asia-Pacific region. According to foreign language learning theories, in order to promote language learning more efficiently, it is necessary that a learner not only receive the target language through reading and listening but also meaningfully make output it through writing and speaking [2]. However, there are limited opportunities to speak English or listen to a speech in English in countries where it is not an official language. In countries of the Asia-Pacific region, reading and writing are emphasized far more than listening and speaking [3]. Several factors lead to this lack of oral and listening practice, including the absence of an English context to stimulate speaking and listening, or deficiency of good spoken English examples, and excessive dependence upon traditional teaching techniques.

Research on teaching and learning EFL suggests that listening and speaking are core elements of interaction that facilitate the language acquisition [4]. The

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_27

relationship between language practice and learning performance has been widely investigated. It is suggested that the more students practice speaking and listening, the better skills they acquire [5], [6]. In order to make students practice more, communicative and situational language teaching methods were proposed [7], [8]. Furthermore, related literature suggests extending students EFL learning experiences with mobile [9], [10], [11], [12] and digital game-based [13], [14], [15] technologies. According to the related research, both, mobile and digital game-based learning can be beneficial in EFL acquisition.

However, not much attention was paid to relevant literature on improving speaking and listening skills of EFL students by using a combination of above-mentioned methodologies supported by learning technologies. Therefore, this study proposed game-based learning activities in situational context to facilitate listening and speaking. After class, students went to authentic environment to practice their skills and apply learned knowledge in surrounding context by creating sentences, speaking them out, and listening to their own and others' speeches. More importantly, students could use surrounding context to prepare meaningful learning material by taking pictures and designing the game cards. Later, when students played the game, they could find clues in surrounding context to finish the game. This study aimed to investigate the feasibility of designed learning activities.

Method

Participants and procedure

Forty first grade female students from one class in a girls' senior high school were randomly assigned into two groups (i.e. the control and experimental) with twenty students in each. Four 30 minute EFL classes were conducted on a weekly basis during three weeks. One teacher taught both groups the same learning content. After class, students practiced and applied what they learned: the control group by using paper and pen method while the experimental group by using mobile application. Students took a pre-test before the experiment and a post-test after the experiment. After a post-test, experimental students filled in a questionnaire survey and participated in one-on-one semi-structured interviews.

Learning activities

Week 1. *Individual learning:* In the beginning, students learned new words. New vocabulary along with its definition in English and Chinese, related pictures and two example sentences to aid in learning new words were displayed for students.

Pronunciation of new vocabulary and example sentences were read out loud. After that students practiced with new vocabularies. A sentence was displayed and read out loud for students (e.g. "I often play basketball in summer vacation."). Then nine cards were displayed with related/unrelated pictures (Figure 1a) from which students had to select those that match words they hear. Students then formed a sentence by assembling selected cards (Figure 1b). *"Jigsaw" game:* In game, students performed the same activity as during individual learning. However, in game, a sentence was not displayed but students were given specific time to complete game and students' performance was scored. Two options were available in game: students could play with 1) ten sentences within six minutes and 2) twenty sentences within ten minutes.

Fig. 2. Cards for the activity (a) and making a sentence with cards (b).

Week 2. *Interactive learning:* This study expected that students would practice EFL skills not only individually but by interacting with others as well. During interactive learning, students were grouped in pairs. Students were provided with cards for the activity as well as they were allowed to design their own cards. Student A had to make a sentence by assembling several cards (with one word and one picture on each card), to speak a sentence out loud, and to record audio of spoken sentence by using voice recorder. Student B then had to listen to audio file recorded by Student A, to identify words in a sentence, to select cards matching to words in a sentence, and to assemble cards together to form a sentence. Students swapped roles after every spoken sentence. What is very important in this activity is that, students' EFL learning experiences were extended to situational context. That is, students created their own cards with content captured from real-life scenarios. Besides, students used their own cards and surrounding context to make sentences and speak them out. Therefore, students were able to acquire the language in classroom as well as to apply it in daily life situations. *"Interactive Jigsaw":* Students performed the same activity in game as during interactive learning. However, in game, a sentence was not displayed, students were given specific time to complete game, and their performance was scored.

Week 3. Card design and game: In this learning activity, students created their own cards with content from surrounding context. Cards then were used for game. In game, students were asked questions and they assembled cards to form a sentence and answer a question. After that, students spoke out their answers. Other students tried to identify words in an answer and to select and to assemble own cards. A student who identified more cards in sentences of others was selected as a winner.

Mobile application

Mobile game-based learning system was developed in this study. The system was implemented as one application using Apache, PHP, and MYSQL. The client platform run on Android and a Linux-based open source operating system and the server platform run on Windows Server 2003. Figure 3 shows an interface of mobile application.

Fig. 3. Individual learning (a), "Jigsaw" game (b), and "Interactive Jigsaw" game (c).

Data Collection

Students' EFL listening and speaking abilities were assessed before the experiment by a pre-test and after by a post-test. The tests were developed by a teacher with more than 10 years of teaching experience based on guidelines of the General English Proficiency Test at the elementary level; thus, the assessments provided superior validity. Listening tests were scored on a 100-point scale and speaking tests on a 21-point scale. Three raters were involved in the marking process and big differences in the assessment were resolved through raters' discussions and obtaining a consensus. One-on-one semi-structured interviews (30 min each) and subsequent data analysis were conducted to explore experimental students' perceptions. During the interviews students were asked open-ended questions.

Results and discussion

An independent-samples t-test was conducted to compare EFL speaking and listening abilities of the control and experimental groups on the pre-test and post-test. The mean scores, standard deviations, and results of the t-test are reported in Table 1.

Table 1. The results of the assessment and t-test for EFL speaking and listening

Assessment	Control		Experimental		F	Sig.	*t*	Sig.
	Mean	SD	Mean	SD				(2-tailed)
Pre-test[1]	6.15	2.85	6.80	2.12	0.320	0.575	-0.818	0.418
Post-test[1]	7.60	3.08	10.40	3.33	0.386	0.538	-2.758	0.009
Pre-test[2]	70.95	12.83	69.30	13.67	0.275	0.603	0.394	0.696
Post-test[2]	67.83	17.88	71.83	9.08	5.169	0.029	-0.893	0.377

[1]Speaking; [2]Listening

There was no significant difference in the scores of the control (M=6.15, SD=2.85) and experimental (M=6.80, SD=2.12) groups on the speaking pre-test; t=-0.818, p=0.418. This result suggests that two groups had equivalent EFL speaking abilities before the experiment. However, the experimental group (M=10.40, SD=3.33) significantly outperformed the control group (M=7.60, SD=3.08) on the speaking post-test; t=-2.758, p=0.009. This result suggests that the students who learned in a mobile game-based learning environment with situational context showed significant improvement in EFL speaking abilities than those who learned in a traditional game-based learning environment. The main reason is that traditional means that control students used for learning were cumbersome to carry out and use in situational context than mobile application. Therefore, experimental students practiced and applied new knowledge in situational context more efficiently and frequently compared to control students.

First, students in the experimental group could both practice EFL speaking skills and reflect on their speaking more frequently. A mobile game-based learning environment with situational context enabled students to speak sentences out loud and record themselves as many times as they liked. Furthermore, they listened to their own and others' recorded files to evaluate content of the audios, or they could compare others' recordings with theirs, and to find out any mistakes. After mistakes were identified, students would modify, improve, and re-record their audios. Such learning process was based on the communicative and situational language teaching methods, and it enabled students to practice speaking frequently, reflect on their own recordings, and further make better quality of recorded content. Related literature [7], [8] suggested that completing the key elements of the communicative and situational language teaching methods, such as practicing, imitating, contrasting, and concluding, facilitate the language acquisition.

Second, experimental students tried to make their sentences and speeches in a way that others comprehend them easily. Otherwise, partners would not understand sentences and finish the game. It was suggested that EFL learners try to speak to others and make their speech and interaction patterns meaningful and understandable [3], [4], [8]; such process can aid language comprehension and promote its acquisition. Furthermore, according to the communicative language teaching, students need to focus not only on the structure and forms of the language, but also on the function and purposes that the language serves in different communicative settings [7], [8].

Third, students in the experimental group could practice EFL speaking skills in surrounding context. That is, experimental students created their own cards for the game with content from surrounding context which made learning material more meaningful. With such learning material, students were willing to make more interesting sentences and to practice speaking more frequently. Furthermore, experimental students played the game in the classroom and in real life context outside of school. Students could use clues from surrounding context that helped them to finish the game. Such learning process was based on situational language teaching method [7]. Related literature suggested that familiar context can help learners reflect on what they learnt as they are able to contact that context frequently [4], [5], [6]. Moreover, when students acquire knowledge in the contextual scenarios, they are more inclined to learn and, in turn, apply that knowledge to solve daily life problems.

Finally, combination of game elements and surrounding context enhanced and maintained students' learning motivation during learning activities and games; thus, students kept practicing their speaking skills [15]. Such learning process leads to more and frequent practice of speaking skills, learning with meaningful learning material, producing comprehensive output, and surly to enhancing students' speaking abilities. This finding is consistent with related literature [9], [10], [16].

According to the results, there was no significant difference in the scores of the control (M=70.95, SD=12.826) and experimental (M=69.30, SD=13.669) students on the listening pre-test; t=0.394, p=0.696. There was also no significant difference between the control (M=67.83, SD=17.878) and experimental (M=71.83, SD=9.079) groups on the scores of the listening post-test; t=-0.893, p=0.377. This result suggests that both groups had equivalent EFL listening abilities before and after the experiment. The main reason for such finding is that some students could not easily identify words in a sentence which was created and spoken out by others without contextual support. That is, these students did not know what the context is without being told which cards and sentences it matches, and therefore, they had no any clue of that context to help them to finish the game. The future study will address this issue. In the future, students will be instructed how to better design content of cards, especially, making context in which cards are designed more explicit. The future study will also employ smart systems [9], [16] to identify surrounding context in which students created learning materials. Furthermore, the system may identify location of other students who would like to play and suggest some appropriate games based on surrounding context and a player's profile.

According to results of the interviews, most experimental students expressed positive perceptions toward mobile application. They believed it was easy to use and useful during learning. Furthermore, students expressed their positive attitude toward using the system for learning in the future. The following content was pulled from interviews.

"I can practice my listening and speaking skills by playing games."
"It's easier to understand and remember new words if I take related photos."
"Taking photos for cards is a nice way to learn in real life scenario."
"Scenarios I used for designing cards could help me to recall sentences I made."
"I think my English speaking ability has improved."

Furthermore, the results of the interviews showed that most students had positive perceptions toward their motivation to use mobile application for learning. It suggests that, in general, students had high motivation to learn in a mobile game-based learning environment with situational context. The following content was derived from interviews.

"It is interesting to learn by using tablet PC and this way to learn increases my interest in English."

"It's funny to play "Interactive Jigsaw Game," it is like playing a real game; the game motivates to play it and learn English."

"Interactive Jigsaw Game" helps me to develop my confidence to speak."

Conclusion

This study designed game-based learning activities with situational context in traditional and mobile learning environments to facilitate listening and speaking. The feasibility of novel approach was tested. Evaluation results revealed that there was no significant difference between the experimental and control groups in the post-test on listening. However, the experimental group significantly outperformed the control group in the speaking post-test. Furthermore, experimental students expressed their high perceptions and motivation toward mobile application. Based on the results, this study concludes that this proposed innovative approach effectively facilitated students speaking skills. Learning activities implemented in a mobile game-based learning environment with situational context fostered students to practice EFL speaking skills frequently and more importantly, to reflect on their speaking. Experimental students were facilitated to make up meaningful sentences and speak them out more correctly and comprehensibly due to the innovative approach. Furthermore, a mobile game-based learning environment enabled students to practice speaking skills in surrounding context; their learning motivation was also increased and maintained.

A few limitations need to be acknowledged about this study and addressed in the future. The first limitation is a relatively small sample size of only female participants involved in this study, which may limit the broad generalization of the results. The future study will address this limitation as well as extend the capacity of the system. For example, in the future study, students will be provided with feedback to immediately correct mistakes in their produced learning materials or output. Locations in which learning materials were created will be recorded and shared so that students will not be confused about surrounding context during learning activities and, perhaps, their listening skills will also be enhanced. Finally, adding new vocabularies from surrounding context to learning activities and games and to learn new grammar by using the system will be considered in the future study.

References

[1] Platt, J.T., Weber, H., & Ho, M.L. (1984). The New Englishes. London: Routledge & Kegan Paul.
[2] Krashen, S. (1998). Comprehensible output? System, 26(2), 175-182.
[3] Hwang, W.Y., Shadiev, R., Hsu, J.L., Huang, Y.M., Hsu, G.L., & Lin, Y.C. (in press). Effects of Storytelling to Facilitate EFL Speaking Using Web-Based Multimedia System.Computer Assisted Language Learning.
[4] Hwang, W.Y., Huang, Y.M., Shadiev, R., Wu, S.Y., & Chen, S.L. (in press). Effects of using mobile devices on English listening diversity and speaking for EFL elementary students. Australasian Journal of Educational Technology.
[5] Hwang, W.Y., & Chen, H.S. (2013). Users' familiar situational contexts facilitate the practice of EFL in elementary schools with mobile devices. Computer Assisted Language Learning, 26(2), 101-125.
[6] Hwang, W.Y., Shadiev, R., & Huang, S.M. (2011). A study of a multimedia web annotation system and its effect on the EFL writing and speaking performance of junior high school students. ReCALL, 23(2), 160–180.
[7] Celce-Murcia, M., & McIntosh, L. (1991). Teaching English as a second or foreign language (pp. 279-295). Boston, MA: Heinle & Heinle Publishers.
[8] Lightbown, P.M. & Spada, N. (2006). How languages are learned. Oxford: Oxford University Press.
[9] Huang, Yueh-Min, Huang, Yong-Ming, Huang, S.H., & Lin, Y.T. (2012). A ubiquitous English vocabulary learning system: Evidence of active/passive attitudes vs. usefulness/ease-of-use. Computers & Education, 58(1), 273-282.
[10] Hwang, W.Y., Chen, H.S.L., Shadiev, R., Huang, Y.M. & Chen, C.Y. (in press). Improving English as a foreign language writing in elementary schools using mobile devices in familiar situational contexts. Computer Assisted Language Learning.
[11] Hwang, W.Y. & Shadiev, R. (2014). Cognitive Diffusion Model with User-Oriented Context-to-Text Recognition for Learning to Promote High Level Cognitive Processes. Knowledge Management & E-Learning, 6(1), 30-48.
[12] Cheng, S.C., Hwang, W.Y., Wu, S.Y., Shadiev, R. & Xie, C.H. (2010). A Mobile Device and Online System with Contextual Familiarity and its Effects on English Learning on Campus. Journal of Educational Technology & Society, 13(3), 93-109.
[13] Prensky, M. (2003). Digital game-based learning. Computers in Entertainment, 1(1), 21-21.
[14] Sandberg, J., Maris, M., & de Geus, K. (2011). Mobile English learning: An evidence-based study with fifth graders. Computers & Education, 57(1), 1334-1347.
[15] Keller, J.M. (2010). Motivational design for learning and performance: The ARCS model approach. Springer.
[16] Ogata, H., Hui, G.L., Yin, C., Ueda, T., Oishi, Y., & Yano, Y. (2008). LOCH: supporting mobile language learning outside classrooms. International Journal of Mobile Learning and Organization, 2(3), 271-282.

Increasing the Sensitivity of a Personalized Educational Data Mining Method for Curriculum Composition

Yukiko Yamamoto[1], Rainer Knauf[2], Yuta Miyazawa[1], and Setsuo Tsuruta[1]

[1] School of Information Environment, Tokyo Denki University
[2] Faculty of Computer Science and Automation, Ilmenau University of Technology

Abstract. The paper introduces an improvement to an Educational Data Mining approach, which refrains from explicit learner modeling along with a recent refinement and evaluation. The technology models students' learning characteristics by considering real data instead of deriving their characteristics explicitly. It aims at mining course characteristics interdependencies of former students' study traces and utilizing them to optimize curricula of current students based to their performance traits revealed in their educational history. The recent refinement aims at increasing the sensitivity of the Data Mining technology by amplifying the influence of data, which shows interdependencies between the students' talents and weaknesses and weakening the influence of data from students, who perform about the same way in most courses (usually, very good or very poor in most subjects). Finally, the paper shows a validation approach by comparing the students' performance with the degree of similarity of their curriculum to the curriculum proposed by our technology.

Keywords: Adaptive Learning Technologies, Personalized Curriculum Mining, Educational Data Mining

1 Introduction

The opportunities to compose personalized university curricula are different in different regions of the world. In some countries, students have a lot of opportunities to compose it according to their preferences. In some cases, students may not be able to cope with the jungle of opportunities, restrictions, prerequisites and other curriculum composition rules to compose a curriculum that meets all conditions, but also individual needs and preferences. Also, students may not know exactly in advance, which performance skills are challenged in the particular courses. Therefore, they cannot know whether or not they can perform really well in it. Moreover, students may be not consciously aware of their own performance traits and thus, they cannot consider them to compose their curriculum to optimally make use of it.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_28

The objective of this work is mining personalized optimal curricula not only based on grade point averages (GPA), as we did in former approaches [4][5][6][7], but on the particular grade points (GP) reached in the particular courses.

Many proposals in related work characterize the skills challenged in university courses are explicit models in terms of describing challenged traits such as the multiple intelligence model of Gardner [2] or learning styles such as the Felder-Silverman model [1] to match with the teacher's style and material. Despite of their successful empirical evaluation the particular properties and parameters in such a model are hard to assess, not to mention to measure directly. Others analyze the navigational behavior of the student and derive some explicit model [3].

Our approach refrains from explicit models, but uses a database of cases as the model and computes (positive and negative) correlations to a current case with the objective of deriving suggestions for optimal curricula.

Our technique uses a database of cases as the model and computes (positive and negative) correlations to a current case to derive suggestions for optimal curricula. From an Artificial Intelligence (AI) point of view, this approach can be classified as Case Based Reasoning (CBR).

Here, we introduce a refinement of this technology, which aims at increasing the sensitivity. The basic idea is to promote data of students with significant differences in-between the performances in different subjects and thus, to limit the influence of data from students, who perform in about the same degree in most courses, which is usually the case with students, who are either (1) good in everything anyway and not challenged enough to reveal individual preferences or (2) bad in everything anyway and overcharged to reveal individual preferences.

Finally, the paper shows a validation approach by comparing the students' performance with the degree of similarity of their curriculum and the curriculum proposed by our technology.

The paper is organized as follows. Section two explains the concept of (positive and negative) performance correlations of a planned course to a course already taken. The correlation concept is expanded to a set of courses taken so far in section three. Section four explains the way to compose an upcoming semester by utilizing this concept. Section five introduces the recent refinement. In section six shows our validation approach and its result.

2 Performance Correlation between Courses

The basic idea of the approach is that people have profiles, which influences their success chance in learning. A learner's success is determined by many issues. A main issue is certainly the content to learn, which may challenge very theoretical and analytical skills towards very practical or creative skills.

Another issue may be the organization form of learning, which ranges from ex-cathedra teaching towards teamwork practices. Furthermore, the degree of matching between the teaching style of the teacher and the learning style of the learner matters. Another issue that influences the learning success is the kind of learning material. Additionally, social and cultural aspects such as the mutual relation between (1) teacher and learner, (2) in-between the learners, and (3) between the learner and people outside the learning process may influence the learner's performance.

There are various attempts to reveal all these issues and to derive a related learner modeling approach, which aims at an explicit model with particular parameters. Indeed, this is a useful research, since it reveals reasons for performing good or bad. Only by knowing these reasons learning scenarios can be improved with the objective to provide optimal conditions for each individual learner. Unfortunately, our former attempts to select and/or combine appropriate explicit modeling approaches failed due to missing or impossible to obtain data.

Therefore, we shifted our approach to the idea of using the "lazy" model (a library of cases) instead of an explicit one. These correlations characterize implicitly a student's profile and can be derived by Educational Data Mining on (former) students' educational history.

In case of perfect positive correlation, this student will receive the same number of GP in course y than he/she achieved in course x. In case of perfect negative correlation, this student will receive a number of grade points in course y which is the higher (lower), the lower (higher) the number of GP in course x was. If there is no correlation at all between both courses, the challenged skills and the preferable learning style and learning material preferences are totally independent from each other.

Indeed, there may be accidental correlations in practice. However, the more data is used for such an analysis, the more the revealed conclusions are reliable. To also include the circumstance that a correlation can change as a result of former learning experience, we consider only correlations $corr(x, y)$ of courses y taken at a later time than courses x.

Based on samples of k students $S = \{s_1, \ldots, s_k\}$ who took a course y after a course x, and each student s_i achieved g_i^x GPs in course x and g_i^y GPs in course y, the linear correlation coefficient can be computed as

$$corr(x,y) = \frac{\sum_{i=1}^{k}(g_i^x - \overline{g}^x)(g_i^y - \overline{g}^y)g_i^x k}{\sqrt{\sum_{i=1}^{k}(g_i^x - \overline{g}^x)^2}\sqrt{\sum_{i=1}^{k}(g_i^y - \overline{g}^y)^2} \qquad (1)$$

Such correlations can be computed based on known educational histories of (former) students and applied to courses of the educational history of a current student to suggest optimal courses for upcoming semesters. Optimal means preferring courses with (1) high positive correlation with courses taken so far, in which the student achieved his/her best results and (2) high negative correlation with courses taken so far, in which the student achieved his/her worst results. However, courses with no correlation should be spread in as well. They may represent learning scenarios that are not experienced so far by the considered learner. On the one hand, they bag the chance to perform better than so far. On the other hand, there is a risk to perform worse.

We don't know a good trade-off between the chances and risks yet and leave this as a parameter in our curriculum composing technology. Of course, the proposed technology applies only to those candidate courses for the curriculum, for which all formal prerequisites are met by the considered student.

3 Performance Correlation between a Course Set and a Candidate Course

In practice, it happens, that a potential upcoming course y correlates with the courses $X = \{x_1, \ldots, x_m\}$ taken so far in various ways, i.e. with some of the courses in X in a strong positive way, with others in a strong negative way and maybe, with others not at all. Despite of the fact, that this may be an indication for not having sufficient data from (former) students, we have to cope with this situation. Also, courses are weighted with their related number of units.

Therefore, it is reasonable to weight the different correlations $corr(x_i, y)$ of a potential upcoming course y with the courses taken so far $X = \{x_1, \ldots, x_m\}$ with the number of units u_i of each x_i? X and to compute a weighted average correlation of the course y to the courses in X:

$$corr(\{x_1, \ldots, x_m\}, y) = \frac{\sum_{i=1}^{m} u_i * corr(x_i, y)}{\sum_{i=1}^{m} u_i} \tag{2}$$

$$= \frac{\sum_{i=1}^{m} u_i * \frac{\sum_{j=1}^{k}(g_j^{x_i} - \overline{g}^{x_i})(g_j^{y} - \overline{g}^{y}) g_j^{x_i} k}{\sqrt{\sum_{j=1}^{k}(g_j^{x_i} - \overline{g}^{x_i})^2}\sqrt{\sum_{j=1}^{k}(g_j^{y} - \overline{g}^{y})^2}}}{\sum_{i=1}^{m} u_i} \tag{3}$$

Here,

- $\{x_1, \ldots, x_m\}$ is the set of courses the student, who composes an curriculum for an upcoming semester, took so far, and m is the cardinality of this set, i.e. the number of these courses,
- y is a candidate course for the next semester, for which the students met all prerequisites and for which the correlation is subject of computing based on the students' samples in the database,
- k_j is the number of students in the database, who took course y after taking the course x_j $(xj \in \{x_1, \ldots, x_m\})$,
- $g_j^{x_i}$ is the number of grade points the j-th $(1 \leq j \leq k_i)$ student in $\{s_1, \ldots, s_{k_i}\}$ of the data base received in the course x_i $(1 \leq i \leq m)$,
- $\overline{g}^{x_i}$ is the average number of grade points achieved by the students $\{s_1, \ldots, s_{k_i}\}$ in the, who took the course x_i $(x_i \in \{x_1, \ldots, x_m\})$,
- $\overline{g}^{y}$ is the number of grade points the j-th $(1 \leq j \leq k_i)$ student in $\{s_1, \ldots, s_{k_i}\}$ received in the course y,
- $\overline{g}^{y}$ is the average number of grade points achieved by the students $\{s_1, \ldots, s_{k_i}\}$ in the course y, and
- u_i is the number of units of course x_i $(1 \leq i \leq m)$.

In this formula, we consider all courses taken by the student so far equally and independent from in which of the former semesters he/she took it for selecting courses for the upcoming semesters.

4 Composing a Curriculum for an Upcoming Semester

Formally, a curriculum for an upcoming semester is a subset of the courses $Y = \{y_1, \ldots, y_n\}$, which are possible to take in the next semester according to whether or not their prerequisites (and maybe individual other preferences such as vocational objectives) are met by the educational history $X = \{x_1, \ldots, x_m\}$.

As mentioned at the end of section two, a reasonable relation between (1) the total number of units for courses that correlate very heavy with the educational history and (2) the total number of units for courses, which require traits and learning preferences, which do not correlate at all (and thus, may bring in new experiences) in the upcoming semester has to be determined. Let F $(0 \ll F \leq 1)$ be a reasonable high fraction of highly correlating courses in the upcoming semester. Also, a reasonable total number of units U in the upcoming semester needs to be determined.

For each candidate course $y_j \in Y$, the correlation $corr(\{x_1, \ldots, x_m\}, y_j)$ to the educational history $X = \{x_1, \ldots, x_m\}$ is computed. Also, the educational history $X = \{x_1, \ldots, x_m\}$ has to be divided into (1) a sub-list $X^+ = \{x_1, \ldots, x_{m+}\}$ of courses, in which the considered student received the highest number of grade points and (2) a sub-list $X^- = \{x_1, \ldots, x_{m-}\}$ of courses, in which the student received the lowest number of grade points.

Additionally, the student is given the opportunity to add some of the 2nd-best performed courses of his/her educational history to X^+ and some of the 2nd worst performed courses to X^-. By doing so, we respect the fact, that a student may receive a "not best mark" by bad luck respectively a "not too bad" mark just by luck. Thus, we provide some space to add subjective feeling about being good or bad in the particular courses of his/her educational history.

Then, the set of candidate courses $Y = \{y_1, \ldots, y_n\}$ should be sorted towards a list $\overrightarrow{Y} = [y^1, \ldots, y^n]$ according to decreasing absolute values of (1) $corr(X^+, y)$, if $corr(X, y) > 0$, i.e. if y correlates positive to the (complete) educational history respectively (2) $corr(X^-, y)$, if $corr(X, y) < 0$, i.e. if y correlates negative to the (complete) educational history of the considered student. Of course, the correlations are computed based on the performance data (grade points) of former students, who too took y after all courses of X^+ respectively X^-.

Finally, the next semester is composed by subjects from the candidate set $Y = \{y_1, \ldots, y_p\}$ (1) the courses taken from the front end of this list until their total number of units reaches a value, which is as close as possible to $F * U$ and (2) the rest of the units are taken from the rear end of this list until the number of units taken from the rear reaches a value, which makes the total number of units in semester is as close as possible to U. Formally spoken, the Semester is composed as follows: $Sem := \{y^1, y^2, \ldots, y^k, y^l, \ y^{l+1}, \ldots, y^p\}$ with (1) $\sum_{i=1}^{k} u_i \approx F * U$ and (2) $\sum_{i=1}^{p} u_i \approx U$.

5 Data Processing for More Sensitivity

This refinement idea is a result of our data analysis, which shoed, that the students can be clustered into three groups, namely (1) students, who perform quite different in different subjects, (2) students, who perform very good in most subjects, and (3) students, who perform very poor in most subjects. Interestingly, there are only very rare cases of students, who perform average in most subjects.

This insight raised the idea of increasing the sensitivity of our technology by (1) amplifying the influence of data, which really shows interdependencies between the students' talents and weaknesses and (2) weakening the influence of data from students, who perform about the same way in most courses.

The basic idea behind it is (1) to promote data of students with significant differences in-between the performances in different subjects and (2) to limit the influence of data from students, who perform about the same degree in most of the courses. Students with a higher deviation in-between the achieved grade points reveal a better interdependence between talents and weaknesses then those, who perform alike in whatever they do. A usual measure for deviation is the standard deviation

$$\sigma = \sqrt{\frac{\sum_{i=1}^{m}(g_i - \mu)^2}{m}} \tag{4}$$

Here, g_i is the number of grade points received by the considered student in a course x_i of his educational history $X = \{x_1, \ldots, x_m\}$ and $\mu = \frac{\sum_{i=1}^{m} g_i}{m}$ is the average number of grade points the considered student received in his educational history. Since grade points range between 0 and 4, σ is a number ranging between 0 and 2. In case we weight the particular influence of a student s_j on the correlation metrics in formula 3 with its standard deviation σ_j

$$corr(\{x_1, \ldots, x_m\}, y) = \frac{\sum_{i=1}^{m} u_i * \frac{\sum_{j=1}^{k} \sigma_j (g_j^{x_i} - \overline{g}^{x_i})(g_j^y - \overline{g}^y) g_j^{x_i} k}{\sqrt{\sum_{j=1}^{k} \sigma_j (g_j^{x_i} - \overline{g}^{x_i})^2} \sqrt{\sum_{j=1}^{k} \sigma_j (g_j^y - \overline{g}^y)^2}}}{\sum_{i=1}^{m} u_i} \tag{5}$$

students with the same number of grade points in each course do not count (since for those students is $\sigma = 0$) and students who have either 4 or 0 grade points with the same number of both counts twice (since for those students is $\sigma = 2$).

6 Validation

We performed an experiment with available data of 186 sample students' traces. Theoretically, for each student, we have six validation data sets starting with the validation of the 2nd semester based on the first one and ending with the validation of the 7th semester based on the data of semesters 1 through 6. These are 1116 data sets. We coded all the data in a big MS Excel file and implemented the above mentioned calculations to compose optimal curricula.

As a quick and easy to perform evaluation we simply compared the number of courses, which are in both, the curriculum that would have been composed by our technology and the curriculum really taken by the considered student. Here, we compute a similarity of the curricula that are really taken by the students, which is the number of courses in common between the really taken curriculum and the recommended one.

If the GPA grows up with the similarity of the real curriculum with the recommended one, it indicates the usefulness of the technology. In our calculation, we used an (empirically reasonable) fraction of correlating courses of $F = 0.9$.

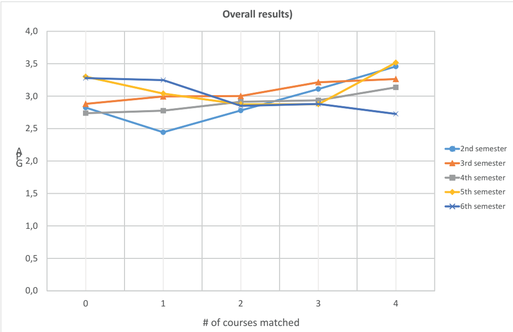


Fig. 1. Validation Results

Fig. 1 shows the evaluation data of all the students when the recommendation based on their curricula was done for each of their 2nd through 6th semesters as a result of our data stored in a big MS Excel file. The "Average GPA", as the y-axes, is the one divided by the number of students belonging to "the number of courses matched", as the x-axes, to the courses that they actually took. In every semester the average GPA comparatively increases with this similarity of the real curriculum with the recommended one.

A possible reason for the tendency to decreasing improvement with increasing semester (especially in the 6th semester) may be the diversification of the courses due to the many special directions of the study chosen by the students. So the number of "similar" students goes down with decreasing semesters and thus, the performance of data mining goes down, too.

7 Summary and Outlook

We introduced a refined technology to mine course characteristics similarities of former students' study traces and utilize them to optimize curricula of current students based to their performance traits revealed by their study achievements so far. This way, our technology generates suggestions of personalized curricula. Furthermore, this technology is supplemented by an adaptation mechanism, which compares recent data with historical data to ensure that the similarity of mined characteristics follow the dynamic changes, which influence the courses (e.g., revision of course contents and materials, and changes in teachers, etc.). To better reveal interdependencies between the students' talents and weaknesses, we proposed an amplification of these interdependencies by weighting each student's influence on the correlation metric with his/her standard deviation, which is ranging between 0 and 2.

Our next objectives in this work are as follows.

We did not consider the impact of navigation within a course on the learning success, despite it seemingly matters [3]. Therefore, we investigate ways to extend the approach by applying it to a higher granularity of learning activities than just complete courses.

We did not yet consider students, who re-take a course, because the GPs of the 2nd attempt should not be compared with the results of other students, who made it only once. Therefore, we investigate a "success measure", which is not just the number of GPs, but also the number of repetitions (mostly 1, but more in particular cases) and include this issue into the correlation computation.

Also, we did not consider the influence of a class composition to the GPs of particular student is not considered. The performance level of co-learners, which surround a particular learner, may influence his/her individual level (1) directly by effecting his/her motivation or (2) indirectly, since the teacher may adapt his/her teaching activities and teaching style to the class composition, namely to the performance to the majority of learners in a class. This issue may be not that relevant in e-learning, but may matter, the more of a course is taught in a classroom style environment.

References

1. R. M. Felder, L. K. Silverman: Learning and teaching styles in engineering education. Engineering Education, vol. 78, no. 7, pp. 674-681, 1988.
2. H. Gardner: Frames of Mind: The Theory of Multiple Intelligences. New York: Basic Books, 1993.
3. S. Graf, T.-C. Liu, Kinshuk: Analysis of learners' navigational behaviour and their learning styles in an online course. Journal of Computer Assisted Learning, vol. 26, no. 2, pp. 116-131, 2010.
4. R. Knauf, Y. Sakurai, K. Takada, S. Dohi: Personalized Curriculum Composition by Learner Profile Driven Data Mining. Proc. of the 2009 IEEE International Conference on Systems, Man, and Cybernetics (SMC 2009), ISBN 978-1-4244-2794-9, San Antonio, TX, USA, pp. 2137-2142, 2009.
5. R. Knauf, Y. Sakurai, S. Tsuruta, K. Takada: Empirical Evaluation of a Data Mining Method for Success Chance Estimation of University Curricula. Proc. of the 2010 IEEE International Conference on Systems, Man and Cybernetics (SMC 2010), IEEE Catalog Number CFP10SMC-CDR, ISBN 978-1-4244-6587-3, ISSN 1062-922X, pp. 1127-1133, 2010.
6. R. Knauf, Y. Sakurai, S. Tsuruta, K. P. Jantke: Modeling Didactic Knowledge by Storyboarding. Journal of Educational Computing Research, vol. 42, no. 4, ISSN: 0735-6331, Baywood Publishing Company Inc., pp. 355-383, 2010.
7. S. Tsuruta, R. Knauf, S. Dohi, T. Kawabe, Y. Sakurai: An Intelligent System for Modeling and Supporting Academic Educational Processes. In Aljeandro Penã Alaya (Ed.): Intelligent and Adaptive Educational-Learning Systems: Achievements and Trends, KES-Springer Verlag Book Series, vol. 17, pp.469-496, 2013.

Investigating the Determinants of Mobile Learning Acceptance in Korea Using UTAUT2

Myunghee Kang, BaoYng Teresa Liew*, Hyunjin Lim, Jeeeun Jang, Sooyoung Lee

Department of Educational Technology, Ewha Womans University, Seoul, South Korea
{mhkang@ewha.ac.kr|teresalby@gmail.com|paradisepia@naver.com|
jjeeeun@gmail.com|sooo_y@naver.com}

Abstract. This study aims to investigate the determinants of mobile learning (m-learning) acceptance of Korean university students based on the Unified Theory of Acceptance and Use of Technology (UTAUT2) developed by Venkatesh, Thong and Xu [1]. 305 students from four universities in Seoul, Korea participated in this study. Stepwise regression results indicate that performance expectancy, social influence, facilitating conditions, hedonic motivation and habit significantly affect behavioral intention to use m-learning among Korean university students. The research model accounts for approximately 45% of variance of behavioral intention. The findings of this study add significant value to our understanding of m-learning adoption among university students. Both theoretical and practical implications are discussed.

Keywords. Mobile Learning, UTAUT2, M-learning acceptance, Korea

1 Introduction

The Ambient Insight Research Comprehensive Report on M-learning [2] reported that the five-year compound annual growth rate of worldwide market in m-learning is 22.7% for the duration of 2010 to 2015. In addition, the report also mentioned that South Korea is one of the most mature m-learning markets in 2010. The penetration rate of smartphone in Korea is 73% [3]. SK Telecom, one of the biggest telecom companies in South Korea, has been providing m-campus service since 2008 [4] which allow students to access university's online portal to check their class schedules, check their grades and also to access library books outside of campus, for instance, in the subway using their mobile devices. In addition to that, with the prevalence of offering unlimited LTE monthly plan for the mobile subscribers in South Korea, students can access developed learning materials and communicate in m-learning platform without technical infrastructure limitation and cost issue. However, the availability of mobile devices and mobile technology does not guarantee their use in education.

According to Traxler [5], higher education students may be ready to adopt m-learning sooner than K-12 students because most of them have their own mobile devices. Previous studies show that m-learning is most prevalent in higher education

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_29

institutions [6, 7]. Therefore, it is important to ascertain students' technology readiness before implementing m-learning. Based on previous researches, the used of Information System (IS) models in m-learning research had been clearly identified and the scales used to measure had been developed and validated [8, 9, 10, 11]. Among several IS models which explained technology acceptance, the extended Unified Theory of Acceptance and Use of Technology (UTAUT2) model [1] was chosen in this study based on the literature review. The purpose of this study is to investigate the determinants of m-learning acceptance among university students in Korea using UTAUT2.

2 Theoretical background

M-learning takes place through the use of mobile devices for learning activities such as smartphones, tablets (iPad or Tab) or even netbooks [11]. M-learning affords students and institutions various benefits including cost savings, ubiquitous communication, study aids, and accessibility, among others [12]. However, if users are not willing to accept new technology for their learning, m-learning cannot be widely diffused [13].

2.1 Technology Acceptance in M-learning and UTAUT2

In this paper, user acceptance is defined as the willingness of students in higher education to use mobile devices and m-learning applications [13]. In m-learning context, users utilize m-learning systems for learning which may be explained by IS theories or models [9, 11]. The UTAUT was developed by integrating eight prominent models in the field of IS user acceptance research. The UTAUT holds that performance expectancy, effort expectancy, social influence, and facilitating conditions are key determinants of information system usage intention and usage behavior [14]. Venkatesh, Thong and Xu [1] have extended UTAUT model and included three additional constructs: hedonic motivation, price value, and habit. Hence, it is typically referred to as UTAUT2. The extensions proposed in UTAUT2 produced a substantial improvement in the variance explained in behavioral intention and technology use [1]. In Wang, Wu and Wang's [11] and Liew, Kang and You's [9] studies, they extended UTAUT to examine users' acceptance of m-learning respectively in Taiwan and Korea.

Performance Expectancy (PE)

In the context of m-learning, PE suggests that individuals will find m-learning useful because it enables them to access information quickly, at a time and place of their convenience, and on the device of their choice [15]. Liew, Kang and You [9], Wang, Wu and Wang [11] and Lowenthal [16] found that PE predicted behavioral intention to use m-learning.

Effort Expectancy (EE)

Effort expectancy is defined as "The degree of ease associated with the use of the system." [14]. Therefore, EE is defined as the degree to which one perceives technology use to be effort free. Previous studies had shown that EE had a significant influence on individual intention to use m-learning [11, 16].

Social Influence (SI)
In the context of m-learning, social influence (e.g. teachers, parents, peers, etc.) will strongly affect younger students' intention to accept and use mobile devices for learning purposes [11]. Liew, Kang and You [9] and Wang, Wu and Wang [11] found that SI had a significant effect on usage intention of m-learning in Korea and Taiwan respectively.

Hedonic Motivation (HM)
Hedonic motivation (HM) can be defined as the intrinsic motivation such as fun, enjoyment or pleasure when using a technology because of technology for its own sake, and it has been known an important construct in determining technology acceptance and use [1, 17]. HM is similar to perceived enjoyment or playfulness to TAM as an intrinsic motivation factor, which is one of intrinsic motivation, has been shown to be a significant factor of the behavioral intention to use m-learning [11, 18].

Facilitating Conditions (FC)
Facilitating conditions is defined as learners' perceptions of the organizational and technological resources and support such as to training, guidance, infrastructure, and help-desk support available to perform behavior [14, 17, and 19]. FC can affect technology use because it means compatibility of currently used system and existing knowledge or support systems of new technology [19, 23].

Price Value (PV)
In general, people chose the services or products when their benefit gives more than the price value compared with its cost [19]. Therefore, price value can be defined as learners' cognitive tradeoff between the perceived benefits of the applications and the monetary cost for using m-learning [1].

Habit (HT)
Habit (HT) is one of a strong predictor of future technology use [20]. In previous researches, HT positively influenced intention to use classroom technology in US faculty members [21]. Moreover Spanish university students' HT positively affects behavioral intention to use Facebook as a learning tool [22].

3 Research Hypotheses

The above literature reviews suggest that PE, EE, SI, HM, FC, PV and HT play substantial role in predicting the behavioral intention to use m-learning. Therefore, these variables were used in our study which was formulated as seven research hypotheses. The hypothesized research model tested in this study is illustrated in Figure 1.

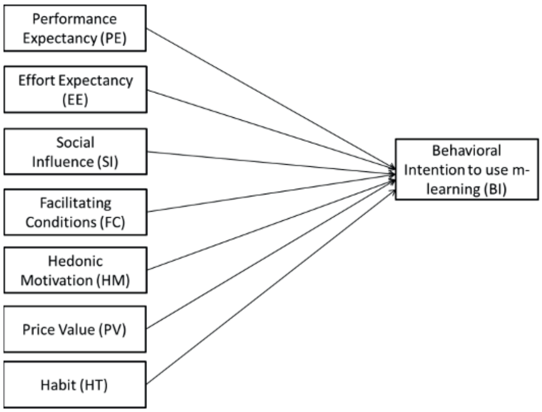


Fig. 1. Hypothesized Research Model

Hypothesis 1: Performance expectancy has a significant effect on behavioral intention to use m-learning.
Hypothesis 2: Effort expectancy has a significant effect on behavioral intention to use m-learning.
Hypothesis 3: Social influence has a significant effect on behavioral intention to use m-learning.
Hypothesis 4: Facilitating condition has a significant effect on behavioral intention to use m-learning.
Hypothesis 5: Hedonic motivation has a significant effect on behavioral intention to use m-learning.
Hypothesis 6: Price Value has a significant effect on behavioral intention to use m-learning.
Hypothesis 7: Habit has a significant effect on behavioral intention to use m-learning.

4 Method

4.1 Participants

In this study, a total of 325 university students from four universities in Korea, participated in this study. Surveys were distributed during the spring semester in 2014. After excluding cases that had unreliable or missing responses among all collected data, 305 cases were obtained and analyzed for the study. The participants in this study were first and second year students. The sample included 154 (50.5%) male and 151 (49.5%) female. The students were between the ages of 19 and 25. Among all the students, only 5 (.1.6%) of them did not have a smart phone. Moreover, besides the basic calling and texting features, most of students who had smart phones reported that they used Social Networking Services (SNS) such as Facebook and KakaoTalk to contact with friends. Most of them also use smartphones for entertainment such as listening to music, watching videos or TV programs.

4.2 Measurements

A survey instrument which consisted of two main parts was developed. The first part focused on gathering the data for key constructs as represented in the conceptual research model. As a second part, the open-ended questions were developed to gather information about demographics of participants and the type of mobile devices and mobile applications they were using. Items PE, EE, SI, FC, HM, PV, HT and BI were adapted from Venkatesh, Thong and Xu [1]. All the items in the first section used 5-point Likert scales ranging from 1 – “Strongly disagree” to 5 – “Strongly agree”. Reliability was examined using Cronbach’s alpha for each variable. The reliability of all variables was ranged from .65 to .91 as presented in Table 1.

Table 1. Variables and reliabilities

Variable	# of items	Reliability (α)
Performance Expectancy(PE)	3	.87
Effort Expectancy(EE)	4	.80
Social Influence(SI)	3	.87
Facilitating Condition (FC)	4	.65
Hedonic Motivation(HM)	3	.91
Price Value(PV)	3	.91
Habit (HT)	3	.85
Behavioral Intention(BI)	3	.79
Total	26	

4.3 Procedure

All the data were collected via offline surveys in March, 2014 in Korea. The data were analyzed using SPSS 18.0 for descriptive analysis, Pearson correlations analysis and multiple regression analysis. The significance level for hypotheses testing was set at .05.

5 Results

5.1 Descriptive Statistic and Pearson Correlation Analysis

The means and standard deviations of each variable and correlations among constructs were presented in Table 2. All the constructs were significantly correlated with each other. Among the independent variables, habit (r = .56, p < .01) showed the highest correlation with the dependent variable.

Table 2. Descriptive Statistic and Correlations among the variables

(n=305)

	1	2	3	4	5	6	7	8
1. PE	1							
2. EE	.69**	1						
3. SI	.54**	.51**	1					
4. FC	.48**	.68**	.41**	1				
5. HM	.50**	.58**	.50**	.53**	1			
6. PV	.30**	.35**	.26**	.30**	.38**	1		
7. HT	.57**	.61**	.56**	.50**	.58**	.40**	1	
8. BI	.55**	.52**	.49**	.50**	.54**	.21**	.56**	1
Mean	3.47	3.761	2.87	3.73	3.36	2.59	2.76	3.59
Standard Deviation	.89	.72	.86	.58	.89	.96	.92	.84

** p < .01

5.2 Hypotheses Testing

A stepwise multiple regression analysis was conducted to test the hypotheses. Seven variables including PE, EE, SI, FC, HM, PV and HT were set as predictors, and BI to use m-learning was set as a dependent variable. As a result, PE (β = .21, p < .05), SI (β= .11, p < .05), FC (β= .16, p < .05), HM (β = .19, p < .05), and HT (β = .19, p < .05) emerged as significant factors on BI. Therefore, we concluded that hypothesis 1, 3, 4, 5 and 7 were supported. Results showed that EE and PV were not significant to predict BI. Therefore, hypothesis 2 and 6 were not supported. The results of multiple regression analysis were presented in Table 3. These results suggest that 45% (F = 50.19, p < .05) variance of behavioral intention to use m-learning can be explained by five critical variables in this study.

Table 3. Results of Stepwise Regression Analysis

(n=305)

Criterion	Predictor	B	SE	β	t	p	F	R^2 (adj. R^2)
Behavioral Intention to use m-learning	PE	.20	.05	.21	3.64**	.00	50.19**	.46(.45)
	SI	.12	.05	.12	2.11*	.04		
	FC	.23	.08	.16	3.00**	.00		
	HM	.18	.05	.19	3.29**	.00		
	HT	.17	.06	.19	3.10**	.00		

*p <.05, **p <.01

6 Discussion

The purpose of this study was to examine the determinants of the Korean university students' m-learning acceptance by using UTAUT2 model from [1]. Our results showed that five out of the seven variables were significant determinants of behavioral intention to use m-learning, namely, performance expectancy, social influence, hedonic motivation, facilitating condition and habit which are consistent with previous researches [9, 11, 16]. Also, consistent with Liew, Kang and You's study [9], effort expectancy showed no significant effects on behavioral intention. Effort expectancy is no more critical variable in prediction behavioral intention of m-learning where penetration of smartphone usage is high among the young generation. In contrast to the previous findings, our results indicated that price value had no significant effects on behavioral intention in m-learning [1]. This may due to that fact that most of the students in Korea could access free Wi-Fi both inside and outside campus easily, therefore, price value seem to be no longer critical for predicting behavioral intention to m-learning acceptance in Korea. Besides, our results revealed that performance expectancy is the strongest predictor of m-learning acceptance in this study. Therefore, in order to diffuse m-learning successfully among university students, universities should provide more instructional mobile learning applications with valuable functions.

Finally, this study is limited to generalize findings because it is limited to only first and second year college students in Korea. Testing the model with a bigger sample sizes and a wide range of university students is suggested. Also, in order to make generalizations, random sample from other geographical areas outside of Korea is recommended. Besides, this study only considered the intention to use m-learning, which actual usage is not included. Further study is recommended to include actual usage so that the participants could perceive more accurately on m-learning. However, with the limited amount of empirical research in this area especially by using UTAUT2, the findings of the present study add significant value to our understanding of m-learning adoption among university students.

Acknowledgement. This research is supported by the BK 21 Plus Project, Seoul, South Korea.

References

[1] Venkatesh, V., Thong, J.L., Xu, X.: Consumer Acceptance and Use of Information Technology: Extending the Unified Theory of Acceptance Use of Technology. MIS Quarterly. 36(1), 157-178 (2012)

[2] Ambient Insight, http://www.ambientinsight.com/Resources/Documents/Ambient-Insight-2010-2015-US-Mobile-Learning-Market-Executive-Overview.pdf

[3] Eight out of ten Koreans use the smartphone every day, http://biz.chosun.com/site/ dta/html_dir/2013/07/22/2013072201641.html>

[4] Shin, D., Shin, Y., Choo, H. Beom, K.: Smartphones as smart pedagogical tools: Implications for smartphones as u-learning devices. Computers in Human Behavior. 27, 2207–2214 (2011)

[5] Traxler, J.: Current state of mobile learning. International Review of Research in Open and Ditance Learning. 8(2), 9–24 (2007)
[6] Viberg, O., Gronlun, A.: Cross-cultural analysis of users' attitude toward the use of mobile devices in second and foreign language learning in higher education: A case from Sweden and China. Computers & Education. 69, 169-180 (2013).
[7] Wu, W., Wu, Y., Chen, C., Kao, H., Lin, C., Huang, S.: Review of Trends from Mobile Learning Studies: A Meta-analysis. Computers and Education. 59(2), 817–827 (2012).
[8] Joo, Y. J., Kim, N. H., Lim, E.: Analysis of factors affecting adoption of mobile learning in cyber university. Korean Journal of Educational Technology and Society. 28(1), 79-102 (2012).
[9] Liew, B.T., Kang, M., Yoo, E. You, J. (2013). Investigating the determinants of mobile learning acceptance in Korea. In World Conference on Educational Multimedia, Hypermedia and Telecommunications 2013, pp. 1424-1430. AACE Press, VA (2013)
[10] Park, Y. S., Nam, M., Cha, S.: University students' behavioral intention to use mobile learning: Evaluating the technology acceptance model. British Journal of Educational Technology. 43(4), 592-605 (2012).
[11] Wang, Y., Wu, M., Wang, H.: Investigating the determinants and age and gender differences in the acceptance of mobile learning. British Journal of Educational Technology. 40(1), 92-118. (2009)
[12] Cheon, J., Lee, S., Crooks, S.M., Song, J.: An investigation of mobile learning readiness in higher education based on the theory of planned behavior. Computers & Education. 59, 1054-1064 (2012).
[13] Liew, B. T., You, J., & Kang, M.: User acceptance for mobile learning: A review and future directions. In 10th Anniversary International Conference of Hanyang Cyber University, pp.249-260, Seoul (2012).
[14] Venkatesh, V., Morris, M. G., Davis, G. B., Davis, F. D.: User acceptance of information technology: Toward a unified view. MIS Quarterly. 27(3), 425-478 (2003).
[15] Donaldson, R. L.: Student acceptance of mobile learning. Unpublished doctoral dissertation, The Florida State University, Florida (2011)
[16] Lowenthal, J. N.: Using mobile learning: Determinates impacting behavioral intention. The American Journal of Distance Education. 24, 195-206 (2010)
[17] Brown, S. A., & Venkatesh, V.: Model of adoption of technology in the household: A baseline model test and extension incorporating household life cycle. MIS Quarterly. 29(4), 399-426 (2005)
[18] Huang, R., Jang, S., Machtmes, K., & Deggs, D.: Investigating the roles of perceived playfulness, resistance to change and self-management of learning in mobile English learning outcome. British Journal of Educational Technology. 43(6), 1004-1015 (2012)
[19] Shao, X., Siponen, M.: Consumer Acceptance and Use of Information Technology: Adding consumption theory to UTAUT2. Proceedings of SIGSVC Workshop. Sprouts: Working Papers on Information Systems. 11(157), 1-7 (2011)
[20] Limayem, M., Hirt, S. G., and Cheung, C. M. K.: How Habit Limits the Predictive Power of Intentions: The Case of IS Continuance. MIS Quarterly. 31(4), 705-737 (2007)
[21] Lewis, C. C., Fretwell, C. E., Ryan, J., Parham, J. B.: Faculty Use of Established and Emerging Technologies in Higher Education: A Unified Theory of Acceptance and Use of Technology Perspective. International Journal of Higher Education. 2(2), 22-34 (2013)
[22] Escobar-Rodríguez, T., Carvajal-Trujillo, E., Monge-Lozano, P.: Factors That Drive Students to Use Facebook As a Learning Tool: An Extension of the UTAUT. In 4th Jornada de Docencia En Contabilidad : Buenas Practicas Doentes en Materia Contble Dentro Del EEES. pp.135-151. Granada (2013)
[23] Kang, M., Shin, E.M., You, J.: A Structural Relationship among Factors Affecting Mobile Learning Acceptance in Foreign Language Learning. Korean Journal of Educational Technology. 29(3), 637-665 (2013)

Learning analysis on learners' wiki-based collaborative knowledge building behaviors

Shuang Li[1], Qi Tang[2], Pengfeng Shi[2]

[1]Research Center of Distance Education, Associate Professor, Beijing, China
lsbnu@163.com
[2] Research Center of Distance Education, Master Student, Beijing, China
tangqi192@163.com; paul89114@126.com

Abstract. Wiki provides a strong support for learners to carry out substantive collaborative learning and to co-construct knowledge in an open and smart learning environment, while there is a lack of effective methods to analyze and promote the quality of Wiki-based CKB. This study referenced Cress's cognitive process model of CKB and Roschelle's learners' view change models in collaborative process to reconstruct quality analysis model for Wiki-based CKB. Based on this analysis model, authors analyzed learners' online CKB behaviors in two cases. The methods used are content analysis and interviews. Authors hope this study can provide the basis for analyzing, designing and promoting Wiki-based collaborative learning in an open and smart learning environment.

Keywords: Online collaborative knowledge building, Wiki, Learning analysis, Quality of collaborative knowledge building

1 Introduction

Many scholars believe that Wiki is an effective tool to support collaborative learning and collaborative knowledge building (CKB).[1, 2, 3] And it provides a more effective support environment for learners to carry out CKB characterized by substantive collaboration and knowledge innovation anytime and anywhere. Many scholars have carried out a large number of studies[4, 5, 6] on Wiki-based teaching and learning. Some of these studies[1, 7, 8] provide a useful inspiration for analyzing and designing Wiki-based CKB.

However, there remain two limitations in these studies: on one hand, the application effect of Wiki was mostly analyzed through questionnaires or interviews on feedback or ability and attitude change of learners or teachers. While few studies focused on the process and quality of CKB. On the other hand, most explorations on teaching methods simply treated Wiki as a collaborative learning tool or environment, lacking reflections on how to use Wiki to support CKB.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_30

Therefore, this study plans to reconstruct learning analysis model for CKB, and based on that to analyze two wiki-based CKB activity cases, in order to find out the actual process and level of learners' CKB, so as to provide a basis for analyzing and designing scaffoldings for Wiki-based CKB.

2 Quality Analysis Model for Wiki-based CKB

Analysis tools for text-based online CKB have been studied by many scholars. Among them, the most influential one is the interactive analysis framework for CKB proposed by Gunawardena et al[9]. This type of tool provides an important reference for this study. However, these frameworks mainly use forum posts, meaning units and sentence as a unit of analysis[10], and do not apply to analyze the quality of Wiki-based CKB. This is because learners' CKB in the Wiki environment is typically through learners' editing content rather than conversation.

Cress and Kimmerle[7] pointed out that the cognitive process of Wiki-based CKB can be described as the process of assimilation and adaptation between individual cognitive systems and knowledge systems in Wiki. When one introduces some information that does not conflict with existing information to the Wiki, assimilation occurs. In this process, organizational structure of Wiki content remains unchanged. Adaptation stands for the process of fundamental changes of the structure of Wiki content, views and concepts resulting from rewriting paragraphs, restructuring content, changing structure and integrating new information, etc. The cognitive conflict in the process of assimilation and adaptation will promote the knowledge rebuilding in Wiki, and the interaction between the individual and Wiki content is the key point influencing the quality of Wiki-based CKB.[1] Therefore, the authors determined the meaning of learners' editing behaviors in wiki as the analysis unit.

When determining levels of CKB, authors referenced Roschelle and Harasim's theory of learners' views changing model during the process of CKB[11, 12]. They state that CKB is an important process causing learners' concept changing. And its key is the convergence of views. And the convergence process is just the process of knowledge co-construction, including three stages: making a point, linking ideas and intelligent convergence.[13] In summary, the author constructed quality analysis model for Wiki- based CKB (Table 1).

Table1. Analysis Model for Quality of Wiki-based Collaborative Knowledge Construction

CKB Phase	Meaning of Wiki operation behavior	Explanation	Coding
Knowledge Sharing	Adding Sharing	Adding knowledge like new concept or new opinion related to the task or theme to Wiki content.	PI-1

PI	Improving Sharing	Improving content(including revising structure, explaining relevant concept, adding case or argument) without communicating with companion	PI-2
Knowledge Connection PII	Improving demonstration	Replying doubt and objection from companion and improving content edited by oneself, such as clarifying the concept, adding explanation, demonstration and argument.	PII-1
	Adding Modification	Adding further explanation to concept or opinion edited by others, or adding argument or case.	PII-2
	Refining Modification	Refining sentence or content edited by others while maintaining the original point of view.	PII-3
	Self-Modification	Replying doubt and objection from companion and modifying content like concept or opinion edited by oneself.	PII-4
	Questioning Modification	Questioning content like concept or opinion edited by others and modifying it.	PII-5
	Rejecting Modification	Rejecting other's modification related to content like opinion and concept.	PII-6
Knowledge Convergence PIII	Integrating Opinion	Organizing, integrating opinions in Wiki, and refining, summarizing and concluding these opinions.	PIII-1
	Optimizing Structure	Optimizing structure of the content edited by others.	PIII-2
	Reflection and Migration	Reflecting on process, method or result related to collaborative knowledge construction and applying it to new circumstance.	PIII-3

3 Case Studies of Learning Analysis on Wiki-based CKB Behaviors

3.1 Case Introduction and Sample

Cases analyzed are wiki-based CKB activities of learners that are selected respectively from two blended teaching courses taught by the same teacher in Beijing Normal University. Table 2 describes the basic information of them.

Table2. Information of Two Cases

	Case 1	Case 2
Type of CKB	Research Based on Theme	Research Based on Theme
Duration of CKB	1 month	1 week
Wiki Environment	JSP Wiki	Wikispaces
Number of learners	6	4
Feature of Learners	Part-time Junior College learners	Full-time Graduate Learners

JSP Wiki is built based on JSP Wiki open source code by the research team the author in. Wikispaces is an open, free Wiki platform provided by Wikispaces.com.

3.2 Methodology

The methods used are content analysis and interviews. The framework for content analysis is quality analysis model for Wiki-based CKB (Table 1). The author coded the meaning of learners' editing behavior on Wiki content, and counted the number of behaviors and edited characters in each phase.

Specific statistical method is: when the corresponding meaning of the model appears in an editing operation, counts 1. If one editing operation reflects several meanings, add 1 to the number of each meaning. In addition, given that restoring history version does not edit the content, so the author only adds 1 to the number of related behavior and don't count the changed characters number for the operation of restoring history version.

After each activity, the author interviewed related learners for their feelings during the activity and motivation of related behaviors.

3.3 Results

Most Wiki-Based CKB activities are on the phase knowledge sharing.
The numbers of edited times were 238, 89, 79 and the numbers of edited words were 8079, 4045, 3472 in CKB 1. While in CKB 2, the numbers of edited times were 64, 30, 24 and the edited words were 4127, 704 and 486. The percentage of edited times and edited words of each phase are shown in Fig.1 and Fig. 2.

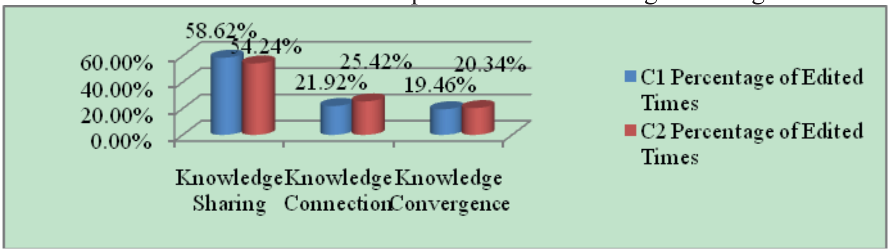


Fig.1 Distribution of Edited Times in Wiki among 3 Phases in Two Cases

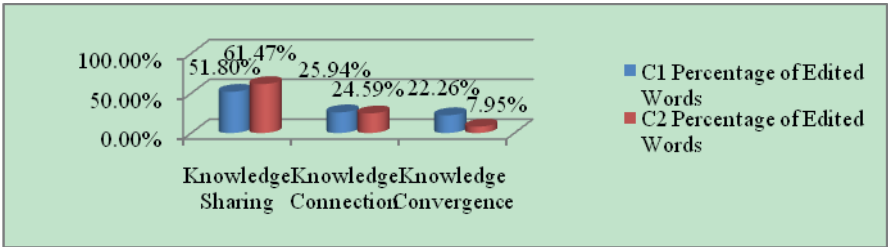


Fig.2 Distribution of Edited Words in Wiki among 3 Phases in Two Cases

According to Fig.1 and Fig.2, the interaction level of CKB was on the low side. More than a half was still in Phase I, which is consistent with the result of many studies which determine CKB levels by analyzing social interaction among learners in forum.

Later interviews revealed that some learners felt embarrassed to modify the content edited by others, especially to revise the content critically. Other learners mostly did not read the contents edited by others in depth, so they could hardly put forward constructive amendments.

Learners tend to assimilate knowledge in the phase of knowledge connecting. Authors found that learners' behavior centered on improving demonstration, adding & modifying content and refining & modifying content, as shown in Table 3 and Table 4. The percentage of edited times were 85.4%, 80% and the percentage of edited words were 72.1%, 79.7%, respectively.

Table 3. Distribution of Edited Times of Knowledge Connection Phase in Two Cases

		PII-1	PII-2	PII-3	PII-4	PII-5	PII-6
C1	Edited Times	23	34	19	4	6	3
	Percentage	25.8%	38.2%	21.4%	4.5%	6.7%	3.4%
C2	Edited Times	8	9	7	2	4	0
	Percentage	26.7%	30.0%	23.3%	6.7%	13.3%	0

Note: In this article, the percentage numbers in this essay's tables have the accuracy of 0.1.

Table 4. Distribution of Edited Words of Knowledge Connection Phase in Two Cases

		PII-1	PII-2	PII-3	PII-4	PII-5	PII-6
C1	Edited Words	754	1432	731	259	654	215
	Percentage	18.6%	35.4%	18.1%	6.4%	16.1%	5.3%
C2	Edited Words	356	523	319	135	171	0
	Percentage	23.7%	34.8%	21.2%	9.0%	11.4%	0

Combining learners' edited times and edited words in phase III (Table2), we could know that, in these two cases, the conflict between learners' individual knowledge systems and Wiki's knowledge system led to the behavior of adding content to Wiki knowledge system, or we could see it as the assimilation of Wiki knowledge system to learners' individual knowledge systems. This result is consistent with the result of Onrubia and Engel's multi-cases research. They found that learners' behavior in Wiki-based CKB activities remained in the initial phase or exploratory phase the researchers defined, and few of learners entered negotiation phase and knowledge collaboration phase.[8]

When interviewed, learners pointed out that even if they found some problems in the content, it is hard to carry out timely, thorough and continuous interaction with the editor by using the comment tool Wiki provides. As a result, most learners chose to ignore the cognitive conflict.

Learners ignore knowledge reflection and migration in knowledge converging phase.

Data analysis of learners' operation in knowledge converging phase (Table 5. and Table 6.) showed that the main knowledge construction behavior in this phase was integrating others' opinions and structuring the existing knowledge of Wiki. The percentages of edited times of synthesis and structural behavior in two cases were 96.2% and 91.7%, and the percentages of edited words were 95.4% and 82.1%.

Table 5. Distribution of Edited Times of Knowledge Converging Phase in Two Cases（Left）

Table 6. Distribution of Edited Words of Knowledge Converging Phase in Two Cases（Right）

		PIII-1	PIII-2	PIII-3
C1	Edited Times	47	29	3
	Percentage	59.5%	36.7%	3.8%
C2	Edited Times	13	9	2
	Percentage	54.2%	37.5%	8.3%

		PIII-1	PIII-2	PIII-3
C1	Edited Words	1875	1439	158
	Percentage	54.0%	41.4%	4.6%
C2	Edited Words	247	152	87
	Percentage	50.8%	31.3%	17.9%

Further observation on the operator of reflection and migration behavior, we found that these behavior mainly done by one or two core participators in group. Later interviews revealed that most learners did not realize that they needed to reflect on the knowledge they constructed and the construction process.

4 Discussion and Reflection

4.1 Impact of Collaboration Strategy on the Level of CKB

The literature review showed there is indeed some relationship between collaboration strategy and the level of CKB. Onrubia and Engel[8] summed up five strategies for Wiki-based CKB: Parallel construction—'cut and paste', Parallel construction—'puzzle', Sequential summative construction, Sequential integrating construction and Integrating construction.

Through multiple case studies, they found that the first one is always used in the initial stages of knowledge sharing; the second and the third will limit CKB in the exploratory stage, which is the primary level of knowledge connection; the last two are more helpful on achieving a high level of consultation and knowledge construction.

4.2 Impact of Interactive Environment in Wiki on CKB

In two cases, JSP Wiki support adding comments to a page, but the learners could not comment on specific words and paragraphs, comments and commented content are also in different positions on the page. This, on one hand, affects comments directivity, on the other hand will also affect the concerns degree on comments. In contrast, Wikispaces not only supports commenting in annotation type, but also provides a forum page to support learners' any needs in discussion. In addition, notifications of new comments and new posts in forum can effectively remind learners concerned about the progress of discussions on corresponding problems. Combining cognitive process model of CKB, the author believe that Wiki supporting discussions on specific content can better support the cognitive conflict generated when learners interact with the Wiki content explicit and in-depth discussions around the conflict, thus promoting CKB into the advanced phase.

4.3 Scaffolding Design for CKB Activities

This study again confirms that the complexity and difficulty of CKB make it difficult to achieve a high level of CKB by learners themselves, thus providing appropriate scaffoldings is necessary. Referencing to Yelland and Masters[14], authors proposed three categories for scaffoldings: cognitive, technology and emotion.

Given that many studies have pointed out that the learners' CKB often stops at the initial stage, the author believe that design scaffoldings should focus on promoting groups' social cognition, guiding CKB smooth into connection and convergence phase, especially helping learners group go into an advanced stage of knowledge connection, and then achieve knowledge convergence. For these, teachers can encourage learners to critically evaluate views and constructively and critically modify shared by others, and offer effective collaborative strategies.

In addition, the study found that the relevant skills, such as writing and literature search & review, affect the level of CKB. Thus teachers need to help learners master those skills through prior training, mutual aid within the group, providing cognitive tools or skills training tasks, etc in order to ensure quality of CKB.

Finally, learners' emotional support, especially motivation incentive and right values guide is the guarantee for an effective CKB activity. The author suggests that teachers can stimulate learners' interest in the task itself, and guide learners willing to take the initiative to share and holding a positive view of the value of teamwork and others' criticism, etc.

5 Conclusions

This study referenced Cress's cognitive process model of CKB[7] and Roschelle's learners' view change model in collaborative process[2] to reconstruct quality analysis model for Wiki-based CKB.[7, 12] Based on this analysis model, authors analyzed learners' online CKB behaviors in two cases, finding that CKB in two cases are overall in low levels, most in the primary phase of knowledge connection; learners are more inclined to complement Wiki content rather than critically construct; Learners ignore knowledge reflection and migration in knowledge converging phase. Future research will further validate the conclusions in more cases, investigate the impact of collaborative strategies and Wiki environmental on the quality of CKB through experimental study, and explore effective online scaffoldings for CKB.

References

[1] Moskaliuk, J., Kimmerle, J., Cress, U.: Wiki-supported learning and knowledge building: effects of incongruity between knowledge and information. J. Journal of Computer Assisted Learning, (25): 549–561(2009).
[2] Reinhold S.Wikitrails.: Augmenting Wiki structure for collaborative, interdisciplinary learning. In: Proceedings of WikiSym'06 – International Symposium on Wikis. NewYork: ACM Press, NewYork: 47–57 (2006)
[3] Bruns A., Humphreys S.: Wikis in teaching and assessment: the M/Cyclopedia project. In: WikiSym 2005 –Conference Proceedings of the 2005 International Symposium on Wikis, ACM Press, NewYork: 25–32 (2005).
[4] Wang Zhouxiu., Xu Yafeng.: Experimental Research on the application of Wiki in Online Higher Education. (in Chinese) J. China Educational Technology, (6): 98-104 (2013)
[5] Wong Chanlam., Zhang Liming.: A Study on Correlations between Contributions and Math Learning Achievements under the Wiki Collaborative Learning Environment. (in Chinese) J. Distance Education Journal, (6): 70-75(2010)
[6] Zhao Jie.: Action Research of Copperative Learning Based on Wiki platform. (in Chinese) Nanjing Normal University. Nanjing (2007)
[7] Cress,U., Kimmerle,J.: Asystemic and cognitive view on collaborative knowledge building with wikis. J. International Journal of Computer-Supported Collaborative Learning, (3): 105–122 (2008)
[8] Onrubia,J., Engel,A.: Strategies for collaborative writing and phases of knowledge construction in CSCL environments. J. Computers &Education, (53): 1256-1265 (2009)
[9] Gunawardena C. N., Lowe C. A., Anderson T.: Analysis of a Global Online Debate and the Development of an Interaction Analysis model for Examining Social Construction of Knowledge in Computer Conferencing. J. Journal of Educational Computing Research, (4): 397-431 (1997)
[10] Wu Yajie., Chen Li.: Review of Evaluation Model of Asynchronous Interaction in Online Learning. (in Chinese) J. E-education Research, (2): 44-53 (2012)
[11] Roschelle, J.: Learning by collaborating : Convergent conceptual change. In: T. Koschmann (Ed.). CSCL: Theory and practice of an Emerging Paradigm, pp. 209 - 248. Mahwah , NY: Lawrence Erlbaum Associates (1996)
[12] Harasim, L. M.: Online education : An environment for collaboration and intellectual amplification. In: L. M. Harasim(Ed.) , Online education: Perspectives on a new environment. Praeger Publishers, New York (1990)
[13] Gan Yongcheng.: Analysis of the Convergence Process of Knowledge Construction in Virtual Learning Community. (in Chinese) J. Modern Distance Education, (6): 29-33 (2005)
[14] Yelland, N., Masters,J.: Rethinking scaffolding in the information age. J. Computers & Education, (1): 1-20 (2005)

Learning through instant-messaging chat logs: A tool for adults to address the communication norms in the new workplace

Bernie Chun Nam Mak[1,*] and Mike Hin Leung Chui[2]

[1] The Chinese University of Hong Kong, China
bcnmak@gmail.com
[2] The Hong Kong Institute of Education, China
mikechui@ied.edu.hk

Abstract. Learning the norms of a firm is challenging. One of the important aspects is to understand how to interact with the integral colleagues online. Based on Wenger's (1998) Communities of Practice as the theoretical framework, we employed Gee's (2011) discourse analysis model to investigate how instant-messaging chat logs could assist a newcomer in realizing the online communication patterns in her new workplace. Analysis of data indicated that through readdressing the previous conversations archived in the chat logs, she came to understand 1) the norms of casual talk, 2) the patterns of using punctuation, and 3) the dis/advantages of learning through chat logs. We suggest that reading and reasoning of the instant-messaging chat logs are conducive to facilitating the adult learning process during workplace socialization.

Keywords: Adult learning; workplace learning; organizational socialization; instant messaging; Hong Kong; computer-mediated discourse analysis.

1 Instant messaging and adult learning in the workplace

This study investigates a topic which has received little attention in adult learning, namely the role of instant-messaging chat logs in workplace learning. Some studies (e.g., Darics 2010; Nardi et al. 2000; Quan-Haase et al. 2005) have evidenced that instant messengers are increasingly used in workplace interaction, while little research (e.g., Mak 2014) has touched on the communication norms in workplace instant messaging. These online communication patterns, however, are vital for an adult who is integrating into a new work environment (e.g., Mak et al. 2012).

According to Knowles et al. (2005), adult learners in the workplace are generally more interested in practical knowledge which is directly relevant to work, and are more comfortable with learning by first-hand practices with authentic materials

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_31

(rather than motor sensory learning). This preference has a good match with Wenger's (1998) framework, Communities of Practice (CofP), which posited that people learn the shared repertoires of their new working environment through behavioral and cognitive practice in an informal, non-pedagogical setting. In such a setting, adults flexibly adopt their personal learning styles. While we adopt CofP as our theoretical framework and focus on instant messaging, we additionally propose that such informal learning takes place when new recruits readdress, recall, and reevaluate their own past conversations which have been archived by the instant messenger, namely the chat logs which embrace information and experiences as common ground of tacit knowledge in the CofP. Although learning through retrieving the chat logs afterwards is different from learning through participating in the activities spontaneously, the former simulates the latter by reactivating the previous situated learning settings and the past experiences in the mind (cf. Richardson 2009). To put it, the former provides flexible, pseudo-social learning experience which can be as useful as the latter (Mak et al. 2012).

2 Data and methodology

Our data were drawn from a database of 70,000 English words of instant messaging which were collected from three white-collar Hong Kong workplaces. In this study we only focused on a few participants in one site. Superstar Electronic Holdings (SEH-HK) was a trading company engaged in export business of computer hardware. We centered on the learning of a female merchandiser trainee, Jenny, who had joined in the company for five months. She was assigned two mentors, Charles and Ricky, who had been integrated into the company.

The existing colleagues of SEH-HK not only talked face to face in the office, but also communicated in Windows Live Messenger (WLM) (merged with Skype in 2013) at work. In the first consultation, they claimed that they had developed their communication patterns in WLM. For socialization reasons, Jenny was supposed to acquire these norms. We employed a mixed-method research design to explore her learning. On the one hand, we requested her to select and read any part of the previous instant messaging interactions with her colleagues, which had been saved in the chat logs, at her convenience and to her interests. On the other hand, we collected the chat logs on a regular basis, and conducted interviews with her. We especially asked 1) what she had realized or learnt from the conversation that she had selected to read, 2) what aspects she had focused on when reading the conversation, 3) whether she had found it useful to read the conversation, and 4) whether she had encountered any difficulties in understanding the conversation. We chose 15 instant messaging conversations, together with ten A4 pages of corresponding interview data, for in-depth analysis. We finally selected three representatives to present in this paper.

3 Analytical framework

We employed Gee's (2011) model to explore how Jenny learned the communication norms in SEH-HK through reading her own chat logs. Gee proposed that face-to-face and/or online language use will construct the reality in seven areas which could be analyzed by six tools. We mainly centered on the areas of Practice, which concerned what conversational goals were achieved. The major tools that we had adopted to analyze the chat logs and interview data were Situated Meanings and Discourses. The former addressed the contextual meanings in a single instant messaging interaction, while the latter addressed the broader process of language use and communication developed by social practices in the CofP.

4 Findings and analysis

Results indicated that Jenny demonstrated an active learning process through re-reading what had been discussed and how some topics were discussed in WLM at work. Her learning contained three dimensions: the norms of performing casual conversation, the patterns of using punctuation, and the dis/advantages of learning through chat logs. We selected three examples to portray each domain.

Example 1: understanding the norms of performing casual conversation
Jenny, through reading her chat logs, learns how the colleagues embed informal talk into business talk in WLM. She is sensitive to the humor which occurred in group instant messaging. Below is an extract readdressed by her. Her mentors are making a decision on the next step in negotiation with the factory and the buyer.

1	14:24:23	Charles	why not ask them to meet the moq?
2	14:24:26		we change the prepay
3	14:24:49	Jenny	-5%?
4	14:24:59	Charles	difficult to say, it depends
5	14:25:12	Ricky	shit
6	14:25:18		just for this small buyer
7	14:25:28		labour division jenny…
8	14:25:32		I call the taiwan po
9	14:25:37		you call john
10	14:25:41		if I call
11	14:25:45		he scolds me…………
12	14:25:48		if you call
13	14:25:53		he will be excited!!!
14	14:26:02	Charles	yea~~ it is a rule so excite him

15	14:26:07		because the life of factory manager is dull
16	14:26:12		facing guys in the factory everyday
17	14:26:16	Jenny	ok :D

Humor can be maladaptive at work (Rogerson-Revell 2007); one example is the use of it in sexist talk (Gray and Ford 2013). In this excerpt, the rationale behind the division of making contact with stakeholders is hardly due to pleasing the manager (i.e. John), but the mentors joke that the division aims to enable Jenny to "excite" him (lines 12-16). She gives a minimal response then (line 17). When asked why she had been impressed by this excerpt, she reported in the interview:

"People often say [that] sexual issues should not appear [at] work, but in this firm males make fun of females [in] many ways in WLM. They easily go to the themes like, this man [being] a womanizer and that woman [being] seductive. I started realizing [this] when I looked back to our discussions saved."

When new starters join in a workplace, they usually start from observing how the existing colleagues go about work (see the concept of "legitimate peripheral participation" in Lave and Wenger 1991). Jenny's answer implicates that re-reading her instant messaging, which has been documented in this chat log, puts her into an observable scenario in which sexist humor takes place in workplace instant messaging. Indeed, because of the less concerns about physical securities, taboo communication is easier to occur when people interact online (Baron 2010). This chat log also inspires her to think and realize the general topical choices of humor in this CofP. When further asked what she had learnt, she stated:

"I first suspected [that] they [might] bully me because I [was] new, but I found later [that] they also joked about their supervisor[s] in the group. This was shown in the record clearly. So I wonder that, well, it is just their style. Don't take it personal[ly]. It has nothing to do with females or males."

Jenny's recalling the chat logs manifests a dimension of shared repertoires in SEH-HK, the use of humor. Through skimming and scanning the archive, she understands that she is not targeted due to her newcomer status. Instead, everyone here can be the butt of humor in WLM. This releases her worries of personal attack, and deepens her understanding of the norms in SEH-HK, which is conducive to her socialization into the workplace (Korte 2008).

Example 2: understanding the pattern of using punctuation

Jenny additionally displays a tendency to be attentive to the paralinguistic cues in informal instant messaging, especially the use of punctuation. In the next snapshot, the ambience in SEH-HK is fraught with stress due to the recent overtime work.

Thus, Tommy as the senior proposes a "treat of drink" for his subordinates to release their tension. He uses WLM to collect their preferred drinks.

1	15:42:29	Tommy	big brother treats you a drink to change your black mood
2	15:44:22	Charles	hawthorn apple juice thanks
3	15:44:45	Jenny	nestle lemon
4	15:44:47		thx
5	15:44:51	Ricky	watson water
6	15:45:02	Tommy	water……
7	15:45:12		plz go to pantry ricky
8	15:45:31	Ricky	arhat fruit drink thx
9	15:46:11	Tommy	cool

Playful teasing can level colleagues at different ranks onto a less imbalance hierarchical relationship (Hay 1994). This talk is an exemplar. Ricky ridicules the treat by asking for "water" (line 5), and Tommy dismisses him by asking him to "go to the pantry" (line 7). In view of Ricky's actual preference "Arhat Fruit drink" and Tommy's acknowledgement (lines 8-9), the exchange about "water" is non-serious. When asked why she had found this excerpt interesting, Jenny said:

"Nobody used punctuations, except [that] Tommy used the dots when he joked. Actually they often drop punctuations in instant messaging but I don't note [this] during the talk. But from time to time they type the dots for some reasons."

This chat log gets her to notice the intentional use of ellipsis dots in WLM in SEH-HK. Her interview answer is in line with the consensus that since the use of punctuation is frequently omitted in instant messaging, any reservations of it should be interpreted carefully and pragmatically (Ling and Baron 2007). When asked what her opinion was, Jenny continued to say:

"After browsing the record again and again I began to understand [that] they use the dots at the end of the line when they want to stress [that] they haven't finished the sentence. It seems that they do not use the dots randomly. But in real-time talk it is difficult to note the pattern. Now I know and follow it."

The literature has reported multifarious potential of ellipsis dots in workplace instant messaging, but the appropriateness depends on the cultural preferences in individual communities (Mak 2014). Jenny through reading the chat logs gains insights into a predominant use of dots in SEH-HK, which is to hold the conversational floor for preventing the interlocutor from taking the turn (cf. Darics 2010). Such subtle use in the CofP is symbolized through her reevaluation.

Example 3: understanding the dis/advantages of learning through chat logs

Last but not least, whereas Jenny perceives the chat logs to be flexible for workplace learning and information retrieval, she reveals some limitations of them. In an interview, she stated that she had once got confused when she read the following vignette. Here Tommy addresses her mentors only. Jenny is away from WLM at that time, but the talk is normally saved in the chat log.

1	12:22:19	Tommy	charles, ricky
2	12:22:25		the deception company mail to us again
3	12:22:42	Charles	so determined to cheat us?
4	12:22:45	Ricky	Shit
5	12:22:49		what do they say this year?
6	12:23:14	Tommy	the letter is very funny………
7	12:23:16		come to my desk

The exchange is based on a deceitful advertising company which contacted SEH-HK last year (lines 1-5). Since Jenny is new, she has no idea on what happened last year. Furthermore, media-shifting at the first few turns is common in workplace instant messaging for richer communication (Nardi et al. 2000). In order to view the “funny” letter, the three colleagues also shift to face-to-face talk shortly (lines 6-7). When asked how she considered this conversation, Jenny described:

“They sometimes shift to talk face to face. I do not always take part [in the talk]. The record fail[ed] to show what was discussed in the real world. I don’t know what company [they referred to]. I only know it might be relevant to some funny junk mail received. So I asked them what letter [was] so funny face to face later.”

Jenny implies a limitation of group instant messaging: the subscribed members easily move in and out a conversation (cf. Gee 2004). This may cause fragment and incomplete conversations. Since WLM cannot codify any subsequent conversations shifted to the offline setting, it is difficult for her to understand merely through re-accessing the chat logs, which is why she needs to seek more information offline later. But still, she acknowledged the value of the chat logs:

“I am unable to capture everything even when I log in. The records are useful because I can recall the past discussions when I am free. I can reflect [on] my own performance and the behavior of other colleagues carefully. I can select [what to read]. If I find any queries I can ask them after that too.”

Jenny considers that chat logs provide a convenient setting for her to learn beyond the constraint on temporal proximity when the chat-history option is checked, though any successive offline interactions will be left out. Chat logs of instant messaging are similar to narratives in that both are sources of information which are possible to individualized sense-making outside the situated context (cf. Hydén 1997). In short, they are a powerful web of learning materials if appropriately used.

5 Discussions and conclusion

Our study demonstrated that a newcomer could socialize into a workplace with online communication norms through addressing the instant-messenger chat logs. Indeed, chat logs visualize and strengthen one's past instant-messaging experience, while the instant messenger itself allows the opportunity to apply what have been learnt within the same digital device.

The major participant, Jenny, illustrated that she had been attentive to the casual conversation, use of punctuation, and affordances of WLM chat logs, and that she made sense of the patterns by actively evaluating the past instant messaging interactions during her leisure time. Since an adult's learning in the workplace is better self-motivated (Kungu and Machtmes 2009) and outcome-based (Merriam and Brocket 2007), it is supposed to work effectively in an informal physical and psychological setting (Wenger 1998). Considering the analyses in examples 2 and 3, we suggest that, for a newcomer, reading the instant-messaging chat logs and thinking about the integral colleagues' symbolic behavior involved can accelerate positive socialization into the workplace, especially in the aspect of internal communication. The newcomer can selectively learn things which matter to him or her. The acquired knowledge will be productive in gaining membership and social capital in the CofP. Additionally, as Blaka and Filstad (2007) pinpointed, adult new starters are unavoidably biased by the past experience when making sense of the new work environment. Such existing knowledge may prejudice the newcomer, as Jenny reported in example 1. We also propose that the instant-messenger chat logs can help to "unlearn" some inappropriate perceptions of the new workplace which are accidentally formed in first impressions.

As the instant-messaging chat logs will enable a newcomer to recall the previous exchanges asynchronously, selective reading and careful reasoning are available. This may informally refine their understanding of the new workplace, accumulate their expertise in observing integrated colleagues, enrich their sensitivity to any communication norms, and position themselves to an identity in the CofP. All of these are what Korte (2008) listed important indicators of workplace socialization and learning. Thus, the instant-messaging chat logs are more than records (cf. Mak et al. 2012; Mak, 2013). Now that we have touched on the potential of readdressing chat logs in adult learning in the workplace; further studies can examine how a newcomer puts what has been learnt through the chat logs into situated practice.

References

[1] S Baron, N. S. (2010). Discourse structures in instant messaging: The case of utterance breaks. Language@Internet, 7, article 4. Retrieved from http://www.languageatinternet.org/articles/2010/2651
[2] Blaka, G., & Filstad, C. (2007). How does a newcomer construct identity? A socio-cultural approach to workplace learning. International Journal of Lifelong Education, 26(1), 59-73.
[3] Darics, E. (2010). Relational work in synchronous text-based CMC of virtual teams. In R. Taiwo (Ed.), Handbook of research on discourse behavior and digital communication: Language structures and social interaction, (pp. 830-851). Hershey, PA: IGI Global.
[4] Gee, J. P. (2004). Situated language and learning. New York: Routledge.
[5] Gee, J. P. (2011). An introduction to discourse analysis. London: Routledge.
[6] Gray, J. A., & Ford, T. E. (2013). The role of social context in the interpretation of sexist humor. Humor, 26(2), 277-293.
[7] Hay, J. (1994). Jocular abuse patterns in mixed-group interaction. Wellington Working Papers in Linguistics, 6, 26-55.
[8] Hydén, L. (1997). The institutional narrative as drama. In B. Gunnarsson, P. Linell & B. Nordberg (Eds.), The construction of professional discourse (pp. 245-264). London: Longman.
[9] Knowles, M. S., Holton III, E. F., & Swanson, R. A. (2005). The adult learner (6th ed.). Amsterdam, Boston: Elsevier.
[10] Korte, R. F. (2008). How newcomers learn the social norms of an organization. Human Resource Development Quarterly, 20(3), 285-306.
[11] Kungu, K., & Machtmes, K. (2009). Lifelong learning: Looking at triggers for adult learning. International Journal of Learning, 16(7), 501-511.
[12] Lave, J., & Wenger, E. (1991). Situated learning: Legitimate peripheral participation. Cambridge: Cambridge University Press.
[13] Ling, R., & Baron, N. S. (2007). Text messaging and IM: Linguistic comparison of American college data. Journal of Language and Social Psychology, 26(3), 291-298.
[14] Mak, B. C. N. (2013). A newcomer's chitchat with colleagues on Facebook Status Updates. International Journal of English Linguistics, 3(6), 1-16.
[15] Mak, B. C. N. (2014). Instant messaging in office hours: Use of ellipsis dots at work and Hong Kong culture. International Journal of Language Studies, 8(2), 25-50.
[16] Mak, B. C. N., Chui, H. L., & Liu, Y. Q. (2012). Instant messaging and microblogging: Situated-learning platforms for educationists and workplace mentors. Social and Behavioral Sciences, 51, 392-399.
[17] Merriam, S. B., & Brockett, R. G. (1997). The profession and practice of adult education. San Francisco: Jossey-Bass Publishers.
[18] Nardi, B., Whittaker, S., & Bradner, E. (2000). Interaction and outeraction: Instant messaging in action. CSCW'00 Proceedings of the 2000 ACM Conference on Computer Supported Cooperative Work (pp. 79-88). New York, NY: ACM Press.
[19] Quan-Haase, A., Cothrel, J., & Wellman, B. (2005). Instant messaging for collaboration: A case study of a high-tech firm. Journal of Computer-Mediated Communication, 10(4). Retrieved from http://jcmc.indiana.edu/vol10/issue4/quan-haase.html
[20] Richardson, W. (2009). Blogs, wikis, podcasts, and other powerful web tools for classrooms. Thousand Oaks, CA: Corwin.
[21] Rogerson-Revell, P. (2007). Humour in business: A double-edged sword. A study of humour and style shifting in intercultural business meetings. Journal of Pragmatics, 39(1), 4-28.
[22] Wenger, E. (1998). Communities of practice. New York: Cambridge University Press.

Measuring learners' working memory capacity from their interactions within educational game

Mohamed Ali Khenissi[1], Fathi Essalmi[2], Mohamed Jemni[3], Kinshuk[4], Ting-Wen Chang[5]

[1,2,3] Research Laboratory LaTICE, ENSIT, University of TUNIS, Tunisia
khenissi_mouhammed@yahoo.fr, fathi.essalmi@isg.rnu.tn,
mohamed.jemni@fst.rnu.tn

[4] School of Computing and Information Systems, Athabasca University, Canada
kinshuk@athabascau.ca

[5] Collaborative & Innovative Center for Educational Technology (CICET),
Beijing Normal University, Beijing, China
tingwenchang@bnu.edu.cn

Abstract Working memory capacity is one of the most important learner's characteristics that can be used as an input parameter for personalizing learning in order to improve the learning process. Therefore, knowing learner's working memory capacity and personalizing the learning contents according to learner's working memory capacity levels are important research issues. This paper proposes an approach for measuring learner's working memory capacity from his/her interactions with a learning version of memory match game.

Keywords: Educational games; Working memory capacity

1 Introduction

Working Memory Capacity (WMC) plays an important role in learning process, because learner often have to hold information in mind while engaged in a learning activities. Learner with poor WMC may fail in these activities, simply because he/she is unable to hold in mind sufficient information, or forgot many things required to complete the task. For that, it important to measure the learner's WMC in order to provide an effective management of learner's working memory loads.

A number of tools have been developed to explicitly measure WMC of learners [1, 2]. The uses of measuring tools can provide direct and precise estimation of learner's WMC, but this would endanger their motivation in case of interrupting their study in order to use these tools.

One of the ways to overcome this issue is to extract the learner's WMC implicitly by using educational games that provide ample opportunities of learner interaction with the computer. As a preliminary step for developing educational computer games to evaluate learner's WMC, a Learning version of the Memory Match Game (LMMG) has been adapted to measure a learner's WMC throughout learner's interactions within the game. This study focuses on the relationships between ele-

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_32

ments of the adapted LMMG and working memory subsystems that store and manipulate visual and verbal information, as well as a central executive.

The rest of this paper is structured as follows: the next section starts by describing the main components of the working memory. In addition, the section describes the LMMG. Section 3 proposes relationships between the elements of the adapted LMMG and different components of working memory model. Section 4 describes an approach for checking whether the proposed relationships can guide us to measure the learner's WMC. Finally, section 5 concludes the paper with a summary of the work and future research directions.

2 Background

2.1 Working memory

Working memory [3] is defined as the system that holds and manipulates several pieces of transitory information in the mind. Researchers have proposed several models regarding how working memory functions [4]. One of the most well-known model is the Baddeley's model of working memory [4]. Baddeley described four components of working memory: central executive, phonological loop, visuospatial sketchpad and episodic buffer.

The central executive is responsible for monitoring and coordinating the operation of the other components. In particular, it is responsible for dealing with cognitive tasks such as mental arithmetic and problem solving.

The phonological loop is responsible for dealing with spoken and written material. It is divided into two subcomponents: (1) The phonological store which is responsible for storing information in speech-based form for short periods of time. Spoken words enter directly to the store. However, written words must first be converted into an articulatory (spoken) code before they can enter the phonological store. (2) The articulatory process which is responsible for converting written material into an articulatory code and to transfer it to the phonological store.

The visuospatial sketchpad is responsible for dealing with visual and spatial information. It is described as a slave system because its main function is only to hold information for short periods of time. Finally, the last component is the episodic buffer which is described as temporary storage system with limited capacity. It is capable of integrating information from a variety of sources.

2.2 A Learning Version of Memory Match Game

Memory Match Game [5], used in this study, is a card game which consists of several cards that have pictures on one side. The number of cards is always even. Typically same picture is printed on two cards. All of the cards are mixed up and laid face down on a surface. In each turn, player selects a card to flip it over. If the next card selected by the player matches the first card, both cards disappear from the surface. The objective of the game is to turn over pairs of matching cards with least possible trials. In the traditional version of this game, all cards hold only visual information. However, in the learning version of the game [6], other types of information have been added. Precisely, the LMMG uses eight types of pair of cards: 1) Visual – Visual, where both cards hold the same visual content.; 2) Visual – Word, where the first card holds visual content, whilst the second card holds written information; 3) Visual – Sound; 4) Word – Word; 5) Word – Sound; 6) Sound – Sound; 7) Calculates – Calculates, where both cards hold simple math problems. In this case, learner must find the result of the calculation on the first card and then compare it to the calculation on the second card; and, 8) Calculates – Sound.

3 Relationships between types of cards and components of working memory

Each pair of card in the LMMG contains specific type of information, and accordingly it will be stored in a specific component of working memory.

In particular, the couple (Visual - Visual) will be stored temporarily in the Visuo-Spatial Sketchpad, since the Visuo-Spatial Sketchpad is responsible for dealing with visual information. The couple (Sound - Sound) will be stored temporarily in the Phonological Loop. In particular, these types of cards will be stored directly in the phonological store. Similarly, the couple (Word - Word) will be stored temporarily in the Phonological Loop. But these types of cards must pass through the articulatory process before they can be stored in the phonological store. Furthermore, the couple (Calculates - Calculates) is linked to Central Executive component as it is responsible for manipulating information, including mathematics calculations. Finally, the rest of couples (Visual - Word, Visual - Sound, Word - Sound and Calculates - Sound) will be stored temporarily in the Episodic Buffer as it deals with information from a variety of sources.

4 Approach for measuring learner's WMC

This study introduces an approach for checking whether the relationships between the elements of LMMG and the component of working memory model can guide us to measure the WMC of the learners.

The approach measures the capacity of each component of learner's working memory while the learner plays the LMMG. The capacity of each component is estimated as 7±2 items [7]. After that, the whole WMC of learner is measured by calculating the average of the capacities of different components of working memory, in order to be estimated as 7±2 items [7].

Learner's WMC= AVERAGE (Capacity of phonological loop, Capacity of visuo-spatial sketchpad, Capacity of episodic buffer, Capacity of central executive)

Specifically, each component of working memory is measured using four learner's traces while he/she interacts with pair of cards. These traces are as follows:

Discovery_duration: time that has elapsed between the first click on the first card of the pair and the first click on the second card of the same pair.

Research_duration: time that has elapsed between the first seeing of the second card of the pair (time of the first click on the second card of the pair) and time of match the pair.

Number_of_clicks: number of clicks on the first card of the pair and the second card of the same pair before the matching.

Remaining_cards: remaining cards at the time of matching between two cards of the pair.

Selected traces are considered as inputs for the fuzzy logic process as described in [8]. Finally, values obtained from fuzzy logic system [8], that describe the capacity of each component of working memory, are passed to the function *AVERAGE ()* in order to calculate the whole learner's WMC.

5 Conclusion

The research reported in this paper is a preliminary step for developing educational computer games to measure learner's WMC. In particular, this paper proposed an approach for measuring learner's WMC from his/her interactions with a learning version of the Memory Match Game.

Information about learner's WMC can be used in adaptive E-Learning systems for providing learners with individualized materials and personalized recommendations that positively affect the learners' learning process.

Future works will empirically validate the proposed approach. In particular, the LMMG will be experimented with participants. After that, we will compare results of participant's WMC obtained from the LMMG and other measuring tools. Such comparison will help in assessing the effectiveness of the LMMG.

References

1. Case, R., Kurland, M., Goldberg, J.: Operational efficiency and the growth of short-term memory span. Journal of Experimental Child Psychology, 33, 386–404 (1982)
2. Turner, M. L., Engle, R. W.: Is working memory capacity task dependent? Journal of Memory and Language, 28, 127–154 (1989)
3. Becker, J.T., Morris, R. G.: Working memory(s). Brain and Cognition. 41. pp 1–8 (1999)
4. Baddeley, A.D.: Working memory: theories, models, and controversies. Annual review of psychology, 63, pp 1-29 (2012)
5. Zwick, U., Paterson, M. S.: The memory game. Theoretical Computer Science 110. pp.169-196 (1993)
6. Khenissi, M. A., Essalmi, F., Jemni, M., Kinshuk: A Learning Version of Memory Match Game.14th IEEE International Conference on Advanced Learning Technologies, July 7-9, 2014, Athens, Greece. (2014). Accepted
7. Miller, G. A.: The magical number seven, plus or minus two: Some limits on our capacity for processing information. Psychological Review, 101 (2), pp. 343-352 (1994)
8. Khenissi, M. A., Essalmi, F., Jemni, M., Kinshuk: Learners' Working Memory Capacity Modeling Based On Fuzzy Logic.14th IEEE International Conference on Advanced Learning Technologies, July 7-9, 2014, Athens, Greece. (2014). Accepted

Mobile Devices and a Modelling Tool for Physics Experiments in High School

Wing-Kwong Wong[1,*], Tsung-Kai Chao[2], Pin-Ren Chen[3], Yunn-Wen Lien[4], and Chao-Jung Wu[5]

[1,3] Dept. of Electronic Engineering, National Yunlin U. of Sci. & Tech., Douliu, Taiwan
{wongwk, M10113212}@yuntech.edu.tw
[2] Graduate School of Engin. & Tech., National Yunlin U. of Sci. & Tech., Douliu, Taiwan
g9810815@yuntech.edu.tw
[4] National Taiwan University, Department of Psychology, Taipei, Taiwan
ywlien@ntu.edu.tw
[5] Natl. Taiwan Normal University, Dept. of Edu. Psychology & Counseling, Taipei, Taiwan
cjwu@ntnu.edu.tw

Abstract. Traditional physics labs in high school suffer from slow data acquisition so that dynamic values of variables are hidden from students. Modern mobile devices such as Lego Mindstorms NXT, smartphones and Arduino can acquire data at a fast rate and can be used to measure dynamic variables in physics experiments. A case in point is the changing angle of a pendulum experiment. With a tool called InduLab, students in three groups using the mobile devices mentioned above in pendulum experiments collected data and built their models with the data. Results reviewed the Arduino group achieved the highest success rate of building correct models, followed by the smartphone group and then the NXT group. This suggested that modern low-cost mobile devices can be used to improve physics labs in high school.

Keywords: Physics experiments, model building tool, mobile devices, Arduino, smartphones, NXT.

1 Introduction

Compared to doing pure calculation with just physics theory, physics experiments can be a hands-on activity with more fun. Physics experiments and related tasks are practice of scientific inquiry, which is a process of investigation leading to some conclusion expressed mathematically.

Another approach of scientific inquiry is microworld, e.g., with Papert's turtle graphics of Logo programming [1], where students manipulate the values of some variables or do programming to explore and enhance their understanding of geometric concepts by observing the data produced by their manipulation. A pedagogy of scientific inquiry is illustrated by Frideriksen and White [2] with a computer assisted learning method called ThinkerTools.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_33

While microworld and ThinkerTools focus on the process of scientific inquiry, they differ from empirical physics experiments in that their inquiry results are based on computer simulation. Despite this difference, both simulated and empirical inquiry share the same scientific method with six steps:

1. Question: Construct a research question.
2. Hypothesis: Generate assumptions that might answer the question.
3. Investigate: Do experiments and collect the resulting data.
4. Analyze: Examine the resulting data to check against their hypotheses.
5. Model: Generate a mathematical model to explain the data.
6. Evaluate: Determine whether the model is correct leading to new hypotheses or new research questions.

In a traditional pendulum experiment in high school, students use a stop watch to time a number of swing periods and then compute the average period, assuming that every period consumes the same amount of time. Wong et al. [3] reported a pendulum experiment using an Android smartphone as the mass of the pendulum. Wong et al. [4] reported a similar pendulum experiment using an NXT instead of a smartphone. A pendulum was set up with a light, thin wooden rod and a cell phone (or NXT) as the mass at the bottom of the rod. The top of the rod had a hole with a plastic axle through the hole and attached firmly to a wall so that the rod can pivot freely about the axle.

As the pendulum swung, a running application of the phone recorded the angular position and the corresponding time of the phone made with the vertical line through the point of attachment. The data plot showed a harmonic motion with decreasing amplitude. In this plot, the period of each wave can be measured and students can judge for themselves whether the swing periods stay the same within a certain time. After collecting the data, students can then build a mathematical model relating the period T of the pendulum and its length L. In this study, they are asked to use a model building tool called InduLab, a previous version of which is presented in [4]. Results from the empirical experiments in the current study could review how InduLab could help the model building process.

The above examples show that with high speed data acquisition devices, students can examine physical phenomena in much greater details, like microbiologists studying bacteria with a microscope. This paper reports a study where high school students did pendulum experiments with three mobile devices of Arduino, smartphone, and NXT along with our model building tool. The results would shed some light on how such devices and model building tool can be used in similar Physics experiments and how students feel about these inquiry tasks that are different from traditional labs.

2 Literature Review

2.1 Pendulum Experiment with Arduino at Queen's University

In a course Physics 350 at Queen's University, students use an Arduino to capture the angular position of a swinging physical pendulum equipped with a shaft encoder [5]. The changing angular position of the pendulum is read by a shaft encoder (HEDS-5500-A14, by Avago Technologies) and sent to an Arduino MEGA2560 which computes the data to produce an angular position. The Arduino periodically sends this position, along with a timestamp, to a computer through a USB connection (type B port on the Arduino, type A USB port on the computer).

2.2 Pendulum Sensor Kit from IORodeo

IORodeo, a commercial corporation providing lab technology, offers a pendulum sensor kit for classroom investigation of the physics pendulum [6]. The kit has a pre-programmed Arduino and uses an LCD to display measurements such as the period of the pendulum in swing. The pendulum is mounted directly above a photogate sensor and a pulley system allows simple adjustment of the length of the pendulum. The pendulum period is computed by the provided computer program driving the Arduino. This is a disadvantage for our target high school students as we want them to learn how to measure the period of a wave and to examine whether the period stays the same as the pendulum swings. Too much automation that removes valuable learning experiences is one thing we should avoid.

3 Physics Experiment

Physics labs in high school are supposed to be fun activities compared to the studying of textbook theories. Compared with physics theories, labs let students set up lab equipment and see physical phenomena with their own eyes. Theories are abstract and equation-driven while labs are concrete and data-driven. Hopefully, fun labs help students understand the theories better and act like scientists with first-hand experiences. Unfortunately, outdated lab equipment with slow data acquisition rate might be an obstacle for students to examine closely the real physical phenomena. Therefore this study proposes to use modern electronic devices that can measure and acquire physical data with a fast rate. An example lab in this study is the measurement of the changing angle of a swinging pendulum.

The data acquisition devices this study tested included an Android smartphone, a Lego Mindstorms NXT, and Arduino development board.

Following the six steps as in the Thinker Tools Inquiry Curriculum (White & Federiksen, 2000), students in this study can examine a target issue, make hypotheses, collect data from experiments, analyze the data, produce a model, validate the model, and can repeat the cycle until satisfactory results are obtained.

After students finish the lab trials and have collected experimental data, they can record the data, analyze them, and produce an equation to relate the measured variables with a software tool called InduLab. If a student finds that her equation does not fit the data well, she can modify her equation in order to improve the fitness.

A simple pendulum from any common Physics textbook is shown in Fig. 1. It consists of a massless rod pivoted at its top end without any friction and a massive bob at the other end. The angle θ the rod makes with the vertical line through the pivot is the angle to be measured at a fast rate. The initial angle should be less than 10 degrees at the beginning of each experiment trial. In our pendulum lab, the rod used is a light, thin piece of wood and the bob is a mobile device such as an Arduino board, a smartphone, or an NXT.

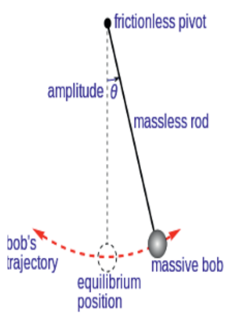
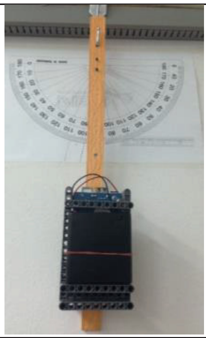
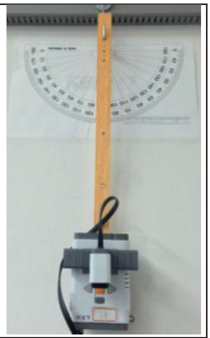
			

Fig. 1. A simple pendulum	**Fig. 2.** Arduino	**Fig. 3.** Smartphone	**Fig. 4.** NXT

Different lengths were used for the pendulum and the corresponding periods were measured. After a set of data points of lengths and periods were obtained, students began to guess the length as a function of period. In textbook theory, the period T is written as a function of the length L, since the length is an independent variable that can be manipulated and the period is a variable dependent on the length: $T = 2\pi\sqrt{\frac{L}{g}}$, where g is the gravitational acceleration. This formula is not used directly and instead the reverse of this relation is used, i.e., the length is a quadratic function of the period: $L = \frac{g}{4\pi^2}T^2$. The reason is that our model building tool restricts the functional form to be a regular polynomial that cannot involve the square root of a variable.

4 Data Acquisition Device and Model Building Tool

4.1 Arduino Board for Data Acquisition

A pendulum experiment can be set up using an Arduino development board and an accelerometer sensor. The particular board used in our study was Arduino ADK Rev3 Developer Edition 2 and the accelerometer was MX2125. A Bluetooth module was also used with Arduino to transmit to a PC the angle of the swinging pendulum and the time instance when the angle was measured. The Arduino hardware was mounted with Lego bricks on a light, thin and flat wooden rod swinging as the pendulum arm, whose top is freely pivoted on a hook attached to a wall. Besides serving as the data acquisition device, the Arduino hardware also served as the weight of the pendulum. The Arduino pendulum is shown in the Fig. 2. The background of a paper protractor can show the initial angle of the pendulum. The pendulum with a smartphone and that with an NXT are shown in Fig. 3 and Fig. 4 respectively.

4.2 InduLab as a Model Building Tool

Once the file of experimental data in csv format is ready on a PC, a student will open the file with Microsoft Excel and obtain a plot of harmonic motion of angle versus time with decreasing amplitude (Fig. 5).

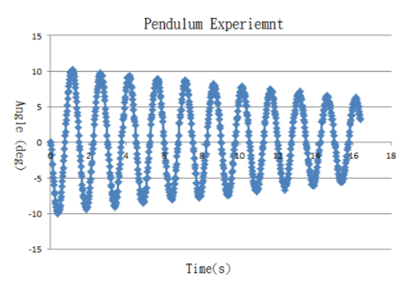
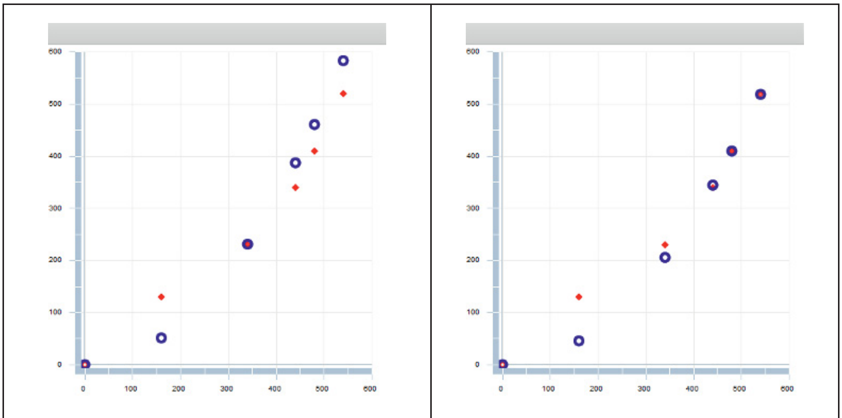


Fig. 5. Plot of the angle of a moving pendulum versus time

Fig. 6. Three pendulum lengths and ten of their corresponding periods

For each pendulum length, a student can measure the periods of ten waves, each of which can be the time between two neighboring maxima in the plot. The student then fills in the ten periods (in ms) and the pendulum length (in mm). Now the student can tell from the data that the periods are more or less the same. Then the system will compute the average of the ten periods. Note that different lengths should be used for a total of six trials of the experiment. So at the end, there will be six data points of periods and lengths. Fig. 6 shows three pendulum lengths and their corresponding ten periods. The average of each set of ten periods is displayed at the bottom of the ten periods.

After six lengths and their corresponding averaged periods are obtained, each student can start to build their model that can predict the experimental data with minimum deviation. The student enters length L as a function of period T. The mathematical expression is restricted to a regular polynomial with real coefficients. Each time he enters a function, the system will show a plot of experimental T versus L and also theoretical T versus L predicted by the model. Also, a measure of deviation between the prediction and the actual data is used to show whether the model has less error than previous models. Figure 7 shows the last four models entered by a subject. The deviation was progressively reduced from 35.6 to 22.7. The last quadratic function was chosen as a final model.



Function	$L = T * T/500$	Function	$L = T * T/562$
Deviation	35.6	Deviation	22.7

Fig. 7. The last four models entered by a student showed progressively less deviation.

5 Pendulum Experiments and Results

The pendulum lab was done by thirty students in a high school in Yunlin County in four weeks. The students were divided into six groups, each of which had about six members. Two groups used Arduino, two used smartphone, two used NXT. In the first week, the instructor introduced the pendulum experiment and its setup with the three mobile devices. In the second week, each group did six trials with different pendulum lengths and collected the data. In the third week, each student worked in InduLab to build a model with her group's data. In the last week, the instructor talked about the pendulum theory and suggested reasons to explain the differences among the models obtained by the students.

Textbook theory says that target formula of a simple pendulum is $L = (g/4\pi^2)*T^2$. Therefore, students whose final model was L as a quadratic equation with a small error of fitness were considered successes. The success rate for each device is shown in Table 1. The success rates for the three groups were very different. The Arduino group succeeded with 80%, the smartphone group 50%, and the NXT group 20%. The data acquisition rates for the three corresponding devices were 50, 50, and 5 points per second. The NXT group suffered a low success rate might very well be due to its relatively low acquisition rate. But the acquisition rate did not explain the different success rates between the Arduino group and the smartphone group.

Table 1. Success rates for three groups using difference devices

Device	#Successes	#Subjects	Success rate
Arduino	8	10	80%
Smartphone	5	10	50%
NXT	2	10	20%

Conclusion

Traditional Physics experiments can be improved with two great tools: low-cost modern mobile devices and a computer-assisted model-building environment. This study shows how to do the pendulum experiment with three devices, including Arduino, smartphone, and Lego Mindstorms NXT. Smartphones are usually treated as toys by students in school and NXTs are usually treated as robotic toys and they are seldom thought as learning tools in physics experiments. Arudino platforms are more widely accepted as a learning tool at college level and mostly by electronics lovers. Its potential as a data acquisition device in physics experiments is proposed by this and other studies as cited above.

After the data were collected in experiments and stored in a file on a PC, students used the data to build a mathematical model of the physical phenomenon of the experiment. A tool called InduLab was used for this purpose. In a pendulum experiment, students simply expressed the length of the pendulum as a function of its period. The predicted values were plotted on the same graph as the experimental data and their deviation was computed. Both the visual plot and the automatically computed deviation helped the students to bring the prediction closer to the experimental data.

For the pendulum experiment, the Arduino group achieved the highest rate of building successful models judged by the theory in textbook. The smartphone group came in second followed by the NXT group. Both Arduino and the smartphone had a high data acquisition rate of 50 points per second while NXT had a relatively low rate of 5 points per second. This might explain the low success rate of the NXT group. But it was intriguing why the Arduino group was doing better than the smartphone group. Anyway, this result was preliminary as the number of subjects was not big enough. Further empirical experiments with more subjects can shed more light on the issues raised by this study.

Besides doing the pendulum experiment, the students also used the same electronic devices with an ultrasonic sensor in other experiments, including free-fall projectile, vertical free-fall projectile, slope motion, the second Newton's law. This shows that the devices are really general-purpose and can apply to many labs.

High school physics teachers are already very busy in preparing students for national aptitude tests and might not be aware of the capability of low-cost modern electronic devices. So one contribution of this study is that we have shown how high school students can use modern electronic devices in physics experiments, instead of using the traditional equipment with low rate of data acquisition. The second contribution is that InduLab serves as an innovative tool of model construction that fits seamlessly in physics labs and might help to bring back the play-scientist fun of rediscovery that is somehow lost in physics education for many years.

Acknowledgments This study is supported by the Department of International Cooperation and Science Education, Ministry of Science and Technology, Taiwan under contract 101-2511-S-224-001- and 102-2511-S-224 -002 -MY2.

References

[1] Papert, S. Computer-based microworlds as incubators for powerful ideas. In R. Taylor (Ed.), The computer in the school: Tutor, tool, tutee (pp. 203–210). New York: Teacher's College Press (1980).
[2] White, B., & Frederiksen, J. A. A theoretical framework and approach for fostering metacognitive development. Educational Psychologist, 40(4), 211-223 (2005).
[3] Wong, W. K., Xu, J. M., Chao, T. K. Using Android mobile device for physics experiments and inquiry, International Conference on Computers in Education, 2011/11/28-2011/12/02, APSCE, Chiangmai (2011).
[4] Wong, W. K., Chao, T. K., Lien, Y. W., and Wu, C. J. Rediscovering scientific laws in high school physics labs with mobile devices, Proceedings of International Conference on Computers in Education, Asia-Pacific Society for Computers in Education, Singapore (2012).
[5] Course phys350 of Queen's University experiment document. http://www.physics.queensu.ca/~steve/phys350/Pendulum-quicksetupguide.pdf
[6] A pendulum sensor kit from a commercial company IORodeo Smart Lab Technology. http://www.iorodeo.com/pendulum_lab

Ontology based semantic metadata extraction system for learning objects

Ramzi Farhat, Baraâ Jebali and Mohamed Jemni

Research Laboratory of Technologies of Information and Communication & Electrical Engineering (LaTICE)
University of Tunis, 5 Avenue Taha Hussein, B.P. 56, Bab Menara, Tunis, Tunisia
jebali.baraa@gmail.com,ramzi.farhat@esstt.rnu.tn,
mohamed.Jemni@fst.rnu.tn

Abstract. Educational metadata play a crucial role in enabling learning objects' discovery for an efficient use. Consequently the e-learning community has developed several educational metadata schemas (e.g. IEEE LOM standard). Unfortunately to implement advanced tools it has been found that those metadata are not sufficient. Thus, many research works suggest the use of educational semantic metadata. However the main barrier is the fact that providing manually semantic metadata still a hard and complex task for authors. Consequently we propose an ontology-based approach allowing the automatic extraction of semantic metadata from a specific sub-set of IEEE LOM metadata. Experimentations results are presented and discussed.

Keywords: Semantic metadata, learning objects, ontology based information extraction, LOM.

1 Introduction

The educational content is delivered, in most of cases, as learning objects. Tedious problems related to their accessibility and to their indexation arise. Consequently educational metadata is proposed as a solution to smooth over these problems. Within the past years, many metadata standards and norms were proposed, and the IEEE-LOM standard has being widely adopted by the e-learning community [1]. The learning object's author has to fulfill metadata manually. In addition to the fact that this is a tedious process, metadata are not designed to be understandable by a machine. Consequently implementing intelligent services - such as semantic search engines and content personalization services- is not yet possible.
On reflection, it is critically important to add a semantic metadata layer for the learning objects to ensure its common comprehension by humans as well as machines. For the same purpose semantic metadata was introduced by the W3C with the appearance of the semantic web. It is defined as a metadata that refers to a given

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_34

domain ontology which presents a common vocabulary to describe domain's concepts and relationships between them [2].

In e-learning, research projects related to semantic metadata have few impacts in the practice. This can be explained in part by the fact that adding semantic metadata to a learning object is a hard and complex task for authors. Moreover, many learning objects already exist and enriching them by semantic metadata will be a tremendous and a time consuming task. Moreover semantic metadata are not universal because they depend on domain ontologies which vary in most cases from a community of practice to another. Consequently the task must be repeated each time the learning object is used in a new context. Thus we can say that the creation of semantic metadata is not suitable to be done by a human.

On this account, we proposed to generate semantic metadata automatically. We proposed an ontology based information extraction approach in order to guarantee the consideration of the use context, always modeled by ontologies. The input of our system is a set of LOM metadata and a domain ontology. The output of our system is a set of semantic metadata presented in the RDF formalism.

The paper is organized as following. The next section gives an overview of our approach. The third section contains experimental results. The last section is a conclusion.

2 Related works and our approach overview

In our point of view, semantic metadata is not supposed to replace classic metadata. In fact, we are for an evolutionary approach (vs. a revolutionary approach) which is compatible with existing tools and existing practices. Moreover, in our opinion the semantic metadata must not be integrated to the learning object's delivery package to conserve its interoperability. In fact they are specific to a domain ontology which is not necessary shared by all its users.

In addition to that, we suppose that semantic metadata must contain relevant information about the content with author's imprint and it must be expressed in a machine "understandable" and processable way. For that, we proposed to use LOM metadata as input in our approach which is summarized information -provided by the author- about the learning object educational content. . After these considerations, we have designed an approach to extract automatically semantic metadata. Firstly we have to choose relevant information from the LOM metadata to take it as input to our system [3, 4]. The domain ontology is also supposed as input. Then we have investigated how to ensure an automatic semantic metadata extraction form the available inputs. Here, we are strongly influenced by the ontology based information extraction (OBIE) domain, which is a subfield of information extraction. In fact, an OBIE system is a system that processes unstructured or semi-structured natural language text through a mechanism guided by ontologies to extract certain types of information and presents the output using ontologies [5]. Clearly, the output of such systems is the basic element to build semantic metadata. For that, we proposed a customized ontology semantic metadata extraction system (OBSemE) architecture presented in [6]. Our system is composed of three main parts: ontology parser, pre-processor and Information extraction module. The ontology parser is used to extract the concepts of the ontology and the relations between them. The pre-processor prepares the LOM metadata to be suitable as input for the information extraction module. The pre-processing module is based on natural language processing technologies. The information extraction is explained in the following section.

3 Extraction method and experimental results

The core of our approach is based on the OBIE principles and the semantic web concepts in order to extract automatically semantic metadata from a preselected subset of LOM data elements. We proposed the use of an OBIE algorithm called Hieron [7] based on the published promising experimental results [8]. The use of this algorithm leads to tow steps of processing. A training step, in which the system learns how to classify the terms using the ontology concepts and a classification step in which the system begins his automatic processing.
To validate our approach we have developed a system called OBSemE (Ontology Based Semantic Metadata Extraction). After the implementation of our system, we moved to the experimentation step. To do that we have prepared a data set composed of computer science domain ontology and a set of LOM files.
In the aim of evaluating the obtained results [6] we used ontology based information extraction metrics called augmented precision and augmented recall based on a hierarchical error metric called BDM [9]. First results are presented by the curves in Fig. 1.

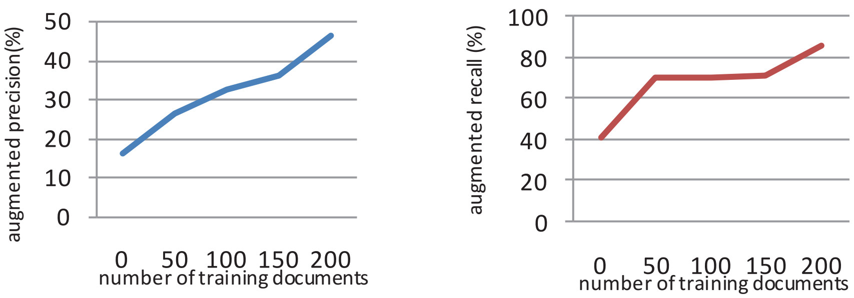


Fig. 1 Augmented precision and augmented recall curves

Obviously, more the training step is rich more the system's precision and recall are higher. Both, the number and the quality of the LOM files affect the precision remarkably. In fact, semantic metadata generation depends on many factors else. It depends on the quality of the information contained in the documents and their coherence with each other and with the ontology [10].

4 Conclusion

In this paper we have presented an automatic ontology based semantic metadata extraction approach. The input of our approach is a subset of LOM metadata which is describing the educational content and is highly available. The output of our approach is a set of semantic metadata when each one contains a concept and its degree of relevance. The extraction process is done throw the execution of an adapted version of the Hieron algorithm. In order to validate our approach we have developed a prototype called OBSemE. The results of the experimentation proved that it is possible to talk about automatic generation of semantic metadata with existing technologies.

References

[1] Duval, E., Hodgins, W., Sutton, S., and Weibel, S.L.: Metadata Principles and Practicalities. D-Lib Magazine, vol 8 (4), ISSN 1082-9873, pp. 13 (2002),

[2] Scerri, S., Abela, C. and Montebello, M.: semantExplorer: A Semantic Web Browser. In : IADIS International Conference WWW/Internet, Lisbon, Portuga (2005)

[3] Farhat, R. and Jebali, B.: OBSemE: An Ontology-based Semantic metadata Extraction System for Learning objects. In: The Fourth International Conference on ICT & Accessibility, ICALT 2013, 24-26 October, Hammamet, Tunisie (2013)

[4] Jebali, B. and Farhat, R.: Ontology-based semantic metadata extraction approach. In: International Conference on Electrical Engineering and Software Applications, Tunis: Hammamet (2013)

[5] Ochoa, X., Klerkx, J., Vandeputte, B. and Duval, E.: On the Use of Learning Object Metadata. In: The GLOBE Experience. EC-TEL ECTEL: European Conference of Technology Enhanced Learning, Palermo, Italy, 20-23, Lecture Notes in Computer Science, volume 6964, Springe, pp. 271-284, September (2011)

[6] Al-Khalifa, H. and x Davis, H.: The Evolution of Metadata from Standards to Semantics in E-Learning Applications. In Proceedings of Hypertext'06, Odense, Denmark (2006)

[7] Dekel, O., Keshet, J. and Singer, Y.: Large Margin Hierarchical Classification. In: The 21stInternational Conference onMachine Learning ICML-2004, Canada (2004)

[8] Li, Y., Bontcheva, K. and Cunningham, H.: Using Uneven Margins SVM and Perceptron for Information Extraction. In: Proceedings of Ninth Conference on Computational Natural Language Learning, CoNLL-2005 (2005)

[9] Maynard, D., Peters, W. and Li, Y.: Metrics for evaluation of ontology-based information extraction. In: Proceedings of the WWW 2006 Workshop on Evaluation of Ontologies for the Web, ACM, New York (2006)

[10] Lei, Y., Uren, V. S. and Motta, E.: SemRef: An Evaluation Reference Model for Semantic Metadata. In: The 4th European Semantic Web Conference (2007)

[11] Farhat, R., Defude, B. and Jemni, M.: Authoring by reuse for SCORM like learning objects. In: The 9th IEEE International Conference on Advanced Learning Technologies, Riga, Latvia , July 14-18 (2009)

Ontology-based Smart Learning Environment for Teaching Word Problems in Mathematics

Aparna Lalingkar[1], Chandrashekar Ramnathan[2], and Srinivasan Ramani[3]

[1] IIIT Bangalore, India aparna.l@iiitb.ac.in
[2] IIIT Bangalore, India rc@iiitb.ac.in
[3] IIIT Bangalore, India ramani.srini@gmail.com

Abstract. This paper demonstrates how to use MONTO – machine readable ontology for teaching word problems in mathematics. MONTO is a combination of various ontologies. The paper gives background of the literature review and then states the gaps. It also describes MONTO and demonstrates its use, and bridges the gaps found in the literature of tutoring systems used for teaching problem solving. A description of the system implemented by using MONTO is included along with the key functionalities of the system derived from the ontology. A discussion of how these functionalities are useful for teaching word problems is included too. This paper also presents the results of a small-scale study conducted to evaluate the functionalities that are derived from the ontology.

1 Introduction and Background

A student who has been taught mathematical problem solving can be strong in analyzing a large amount of quantitative data, can use mathematics in practical ways, and can be analytical both in thinking for herself and in examining the arguments put forward by others [1]. Good conceptual knowledge and the ability to solve various problems in high school-level mathematics form a basis for quality higher education. Hence it is very important to study how Information and Communication Technology has been used for teaching mathematical problem solving at the high school level. By the term *mathematical problems* we mean problems which are solved by using mathematical formulas, mathematical logic and rules. There are various types of problems but the real training in problem solving begins when *word (story) problems* get introduced, where students need to process the real world scenario and connect it to mathematical knowledge. Hence, we focused on word (story) problems. While describing his research on teaching mathematical problem solving [2] gave a framework for analysis of mathematical behavior. The framework comprises four components: *resources* i.e. basic concepts and mathematical knowledge (cognitive aspect); *heuristics* i.e. broad range of problem solving strategies illustrated by [3] and some sub-strategies added by Schoenfeld himself (meta-cognitive aspect); *control* i.e. efficiency in combining resources and heuristics to take the decision to solve a problem (decision making aspect which is part of meta-cognitive aspect);

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_35

and *belief systems* i.e. one's opinion and belief about mathematics and mathematical problem solving (motivational aspect). Despite more than seven decades of work in teaching problem solving [3, 4, 2, 5–7], classroom teaching of the solving of mathematical problems at the school level has remained a great challenge. In this paper initially we offer state of the art of the systems used for teaching word problems in mathematics followed by evaluation of the systems against a rubric developed by extensive review of the literature of mathematical thinking and understanding to highlight the gaps. Next, we discuss the solution, MONTO -machine readbale ontology for teaching word problems in mathematics, to fill the gaps. Further, we describe the system implemented by using MONTO at the back-end as a proof of concept. This is followed by discussion of results of the study of evaluation of functionalities of the system. Finally, contributions and future work are presented.

2 State of the Art

There are several systems such as ACTIVEMATH [8], Khan Academy [9, 10], WORDMATH [11], Cognitive Tutors [12],(available over the internet either free or subscription basis) and LIM-G [13] designed for tutoring mathematics in general and word problems too. Some schema models such as ROBUST [14], CHIPS [15]are also developed for teaching arithmatic word problems. A framework is developed (see Table 1) consisting of a number of criteria extracted from the literature to evaluate the existing available systems for tutoring mathematical problem solving so that we could find the gaps in the existing systems with respect to the literature. Generally speaking there are two major parameters which are considered: *Knowledge Representation*, and *Meta-cognitive Aspect*. In Figure 1, the availability of a criterion for a system is shown by a cross mark and unavailability is shown by a blank. The grey textured boxes with cross mark show that the criterion exists but is explored in a weak manner. From the

Table 1. List of Parameters and Detail Criteria of the Framework

Parameters	**Criteria**
Knowledge Representation	Linguistic Knowledge Semantic Knowledge Syntactic Knowledge Multiple Knowledge Representation
Meta-cognitive Aspects	Controls/Decision Making Modeling of Problem Strategies Questioning to support problem solving Modeling of Problems Modeling of Students

literature review and evaluation of the systems against the parametric framework (refer to Figure 1) it is concluded that modeling of problem strategies, asking analytical questions to students, building students models for diagnosis of students' missing concepts (a sub-set of all concepts which are expected to be known to experts but are not known by students) and misconceptions (these are created by students on their own due to misunderstanding) offering remedial feedback is less researched. For teaching word problems semantic and syntactic knowledge representation is useful together with multiple knowledge representations for reducing cognitive load (the number of interactive information elements that need to be processed simultaneously before any meanigful learning takes place[16]) and better understanding. Ontology is a specification of a conceptual-

Parameters & Criteria	LIM-G (2005)	WORD MATH (1996)	Cognitive Tutors (1995)	ROBUST (2007)	CHIPS (1984)	ActiveMath (2004)	Khan Academy (2011)
Linguistic KR	x		x		x		
Semantic KR	x		x	x	x	x	x
Syntactic KR	x		x	x	x		
Multiple KR	x	x	x			x	
Controls	x		x			x	x
Modeling of Problem Strategies			x	x	x		x
Questioning	x		x				
Modeling of Problems	x	x	x	x	x	x	
Modeling of Students			x			x	x

Fig. 1. Evaluation of the systems Against the Parametric Framework

ization [17]. The review of literature of application of ontology suggests that use of ontology for education and tutoring mathematics has been explored but use of ontology for teaching word problems is not evident in the literature. Beginning in childhood, we develop a kind of ontology in our minds for whatever concepts and relationships between concepts we learn. This ontology evolves as we continue learning. This is the natural way of learning. Hence, MONTO, a machine readable ontology for teaching word problems in mathematics is proposed. The proposed MONTO ontology is divided into four main parts: *system/pedagogy ontology*, *task ontology*, *student model ontology*, and *domain ontology*. In *system/pedagogy ontology*, analytical questions are asked for a particular problem and answer choices are provided with remedial feedback. *Task ontology* includes the set of tasks students needs to complete or do for solving a problem. *Domain ontology* includes all the domain knowledge required for solving a problem. In *student model ontology*, all the information about student's interaction with the system is stored. For the proof of concept, an ontology for the domain of 3D mensuration was created based on an analysis of grade IX and grade X word problems. The detailed description of MONTO and evaluation of its robustness is outside the scope of paper.

3 The Ontology-based System

This section describes a system developed based on the MONTO ontology. This ontology-based system has three major components: *Learning Mode*, *Solving Mode* and *Student's Learning Profile*. After a student logs onto the system by using *User Name* and *Password*, system displays the list of *problem types* from which student can select a problem type and the difficulty level i.e. *easy*, *medium* and *hard*. Every word problem contains some real world scenario together with some given items (*Given*) and some items that need to be found (*To-find*). A problem in which the *Given* and *To-find* items are given directly is considered as an *easy* problem. A problem whose schema contains a greater number of *Given* items and has some complex real world scenario is considered as a *medium* problem. A problem whose schema contains a greater number of items in which the *Given* and *To-find* items are given indirectly and a problem that has more complex real world scenario is considered as a *hard* problem. Once a *problem type* and the *difficulty level* is selected the system displays problem statement and two options: *Learn How to Solve* and *Solve the Problem*. Once a student selects *Learn how to solve*, system takes the student to learning mode. Learning Mode offers a tutoring module where system asks the student analytical questions that can help her to analyze a problem. This provides training for how to think for solving any given problem. Solving mode has various parts such as *Schematic Knowledge*, *Semantic Knowledge*, *Formula*, *Image*, *Given*, *To Prove* and *Solve*. While learning mode helps student to analyze a problem and devise a plan to solve the problem by asking analytical questions, offering answer choices and providing constructive feedback; solving mode enables her to solve the problem on her own. The information captured by student model ontology is used for displaying student's learning profile. There are six parts of the *student's learning profile*: a) *Problem Solving Progress*; b) *Misconceptions*; c) *Missing Concepts*; d) *Learned Concepts* (specific to particular problem type); e) *Learning profile of Mensuration Domain*; and f) *Activity*. When student clicks on the tab *Student's Learning Profile* the list of six parts gets displayed.

4 System and Component Architecture

The system can be broadly divided into four modules: *user interface*, *logic*, *data access*, and *ontology file*. *User interface* is a collection of jsp files. The system is implemented using Java technologies. The user interface is implemented using JavaServerPages (JSP). The system follows a Model-View-Controller architecture with the clear separation of the logic and the data modules. Ontology is

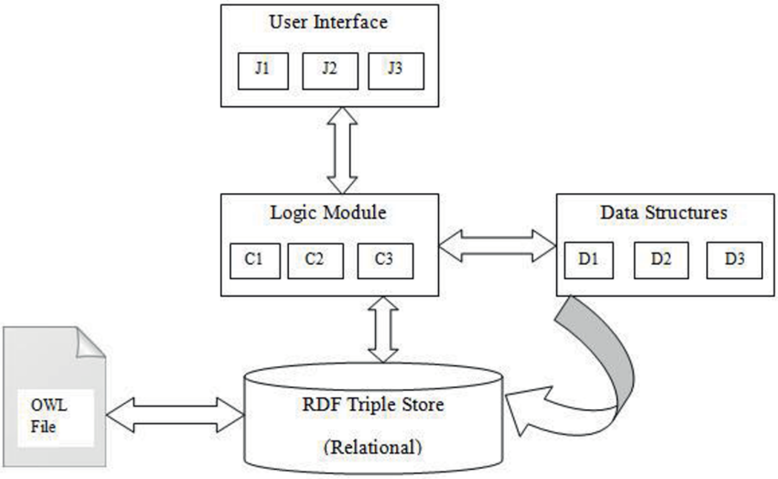


Fig. 2. System Architecture

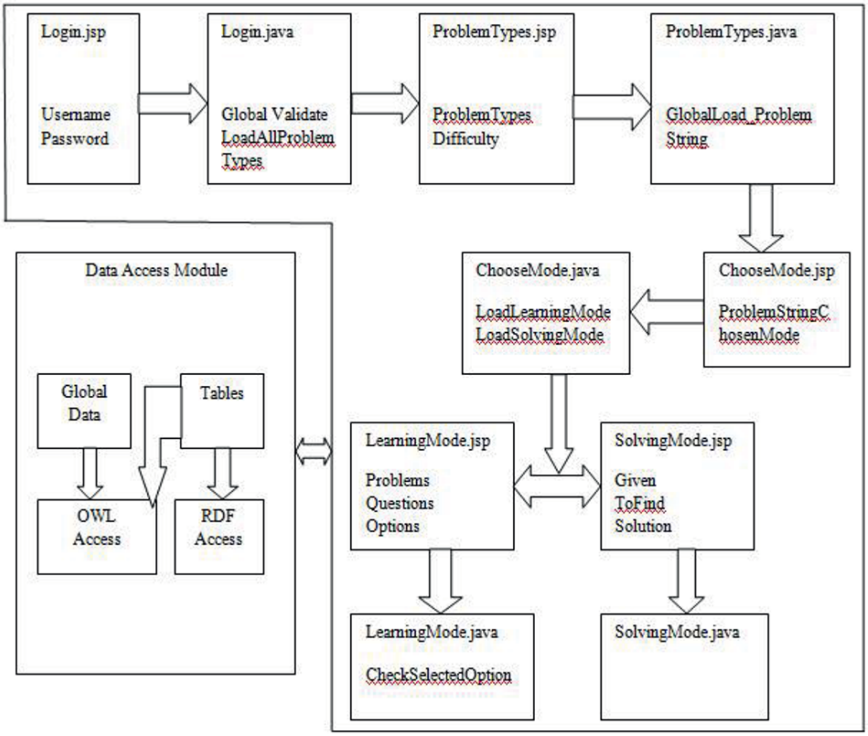


Fig. 3. Component Architecture

implemented using the Web Ontology Language: OWL. OWL data is stored in a relational triple store. Please refer to the Figure 2 for system architecture and the Figure 3 for component architecture. In Figure 3, the .jsp pages describe front-end actions and the .java pages describe back-end actions. The system is implemented as a multi-tier architecture. Such architecture increases the independence of each module. In our system, the ontology is continuously evolving. An evolving ontology means continuous change in data format, data structures, etc. We need a system that is open to change. A loosely tied multi-tier system fits these needs. The level of independence is not absolute due to query result format of SPARQL (SPARQL Protocol and RDF Query Language).

5 The Functionalities derived from Ontology

Following are the functionalities of the system that are derived from the ontology used at the back-end: a) Ontology is used in all the four parts of the intelligent tutoring system (ITS). Pedagogy ontology is used in tutoring module, domain ontology is used in expert module, task ontology is used in interface module or problem solving environment, and user model ontology is used in student module. b) The list of problem types and the list of difficulty levels from which a student selects type of problem and the difficulty level are directly fetched from the ontology. c) In learning mode, the analytical questions asked and the choices offered by the system are derived from ontology. d) The constructive feedback provided for each action (i.e. selection of correct or incorrect answer) is also taken from the ontology. e) In solving mode, the correct items that are accepted into the text area of "Given", "To-find" are fetched from the ontology. f) The correct items that are accepted into the text area of "Solve" are fetched from the various tasks listed under the *Task class* for that particular problem in the ontology. g) Schematic knowledge, semantic knowledge, list of formulas, and a static image for a particular problem are also derived from the ontology at the back-end. h) The information displayed in student's learning profile – namely problem solving progress, capturing of bugs (i.e. missing concepts and misconceptions), the remedial feedback provided for each bug, learned concepts, learning profile of mensuration domain, and the activity – is also derived from the ontology used at the back-end.

6 Evaluation of the Functionalities

We evaluated the usefulness of the functionalities of the system, which are drawn from ontology, by teachers. A set of structured questions based on five point Likert-like scale were used. The questions were based on the usefulness of the functionalities of the system that are derived from ontology. Teachers were oriented about the ontology and the system and then were asked to interact with the system. During or after the interaction, they were asked to answer the survey questions. Results are shown in Figure 4. A total of 19 teachers of mixed

		Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)	Mean	SD
General Functionalities	Usefulness of Selection Choices for Problem Type and Difficulty Level	52.63	47.36	0	0	0	1.52632	0.51299
Learning Mode Functionalities	Usefulness of Learning Mode Analytical Questions	78.94	21.05	0	0	0	1.78947	0.41885
	Usefulness of Constructive Feedback to Incorrect Answers	68.42	31.57	0	0	0	1.68421	0.47757
Solving Mode Functionalities	Usefulness of Schematic Knowledge Representation	36.84	57.89	5.26	0	0	1.31579	0.58239
	Usefulness of Semantic Knowledge Representation	57.89	42.1	0	0	0	1.57895	0.50726
My Learning Profile Functionalities	Usefulness of Problem Solving Progress	52.63	36.84	10.53	0	0	1.42105	0.69248
	Usefulness of Missing Concepts and Misconceptions and Remedial Feedback	73.68	26.31	0	0	0	1.73684	0.45241
	Usefulness of Learned Concepts	57.89	42.1	0	0	0	1.57895	0.50726
	Usefulness of Learning Profile Mensuration Domain	52.63	47.36	0	0	0	1.52632	0.51299
	Usefulness of Activity	47.36	42.1	10.53	0	0	1.36842	0.68399

Fig. 4. Survey Results for Functionalities of the System

IT-proficiency responded and participated in the survey. All of them were mathematics teachers but at various levels. Maximum teachers taught mathematics at high school level. It is observed that more than 95% of teachers have largely **strongly agreed** or **agreed** to the assertive statements about usefulness of the systems functionalities. After finishing the structured opinionnaire, teachers were also asked to give their more opinions about the system. One teacher mentioned that: *After seeing the way questions are asked in analytical mode and reading the distractors or even the constructive feedback, I learned many things which I had never thought of in my twenty years service. I am interested in knowing about how to create ontology.* Some of teachers mentioned that: They had seen many educational softwares being sold in the market but they had not seen the granularity of captured mistakes the way it is captured by this system. When asked to elaborate more they mentioned about diagnosis of missing concepts and misconceptions. This opinion can be seen reflected in the results of structured opinionnaire. A few other teachers said that: They did not quite visualize the schema of a problem and did not get convinced with the schematic knowledge representation. Hence, they could not give any opinion about it.

7 Summary and Conclusions

In summary, the MONTO ontology very well fits into the general architecture of the Intelligent Tutoring Systems (*pedagogy ontology* to *pedagogy module*, *Domain Ontology* to *expert module*, *task ontology* to *problem solving environment*, and *student model ontology* to *student module*). The MONTO ontology at the backend is used for eight critical aspects of the teaching system. It is concluded that the use of MONTO based system, bridges the gaps highlighted in the state of the art (See Figure 1). With more effective implementation (constraint free text entry, different way of presentation of schematic and semantic knowledge, inclusion of diagramatic tool for drawing diagrams) would make the system more user-friendly. This ontology can also be used for drawing diagrams automatically for a problem by using the problem schema. Those diagrams can be matched with the diagrams drawn by students to find missing concepts and misconceptions of the students. This system can be a part of bigger system, which can be used for teaching mathematics.

References

1. Schoenfeld, A.H.: Learning to think mathematically: Problem solving, metacognition and sense-making in mathematics. In: Handbook for Research on Mathematics Teaching and Learning. MacMillan, New York (1992) 334–370
2. Schoenfeld, A.H.: Mathematical Problem Solving. Academic Press Inc, Orlando, Florida, USA (1985)
3. Polya, G.: How to Solve It: A New Aspect of Mathematical Method. 2 edn. Princeton University Press, Princeton, New Jersey (1946)
4. Newell, A., Simon, H.A.: Human Problem Solving. NJ:Prentice-Hall, Englewood Cliffs, NJ (1972)
5. Silver, E.A.: Teaching and Learning Mathematical Problem Solving: Multiple Research Perspectives. Lawrence Erlbaum Associates, Publishers, New Jersey, USA (1985)
6. Marshall, S.A.: Schemas In Problem Solving. Cambridge University Press, Cambridge, UK (1995)
7. Jonassen, D.H.: Learning to Solve Problems: A Handbook for Designing Problem-Solving Learning Environments. Taylor and Francis Group, Routledge, New York, USA (2011)
8. Melis, E., Siekmann, J.: Activemath: An intelligent tutoring system for mathematics. In: 7th International Conference 'Artificial Intelligence and Soft Computing' (ICAISC), Springer (2004) 91–101
9. Khan, S.: The Khan academy. Salman Khan (2004)
10. Sahlman, W.A., Kind, L.: Khan academy. Harvard Business (2011)
11. Looi, C.K., Tan, B.T.: Wordmath: A computer based environment for learning word problem solving. Computer Aided Learning and Instruction in Science & Engineering **1108** (1996) 78–86
12. Anderson, J.R.: Rules of the Mind. NJ: Lawrence Erlbaum Associates, Hillsdale (1993)
13. Wong, W., Hsu, S., Wu, S., Lee, C., Hsu, W.: Lim-g: Learner-initiating instruction model based on cognitive knowledge for geometry word problem comprehension. Computers & Education **48**(4) (2007) 582–601 Elsevier.
14. Bakman, Y.: Robust understanding of word problems with extraneous information. arXiv preprint math/0701393 (2007)
15. Briars, D.J., Larking, J.H.: An integrated model of skill in solving elementary word problems. Cognition & Instruction **1**(3) (1984) 245–296
16. Sweller, J.: Cognitive load during problem solving: Effects on learning. Cognitive Science **12** (1988) 257–285
17. Gruber, T.R.: A translation approach to portable ontologies. Known Acquisition **5**(2) (1993) 199–220

Paradoxical tensions of online peer assessment: A case study of a secondary school in Singapore

Wan Ying Tay*, and Zhi Ying Ng
National Institute of Education, Office of Education Research, Singapore
wanying.tay@nie.edu.sg

Abstract. Despite its potential benefits, factors such as negative perceptions have affected the use of peer assessment in schools. Through applying the concept of 'paradoxes', we sought to identify contradictory yet interwoven elements that were inherent in web-mediated peer assessment practices. Applying a phenomenographical approach, we interviewed 6 teachers and 30 students in a secondary school in Singapore, where an online peer assessment tool was used to support students in their English classes. Our findings suggested four main paradoxes: (1) increased student ownership but reduction in teachers' sense of control over student learning; (2) anonymity of peer comments lowered students' anxiety but reduced accountability; (3) reviewing multiple peers' essays increased student feedback but gave rise to more contradictory and non-constructive comments; and (4) the online peer assessment tool provided a good platform for peer review but overemphasised on the outcomes rather than processes.

Keywords: peer assessment · paradoxical tensions · phenomenongraphy · perceptions · online learning environment

1 Introduction

In recent years, peer assessment is increasingly used to help supporting learners in reviewing and giving feedback on one another's work [1,2,3]. The literature suggests that whilst instructors and learners recognise that there are benefits to peer assessment, there exist factors that may hinder its implementation in the classrooms and outweigh its benefits, of which negative impressions of students on the usefulness, reliability and validity of peer assessment have been noted to be particularly significant [4,5]. Whilst it has been suggested that conducting peer assessment online can help improve the effectiveness of students' learning outcomes and quality of their work, most of such research focuses on higher or tertiary education students, and it is still unclear how secondary school students and their teachers perceive peer assessment and engage with the activity in online environments. So as to understand if peer assessment is an effective way of learning and assessing one's work in schools, we first have to understand what the current peer assessment practices are like in schools and how teachers and students perceive and experience peer assessment.

Additionally, research has shown that paradoxes are inherent in the concept of assessment [6]. In particularly, the literature suggests that there are tensions in the

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_36

ways assessment is being perceived and experienced. Colwell [7], for instance, suggests that whilst teachers know that assessment is important, they may have not been adequately trained or grasp the concept of assessment well enough to truly appreciate its potential benefits and challenges. In this paper, the concept of 'paradoxes' is applied to help identify contradictory yet interwoven elements that are inherent in the peer assessment practices in classroom environments. Through identifying the tensions and contradictions that characterise peer assessment in classrooms, we aim to explore how they may influence teachers and students' perceptions of and experiences with peer assessment.

The aims of this study are two-fold. It seeks to (1) identify how students and teachers perceive and experience web-based peer assessment; and (2) understand how students and teachers reconcile the paradoxes resulting from the tensions and contradictions that arise in carrying out web-based peer assessment in their classrooms.

2 Literature review

2.1 Online peer assessment in schools

Review of the literature suggests a number of benefits of peer assessment. For instance, Yang and Tsai [9] observe that peer assessment encourages more active learning amongst the students by increasing interaction between student and student as well as student and teacher. Additionally, students' appreciation of peers' ideas may also increased as they learn together and support each other's learning during the peer assessment activity. Other benefits include learning about the evaluation process [10], building skills and increasing competencies such as autonomy and independence [11], self-efficacy [12] and responsibility [13].

Despite the many empirical studies demonstrating the benefits and effectiveness of peer assessment, certain issues with peer assessment have been widely discussed too. For instance, the study by Lin, Liu and Yuan [14] conducted on undergraduates found that several challenges and limitations of peer assessment: (1) time and effort consuming; (2) peers may not have adequate understanding and knowledge on the subject/topic to give constructive comments; (3) having reservations about giving comments; and (4) competition amongst peers led to awarding of a lower grade than one deserved. In Hanrahan and Isaacs's [15] study, they reported similar findings to Lin *et. al* [14], with the main difference being their participants had reservations about failing their friends. The difficulty in being truly objective in assessing their peers' work was also reported in a study by Liu and Carless [16], whom student participants commenting that they found it hard to manage the power relations amongst peers whilst carrying out the peer assessment activity. So as to increase the reliability and validity of students' feedback, researchers have found several ways that were shown to be effective. These include increasing the number of peer reviews for an individual piece of work [17,18] and allowing students to give and receive feedback anonymously [14].

Whilst research on peer assessment and web-mediated peer assessment has made good advances in informing practice, particularly in how they can be implemented more effectively and successfully, some research gaps still exist. Firstly, most studies are focused on higher education and little research has been conducted at schools [19]. Secondly, most studies are of a quantitative nature, and although qualitative methodologies are believed to be as important in informing how we could improve on peer assessment [20], there is still a lack of research that applies qualitative approaches in examining such practices. Furthermore, as Cheng and Tsai [21] observe, few studies have examined students' perceptions of web-based peer assessment, thus, little is known about how students perceive and experience such practices in online environments or through online tools. Additionally, as discussed previously, peer assessment practices in the classrooms are often laden with inherent tensions and contradictions, which have not been adequately examined or addressed.

2.2 Understanding paradox

Contradictory elements often create tensions amongst people, forcing them to choose between elements and reconcile these tensions so as to manage these paradoxes. Thus, paradoxical tensions tend to be triggered by inherent dualisms. As Andriopoulos [8] observes, examining these dualities can help us better understand the "coexistence and interrelationships" of paradoxical tensions (pp. 376). So that we can understand and learn how to manage paradoxical tensions, it is first necessary to examine and make sense of common and/or differing viewpoints. These will help us understand how various individuals work towards accommodating their converging and/or conflicting views and interests. Whilst reconciling conflicting views and interests is not our main aim, we believe that understanding how individuals try to reconcile these differences will help us explore the ways in which paradoxical tensions of online peer assessment could be potentially managed.

3 Adopting a phenomenographic approach

So as to better elicit and understand these variations, we adopted a phenomenographic approach as the guiding methodology for our study. Phenomenography allows for the illumination and elicitation of the different ways in which people think and make sense of the world. Its aim is to discover and describe the qualitatively different ways in which people experience, conceptualise, and understand various aspects of a certain phenomenon. Thus, it seeks to describe the variation of the ways in which people experience and make sense of a given phenomenon. Given its focus, phenomenography foregrounds the need to examine experiences, perceptions, approaches, ways of understanding and ways of comprehending [22].

We conducted interviews with 6 teachers and 30 students. These interviews were semi-structured and all interviews were digitally recorded and transcribed verbatim. Some guiding questions within the interview protocol included: tell me about your previous experiences of doing peer assessment; how confident are you in evaluating your peers' work, etc.

In keeping with the phenomenographic, interpretive approach, themes were allowed to emerge from the data, rather than attempting to fit them into preconceived categories or predefined themes. Analysis of the data followed a constant comparative and iterative method, which continued until no additional theses were uncovered. The individual narratives of the students were then compared to the teachers, so as to identify the common and different themes that emerged from these two groups of participants. The analysis done by each of the two authors of this paper was crosschecked against one another.

3.1 Web-mediated peer assessment on SWoRD

The study was conducted in a secondary school in Singapore where an online peer assessment tool, Scaffolded Writing and Reviewing in the Discipline (SWoRD ™[1]), was used to support part of the secondary three English language curriculum to help improve students' competence in writing argumentative essays. The peer assessment activity was carried out for a term, i.e., ten weeks, in the secondary three students' English language lessons. Students first submitted a pre-test writing, which was uploaded onto the online tool. This was followed by a round of multiple-peer-reviewing and back-evaluating (rating and commenting on their peers' comments). In reviewing their peers' work, students were given a copy of a rubric for assessing the quality of writing of an argumentative essay, which was jointly redesigned by the teachers and the researchers. Before doing the reviewing, teachers went through the criteria and rating as stated on the rubric with their students. Besides giving a rating, students were also asked to give qualitative feedback on each of the components, such as quality and effectiveness of the introductory paragraph, strength of the main arguments and counter-arguments, etc. The peer reviewing was a double-blinded process, i.e., students did not know whose essays they were reviewing, nor did they know from whom the comments

[1] Please see SWoRD™'s website: http://www.pantherlearning.com/ for more details on the online tool.

were from. The online tool randomly assigned 4 reviewers for each individual essay and only their teachers and the researchers had information on the reviewers and the recipients. Lastly, students were asked to review their own writing based on the peers' comments and resubmit a post-test writing onto the system again. Observations were conducted during the lessons and semi-structured interviews with 30 students who were randomly selected. The 6 teachers who were teaching the students were also interviewed.

4 Findings & Discussion

The findings reveal that paradoxical tensions were present as teachers and students went through the web-based peer assessment activity. Through inductive data analysis, our findings suggest four paradoxes of web-based peer assessment: (1) increasing student ownership but reduces teacher's sense of control over student learning; (2) anonymity of peer comments lowers anxiety of receiving and giving comments but reduces accountability; (3) peer reviewing of multiple peers' essays increases number of comments but gives rise to contradictory and unconstructive comments; (4) the online peer assessment tool provides a good scaffold for peer review but overemphasises on the outcomes rather than processes.

Increased student ownership but reduction in teachers' sense of control over student learning

Whilst all 6 teachers who were interviewed believed that the web-mediated peer assessment activity increased student ownership and was a purposeful collaborative activity for their students, at least three of them expressed concern over the perceived reduction of their sense of control over student learning. Teachers shared in the interviews that they felt that their sense of control was reduced when conducting and facilitating the web-mediated peer assessment activity. Comparing it to the "traditional, pen and paper" way of conducting peer assessment, Teacher1 thought that she felt she had less control over what students were doing, as much of this doing commenced in the classrooms but were resumed out of school hours. Similarly, Teacher2 too observed that due to the reduction in her perception with regards to management and control over what students were doing, she felt that students needed to have a "certain level of maturity, so perhaps tertiary level kids may do better" in the peer assessment. When asked if the peer assessment activity could be coupled with appropriate instructional strategies, Teacher4 commented that doing so would go "against the (self-directed learning) culture of what we want to build".

As could be observed in the interview transcripts above, the teachers felt a paradoxical tension between allowing for more self-directed, student-centred learning, buttressed with a collaborative learning culture, and that of teacher facilitation and maintaining a certain level of control over student learning.

Anonymity of peer comments lowered students' anxiety but reduced accountability

Most students felt that giving and receiving peer comments anonymously lowered their sense of anxiety. For example, Student23 commented that, "people tend to be more willing to provide feedback for others when they can be anonymous and do not have to worry about how the other party might feel about their comments and whether they might hurt their friends' feelings. Therefore, I believe this activity will allow us to get a more open and honest opinion of what our essays are like". Another student, Student30, shared that as the activity was carried out anonymously, her peers would not judge her if she could not come out with productive comments, and that made her feel more assured in writing out what she really feel about an essay.

However, their teachers seemed to have a different opinion on anonymity of comments in peer assessment. For instance, Teacher3 felt that students could be made accountable for what they said or commented more if the activity was not anonymous. As she shared, "we know who edited and sometimes you can just go and take the one who wrote the nonsense and you take her side and tell her very nicely "why like that?" Yah, I think it's not just about language acquisition at the end of the day". Teacher5 shared that instilling values such as empathy, sensitivity and teamwork as essential. She added that this would make students aware that they would be accountable, yet be as objective as they could in the peer assessment activity.

As the finding suggests, there seems to be a paradoxical tension between anonymity and accountability. Whilst students were mostly encouraged that they would be less anxious and worried in giving comments to their peers if this was done anonymously, teachers were concerned about how best to ensure that students could engage in the activity anonymously yet be aware that they would have to be accountable and responsible for what their comments. This reflects the importance of inculcating appropriate values in students, such as that of accountability, when conducting and carrying out peer assessment, even in the online space.

Reviewing multiple peers' essays increased student feedback but gave rise to more contradictory and non-constructive comments

From the students' point of view, 22 out of 30 of them commented that although they were much encouraged by the possibilities of learning from and improving on their writing from their multiple peers' comments, and that these comments would likely be different from their teachers, 8 of them thought that they would still rely on teachers' comments for they believed their teachers were the experts and would be more "professional" in giving their comments. Of the remaining 14, about half of them expressed confidence in their peers' comments, and thought that their confidence in the comments may be reduced if they were different from those given by other peers or if they contradict those given by their teachers. They also felt that the likelihood of this would increase since multiple peers would be giving them feedback and as each individual read and perceived things differently, the chances of them receiving or giving contradictory comments would too increase. 3 students thought that this may render comments non-constructive and that they would still rely on their teachers' comments for improving on their writing.

The online peer assessment tool provided a good platform for peer review but overemphasised on the outcomes rather than processes

Both students and teachers reflected that whilst the online tool helped in scaffolding their learning, in that it provided a very systematic way of writing, reviewing, giving feedback to peers' comments, re-writing based on peers' comments, such a procedure seemed to gave them the perception that the ultimate aim was the final essay that they had written. The web-mediated peer assessment tool was particularly designed in such a way to support independent, self-directed learning. However, as Teacher6 commented, her students found it to be "tedious" to be giving comments, then commenting on each other's comments. Teacher3 too shared that conducting peer assessment in a cyclical approach was a common practice in the school, "we've always been doing this five cycle writing process, so the kid writes a first draft and then she gets, her friend will help her edit her work, and we usually give them things to look out for, so they don't just write things like "nice", "good handwriting", yah and then we give them like focused questions or items to look out for, like discrete grammar items". Whilst students may not always know what to do with the comments given, Teacher1 felt that what was important was that students learned about giving and receiving feedback from one another, reflecting that the learning process was more important than the outcomes. The perceived emphasis on the learning process rather than on the outcomes is perhaps one of the main things that would have be tweaked so that the online peer assessment tool could be more appropriately used to help secondary school students' learning.

As we could see from the findings above, conflicts and tensions arose not only due to the nature of the peer assessment activity, but may be attributed to the perceived and attached values that each individual teacher and student carry with them. These tensions and contradictions were also mediated by the affordances of the online tool, such as allowing for the peer assessment to be done anonymously, and by multiple peers. School culture and school values too seem to have a bearing over how students and teachers may perceive and experience the peer assessment activity.

5 Conclusion

Paradoxical tension exists in a relationship when there are both conflicting and converging interests. In presenting the paradoxical tensions experienced by teachers and students whilst carrying out the peer assessment, we hope that the findings would extend our thinking beyond the traditional and limited perspectives on web-based peer assessment and provide us with a better understanding of how we could better implement and facilitate such activities in the classrooms.

References

[1] Topping, K. J. (1998). Peer assessment between students in colleges and universities. *Review of Educational Research*, 68(3), 249-276.

[2] Topping, K. J. (2005). Trends in peer learning. *Educational Psychology*, 25(6), 631-645.

[3] Topping, K. J. (2009). Peer assessment. *Theory Into Practice*, 48, 20-27.

[4] Kaufman, J. H., & Schunn, C. D. (2011). Students' perceptions about peer assessment for writing: Their origin and impact on revision work. *Instructional Science*, 39, 387-406.

[5] Li, L. and Steckelberg, A. L. (2006). Perceptions of web-mediated peer assessment. Academic Exchange Quarterly, 10(2). 265-270.

[6] Orzolek, D. C. (2006). The paradox of assessment: Assessment as paradox [Electronic version]. Research and Issues in Music Education, 4. Retrieved April 1, 2011 from http://www.stthomas.edu/rimeonline/vol4/orzolek.htm

[7] Colwell, R. (2003). The status of arts assessment. Examples from music. *Arts Education Policy Review*, 105(2), 10-17.

[8] Andriopoulos, C. (2003). Six Paradoxes in Managing Creativity: An Embracing Act. *Long Range Planning*, 26, 375–388.

[9] Yang, Y.-F., & Tsai, C.-C. (2010). Conceptions of and approaches to learning through online peer assessment. *Learning and Instruction, 20*(1), 72–83.

[10] Zevenbergen, R. (2001). Peer assessment of student constructed posters: assessment alternatives in preservice mathematics education. *Journal of Mathematics Teacher Education*, 4 (2), 95-113.

[11] Beaman, R. (1998) The unquiet…even loud andragogy! Alternative assessments for adult learners. *Innovative Higher Education*, 23(1), 47-59.

[12] Bangert, A.W., (1995), Peer assessment: An instructional strategy for effectively implementing performance-based assessment, *Dissertation Abstracts International*, 56, 3505.

[13] Douchy, F., Segers, M., & Slujismans, D. (1999). The use of self-, peer and co-assessment in higher education: A review. *Studies in Higher Education*. 24 . 331-350.

[14] Lin, S. S. J., Liu, E. Z. F., & Yuan, S. M. (2002). Student Attitudes toward Networked Peer Assessment: Case Studies of Undergraduate Students and Senior High School Students. *International Journal of Instructional Media, 29*(2), 241-254.

[15] Hanrahan, S. and Isaacs, G. (2001). Assessing self- and peer-assessment: the students' views. *Higher Education Research and Development*, 20(1), pp.53-71.

[16] Liu, N. and Carless, D. (2006). Peer feedback: the learning element of peer assessment. *Teaching in Higher Education*, 11(3), pp.279-290.

[17] Cho, K. & MacArthur, C. (2010) Student revision with peer and expert reviewing. *Learning and Instruction*, 20, 328-338.

[18] Cho, K., & Schunn, C. D. (2007). Scaffolded writing and rewriting in the discipline: A web-based reciprocal peer review system. *Computers and Education*, 48(3), 409-426.

[19] Vanderhoven, E., Raes, A., Schellens, T., & Montrieux, H. (2012). Face-to-face peer assessment in secondary education: does anonymity matter? In Z. Bekirogullari (Ed.), *Procedia: Social & Behavioral Sciences,* 69, 1340–1347. Presented at the 3rd International Conference on Education & Educational Psychology (ICEEPSY 2012), Elsevier.

[20] Strijbos, J.-W. & Sluijsmans, D. (2010). Unraveling peer assessment: Methodological, functional, and conceptual developments. *Learning and Instruction*, 20(4), 265–269.

[21] Cheng, K. H. & Tsai, C. C. (2012). Students' interpersonal perspectives on, conceptions of and approaches to learning in online peer assessment. *Australasian Journal of Educational Technology,* 28(4), 599-618. Retrieved online from http://www.ascilite.org.au/ajet/ajet28/cheng-kh.html on April 1, 2014.

[22] Marton, F., & Booth, S. (1997). *Learning and Awareness*. New Jersey: Lawerence Erlbaum Associates.

Redesigning the Classroom Environment to Enhance Students' Collaborative Learning Activities

Fui-Theng Leow[1], Mai Neo[2]

[1] INTI International University, Nilai, Negeri Sembilan, Malaysia

fuitheng.leow@newinti.edu.my

[2] Multimedia University, Cyberjaya, Selangor, Malaysia

neo.mai@mmu.edu.my

Abstract Studies found that complex knowledge can be learned more effectively when students are engaged in a collaborative classroom environment. Therefore, conventional classroom learning should be redesigned into collaborative learning activities and study how students interact. In this study, Laurillard's conversational framework was used to redesign collaborative university classroom environment which centered at developing a multimedia project. Student comments and interaction were collected from open-ended questions and web 2.0 tools which were used in the interaction process, before analyzed by using Cecez-Kecmanovic and Webb's (2000) Communicative Model of Collaborative Learning (CMCL). Result showed that Laurillard's conversational framework was effective in redesigning the classroom to capture and reflect collaborative learning activities, and that the CMCL framework was a viable instrument in analyzing students' interaction in the collaborative learning activities. A flow diagram was developed to illustrate the pattern of conversation from Laurillard's conversation framework and the forms of teacher-students' interaction.

Keyboard Collaborative learning, web 2.0 tools, CMCL, Laurillard's conversational framework, university classroom environment, interaction

1 Introduction

As stated by Dembo and Seli [1] '…some of the strategies effective for learning basic knowledge may not be useful for learning more complex knowledge…' which explaining that complex knowledge needs to be obtained through a meaningful learning process for making sense of the information, solving problems and

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_37

then reflecting new meaning. This brings new roles for teachers and students in transforming classroom learning toward the collaborative learning activities.

21st century students are raised in the information-rich generation with digital media, mobile devices and Internet [2]. NMC Horizon Report highlighted that since year 2013, tablet computing becomes increasingly popular in higher education for online learning. Therefore, the learning environment and students' expectations are undergoing the evolutionary change [2, 3]. Current studies also found that the use of technologies and social tools has potential impact on teaching and learning, and becoming a trend in student learning and interaction. This pedagogical shift stimulated changes in teaching and learning approaches which make learning more meaningful [4, 5, 6].

Despite students in this digital era are more Internet savvy and experienced in using technologies in their daily activities [3]; however it was reported that problem solving skill and communication skill are the two most sought after but most difficult attributes to find in graduates skills set. Therefore, it caused the mismatch between the supply and demand in the employability of IHL graduates. This revealed that the role communication needs to be emphasized to enhance students' communication skill, problem solving skill and self-confidence through collaborative learning, before entering into the knowledge-driven industries [7].

2 Collaborative Learning

Researchers have increasingly recognized that collaborative learning is evolved from Vygotsky's social constructivist theory. Collaborative learning emphasizes on learning process whereby ideas are constructed through interacting with others in social context [6],[8],[9]. In this process, teachers act as facilitators to provide guidance, support and motivation to students, rather than just aiming for the completion [10]. Over the year, collaborative learning has become increasingly popular as an instructional approach, especially with the advantages of enhancing students' critical thinking skills, problem solving skills, and self-reflection through the collaborative learning activities [5, 6]. This is because collaborative learning engages students through discussion and enriches their learning experience instead of having students to merely answering exercise questions [8, 9].

In this study, collaborative learning that based on social constructivist concept is employed to redesign the university classroom learning environment. By encouraging the use of web 2.0 tools for facilitating the teacher-students' interaction processes, it aims to engage students in a networked learning community, to participate in collaborative learning activities, to construct a shared conception, and to develop an interactive multimedia application for solving the given problems.

3 Laurillard's Conversational Framework

According to Laurillard [11], learning is a complex process and she mentioned that '…there is no escape from the need for dialogue, nor for practice without description, nor for experimentation without reflection, nor for student action without feedback…' Laurillard developed a conversational framework for technologically mediated instruction, which emphasize on iterative dialog between teacher and students with relation to learning content [12]. This framework consists of four aspects of teaching and learning process: teacher's theoretical representation, student's conceptual representation, teacher's constructed environment, and student's goal-oriented actions. All are connected by four processes: discursive process, adaptive process, interactive process, and reflective process, to support and motivate students to go to next phase and remain iteration (see Fig. 1).

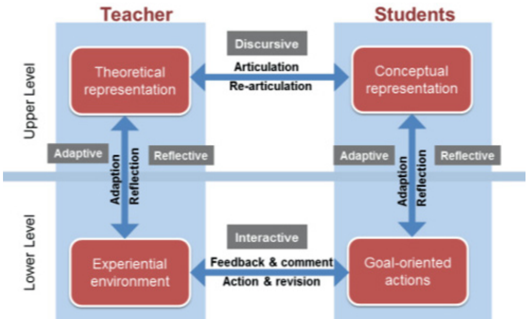


Fig. 1. Laurillard's Conversational Teaching and Learning Framework [11]

Laurillard recommended that the curriculum in higher education should engage individual with learner community to work on the project for creating new knowledge and gaining experience in the practice context [12]. In this study, Laurillard's conversational framework was used to redesign the university classroom learning environment, followed by analyzing how students interact with the peers and their course lecturer (who is also known as 'teacher' in this study) in the collaborative learning activities, which were also facilitated by the web 2.0 tools.

4 Redesigning Classroom Learning Environment

The classroom environment was redesigned for a multimedia subject offered to IT Degree students. They were required to form a project group to share experiences and learn to use multimedia software and media elements for developing a new interactive multimedia application to solve the given problems. They were also encouraged to use web 2.0 tools for communication and interaction. The group-based collaborative learning activities ran throughout the semester.

By referring to the pattern of conversation in Laurillard's conversational framework [11,12], the teacher-students' interaction among the four aspects of teaching and learning process is the main focus in this collaborative classroom environment. The flow diagram below (see Fig. 2) presents the patterns and interactions with the supporting web 2.0 tools, and these were divided according to three different teaching and learning processes.

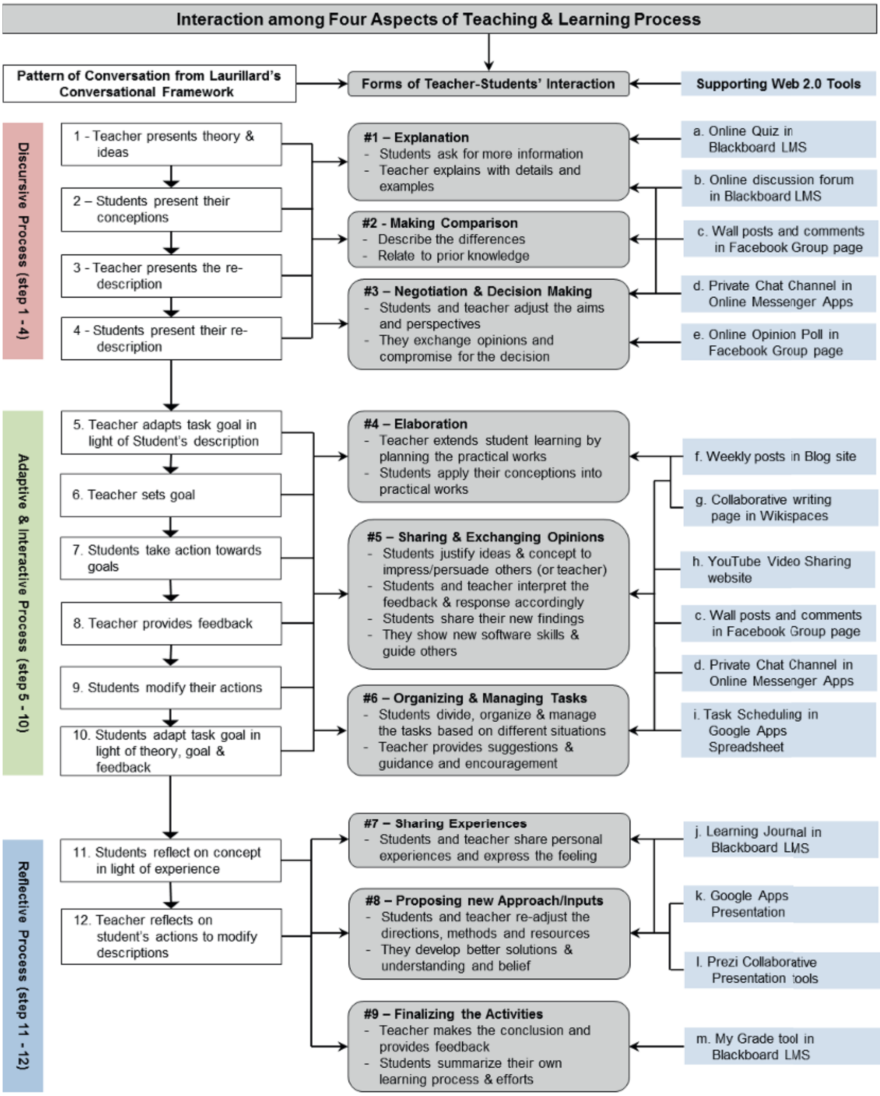


Fig. 2. Flow Diagram of the conversation and interaction in collaborative learning activities

5 Analyzing students' comments by using CMCL

The students' comments and interaction in web 2.0 tools were analyzed by using Communicative Model of Collaborative Learning's (CMCL) [13] dimensions [14]. This framework was developed based on Habermas' theory of communicative action, and built along two dimensions: three knowledge domain, and three dominant orientations, which are interwoven to produce nine dimensions in distinguishing between where students are coming from, and when they place their focus of attention in the collaborative learning processes [13, 14] (see Table 1).

Table 1. Framework of CMCL and students' comments

Oriented to	Subject Matters (1)	Norms & Rules (2)	Personal Experience (3)
Learning (A)	1. "*We discuss again and again…to enhance the better understanding....*" 2. "*…teach each other technique…can learn faster…*"	2. "*…we will find the best solution through negotiating…*" 4. "*…shared a conversation box in Facebook to update the latest information…*"	5. "*…spend time to design…I am happy that we learn something new...*" 6. "*…learnt to be flexible in my communication and adapt it…*"
Achieving Ends (B)	7. "*I share knowledge… get high mark from group…*" 8. "*…we want to gain knowledge…come up with a great design…*"	9. "*…we separated tasks…they were started their own jobs…*" 10. "*We made a plan and schedule the timeline activities…*"	11. "*…achieved the goal that we have set earlier…*" 12. "*…finishing the project faster, compared with doing alone…*"
Self-representation & Promotion (C)	13. "*…doing self-study helps me to understand…enhance skills…*" 14. "*…I contributing ideas …attended meeting...*"	15. "*…know very well of our group mate…solve the problem among us...*" 16. "*I was the driving force in the project…*"	17. "*…manage to complete…I feel proud…*" 18. "*…can absorb the ideas and get different ideas…*"

Based on student comments, the interpretation can be divided into 9 dimensions:

A1 – When oriented to learning and focused on subject matters, students were able to gain better understanding through **discussing and interacting** with others.

A2 – When oriented to learning and focused on norms and rules**,** students **collected feedback and opinions** to refine misconceptions and enhance consistency.

A3 – When oriented to learning and focused on personal experiences, students exchanged experiences and **synchronize their actions** for mutual understanding.

B1 – When oriented to achieving ends and focused on subject matters, students **devoted efforts**, **overcome difficulties**, and **find resources** to complete the tasks.

B2 – When oriented to achieving ends and focused on norms and rules, students **delegated tasks and standardized methods** to complete with more efficiency.

B3 – When oriented to achieving ends and focused on personal experiences, students **felt more motivated and engaged as they shared the goal together**.

C1 – When oriented to self-representation and focused on subject matters, students **enhanced their own hard skills and knowledge** to contribute in the tasks.

C2 – When oriented to self-representation and focused on norms and rules, students **demonstrated leadership skills** in organizing and coordinating the tasks.

C3 – When oriented to self-representation and focused on personal experiences, students were **motivated to participate in activities to show their strengths**.

6 Discussion

1. In the **discursive process**, both teacher and students articulated their understanding on the concepts and problems to be solved. As shown in Fig.2, this discursive process involves four patterns of conversation and has stimulated different forms of teacher-students' interaction. This paper discussed the most common form of interaction, which is **Interaction #3 – negotiation and decision**, and students commented that*: "we will find out the best solution through negotiating…"*, *"…shared a conversation box in Facebook to update the latest information…"*. This form of interaction shows that teacher plays a role in initiating students' interaction by gaining their attention to learn something new and encouraging them to produce an outcome. As analysed by CMCL, it can be noticed that this form of interaction mostly involves standardizing the differences and collecting the opinions from everyone to gain mutual understanding. Therefore, this form of interaction can be categorized with the dimension of A1, A2 and B2; when students were more oriented to learning and concerning about each other's understanding, their efforts moved towards collecting quality ideas and inputs for developing the interactive multimedia application, and for setting up the work mode and rules. As for mediating this form of interaction, the appropriate web 2.0 tools were those tools with the features of allowing everyone to take turn in exchanging opinions systematically and constructively. These include online polling tool, online chat messenger, and social networking website, so that besides face-to-face mode, both teacher and students could have a proper space to extend their interaction for developing mutual understanding.

2. In the **adaptive and interactive process**, both teacher and students provided and responded to the feedback based on the actions taken, particularly in developing the interactive multimedia application. As shown in Fig.2, this adaptive and interactive process involves six patterns of conversation, and has encouraged different forms of teacher-students' interaction. Among these, the **Interaction #5 –**

Sharing & Exchanging Opinions was discussed in this paper, and some student commented that*: "we discuss again…to enhance the better understanding....",* *"…we want to gain knowledge…come up with a great design…", "…I contributing ideas …attended meeting...".* It was observed that the students were more interested in interpreting the collected resources and became more active with feedback given in a practical environment when they could also find the relevance in their learning process, especially with the teacher plays the mediating role in gaining students' understanding on their expectation. The analysis with CMCL shows that this form of interaction focused on the dimension of A1, B1, C1, which means that students were more concerned on learning new knowledge or aiming to achieve a successful goal, so that they tend to spend more effort in gaining new ideas, enhancing new capabilities, or building new skills to fit into the development and personal understanding. The study also suggested that various web 2.0 tools that support 2-way real-time responses can be effective in expanding and making the interactive process borderless, such as using online chat messenger and social networking website to describe their new inputs, and then inspiring others to take part for more enhancements or though-provoking discussions.

3. In the **reflective process**, both teacher and students adjusted and updated their concepts and understanding with the experiences and results gained from the practical environments. As shown in Fig.2, this reflective process involves two patterns of conversation, and has stimulated different forms of teacher-students' interaction with different focuses. The **Interaction #7 – Sharing Experiences** was the most responded form of interaction, such as students commented that*: "…learnt to be flexible in my communication and adapt it…", "…can absorb the ideas and get different ideas…"* Feedback shows that this reflective process encouraged students to willingly share their experience and feeling in all situations, such as to describe the difficulties faced, or show the proudness of own abilities. As analysed by CMCL, the dimension of A3, B3 and C3 can be used to categorize the feedback from this interaction, indicating that students were able to express in the peer learning or achieving a goal or self-promotion, for motivating and engaging with others to identify their similarities and enhance the engagement, before working together as a developer team. The study also shows that with the use of online learning journal, students could be provided with a virtual space for further expression and extending other's thoughts.

7 Conclusion

In this study, the collaborative activities in this classroom environment which designed by using Laurillard's conversational framework had enabled different forms of teacher-students' interaction and transform students to be the active learners who are capable to develop their skills, engage with others, and gain more learning experiences and positive learning attitudes. This study concluded that Laurillard's conversational framework can be used to redesign collaborative university classroom environment effectively, and that the CMCL framework was a viable instrument to analyze students' communicative practices in a collaborative learning activities. These results provide positive and encouraging support for redesigning university classrooms to reflect and capture collaborative learning activities that engage and enhance the student learning process.

8 References

1. Dembo, M.H. & Seli, H.: Motivation and Learning Strategies for College Success: A Focus on Self-Regulated Learning. NY: Erlbaum (2012)
2. Chisanu, J., Sumalee, C., Issara, K., & Charuni, S.: Design and Develop of Constructivist Learning Environment on Learning Management System. Procedia - Social and Behavioral Sciences, 46, 3426–3430. doi:10.1016/j.sbspro.2012.06.07 (2012)
3. Johnson,L., Adams Becker,S., Estrada,V., & Freeman,A.: NMC Horizon Report: 2014 Higher Education Edition. Austin, Texas: New Media Consortium (2014)
4. Mcloughlin,C. & Lee, M.J.W.: Personalised and self-regulated learning in the Web 2.0 era : International exemplars of innovative pedagogy using social software. Australasian Journal of Educational Technology, 26(1), pp. 28–43 (2010)
5. Garcia, P.G.: Collaborative Learning Activities in Online Courses: Issues and Strategies. ASEAN Journal of Open Distance Learning, 4(1) (2012)
6. Chiong, R. & Jovanovic, J.: Collaborative Learning in Online Study Groups: An Evolutionary Game Theory Perspective. Journal of Information Technology Education, vol. 11, pp. 81-101 (2012)
7. Ministry of Higher Education Malaysia: The National Graduate Employability Blueprint 2012-2017. Ministry of Education, Malaysia (2012)
8. Pun, S. K.: Collaborative Learning: a Means to Creative Thinking in Design. International Journal of Education and Information Technologies, 6(1), pp. 33-43 (2012)
9. Tiantong, M. & Siksen, S.: The Online Project- based Learning Model Based on Student's Multiple Intelligence. International Journal of Humanities and Social Science, 3(7), pp. 204–211 (2013)
10. Vygotsky, L.S.: Speech and thinking, in L.S. Vygotsky, Collected Works, 1, N. Minick, Tr. New York: Plenum (1987)
11. Laurillard, D.: Rethinking University Teaching: A Conversational Framework for the Effective Use of Learning Technologies, 2nd edition. London: RoutledgeFalmer (2002)
12. Laurillard, D.: Rethinking University Teaching in the Digital Age (2002)
13. Cecez-Kecmanovic, D. & Webb, C.: Towards a communicative model of collaborative web-mediated learning. Australian Journal of Educational Technology, 16(1), pp. 73-85 (2000)
14. Treleaven, L.: Drowning in information: evaluating web-mediated collaborative learning. In Winds of change in the sea of learning : proceedings of the 19th Annual Conference of ASCILITE, pp. 8–11 (2002)

Relations between Student Online Learning Behavior and Academic Achievement in Higher Education: A Learning Analytics Approach

Il-Hyun Jo[1], Taeho Yu[2], Hyeyun Lee[1,*] and Yeonjoo Kim[1],

[1] Department of Educational Technology, Ewha Womans University, Seoul
ijo@ewha.ac.kr, {hyeyun521,aoao1992}@naver.com
[2] Purdue University, IN, USA
yu134@purdue.edu

Abstract. The purpose of this study is to suggest more meaningful components for learning analytics in order to help learners to improve their learning achievement continuously through an educational technology approach. 41 undergraduate students in a women's university in South Korea participated in this study. The seven-predictor model was able to account for 99.3% of the variance in the final grade, $F_{(8, 32)} = 547.424$, $p < .001$, $R^2 = .993$. Total login frequency in LMS, (ir)regularity of learning interval in LMS, and total assignments and assessment composites had a significant ($p < .05$) correlation with final grades. However, total studying time in LMS (ß=.038, t=.868, p > .05), interactions with content (ß=-.004, t=-.240, p > .05), interactions with peers (ß=.015, t=.766, p > .05), and interactions with instructor (ß=.009, t=.354, p > .05) did not predict final grades. The results provide a rationale for the treatment for student time management effort.

Keywords: Learning analytics, Educational technology, Higher education, E-learning.

1 Introduction

Learning analytics have received significant attention from educators and researchers in higher education since its inception [6, 14, 33]. The main concept of learning analytics is quite attractive in that by means of this concept instructors can predict their students' learning outcomes in advance through use of big data mining technology. To produce a fast and precise prediction, the pioneers of learning analytics, such as Baylor University, the University of Alabama, Northern Arizona University, and Purdue University, have considered diverse exogenous variables such as SAT scores, cumulative GPA, and high school GPA as a significant component of their learning analytics models [6]. In fact, it has

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_38

been verified that these variables are significant factors when predicting students' learning outcomes from the previous research. However, these variables cannot be improved by students' current efforts because these are past-oriented variables. For this reason, it is important to provide precautionary interventions with present-oriented controllable variables, which can be improved by each learner's effort, for individual learners to support their learning process [19].

In the process of integrating education and technology, a new learning environment has been created and a variety of controllable variables can be collected. For instance, students login into a Learning Management System (LMS) to take online courses or to download course materials. Whenever students utilize the Internet, computers, or LMS, many log files are recorded [4, 15]. We can understand the current status of students' learning and even predict their possible learning achievements in a course by analyzing those log data which they leave within the database. In other words, those log data are the core source to generate controllable variables such as: a) total studying time in LMS, b) total login frequency in LMS, c) (ir)regularity of learning interval in LMS, d) interactions with content, instructor, and peers, e) assignments and assessment composite, and f) discussion composite.

Since the concept of learning analytics was derived from business analytics, prediction of learning outcomes became a major area of learning analytics [14, 33]. However, the main purposes should be different between learning analytics and business analytics. Learning analytics should pay greater attention to students and the improvement of their processes toward learning achievement, whereas the main focus of business analytics is to maximize a profit through the prediction of customer's behaviors and patterns [14]. Therefore, this study determines which controllable components need to be included in learning analytics in order to help learners to continuously improve their learning achievements through an educational technology approach.

2 Review of the Literature

2.1 Learning Analytics

Learning analytics has been defined by different researchers since its emergence in education. Elias [14] defines learning analytics as a process of data gathering, information processing, knowledge application, and sharing for the improvement of teaching and learning. Johnson et al. [15] defines learning analytics as "the interpretation of a wide range of data produced by and gathered on behalf of students in order to assess academic progress, predict future performance, and spot potential issues" (p. 28). In addition, Brown [4] describes it as collecting and analyzing "the usage data associated with student learning" (p. 1) to provide actionable interventions for students by observing and understanding learning behaviors. Learning analytics also refers to a student success management system with warranted interventions that operates by collecting and analyzing data from the Learning Management System (LMS) and Student Information System (SIS) [2]. In addition, learning analytics refers to "the use of predictive modeling and other advanced analytic techniques to help target instructional, curricular and support resources to support the achievement of specific learning goals (p. 2)" [3].

There are other attempts to define learning analytics through the educational technology approach. Jo, Kang, Yoon, and Kang [17] define learning analytics as a "systematic understanding of each learner's educational needs and prepared customized instructional strategy and contents by collecting, analyzing, and systematizing learner's data especially from LMS" (p. 3). Jo and J. Kim [18] have pointed out that learning analytics is an emerging field that applies the prediction model identified in educational systems. Furthermore, Jo [16] introduces the Learning Analytics for Prediction and Action (LAPA) model as shown in Figure 1. In his paper, he indicates that it is possible to provide a prompt and personalized educational opportunity to both the student and instructor in accordance with their level and needs though learning analytics with an educational technology approach.

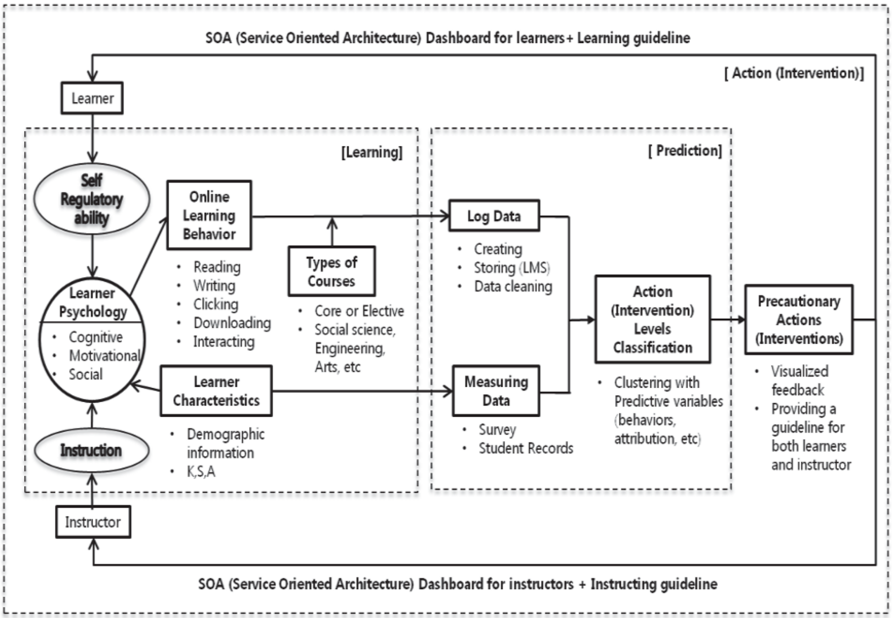


Fig. 1. LAPA (Learning Analytics for Prediction & Action) Model (Jo, 2012).

According to Jo [16], LAPA consists of three segments, identified as learning, prediction, and action (intervention). The first segment presents the learning process with six specific components, i.e. the learner's self-regulatory ability, learner psychology, instruction, online learning behavior, learner characteristics, and types of courses. In the second segment, predicting student's learning achievements and classifying action (intervention) levels are implemented by analyzing log data and measuring data. Finally, precautionary actions (interventions) are provided through the Service Oriented Architecture (SOA) dashboard and guideline for both learners and instructors.

Although learning analytics has various definitions created by different researchers, there is some common ground in these definitions, such as big-data mining, predicting future performance, providing interventions, and improving teaching and learning. Thus, in this study, learning analytics refers to the process of predicting academic performance and providing meaningful interventions with educational big-data mining for students to improve their learning achievement continuously.

2.2 Controllable Variables for Learning Analytics with an Educational Technology Approach

Non-Controllable Variables for Learning Analytics. Numerous non-controllable variables have been determined to be influential factors in terms of learning achievement. Much research has indicated the existence of highly positive correlations between high school GPA and SAT scores and learning outcomes in both face-to-face and online learning environments [1, 5, 7, 22, 25, 31]. Individual student characteristics, such as age, residency, gender, or race, are also determined to be significant factors that are positively related to academic achievement [1, 5, 7]. Other research has investigated the effect of socio-economic variables on students' academic outcomes. Allen [1] argued that the parents' financial and affective support impacts students' learning achievements. Campbell [5] found that a negative relationship existed between the amount of aid and learning outcomes. However, these variables are not changeable despite the learners' efforts and educators' interventions.

Controllable Variables for Learning Analytics. Based on the literature review, this study pays greater attention to the variables that can be improved in an educational technology approach, which are as follows: a) total studying time in LMS, b) total login frequency in LMS, c) (ir)regularity in the learning interval in LMS, d) interactions with instructor, e) interactions with peers, f) interactions with content, g) assignments and assessment composite, and h) discussion composite.

For total studying time in LMS, Rau and Durand [29] and Thurmond el al. [32] determined that total studying time was a significant predictor for GPA. In both studies, the total amount of time spent between login and logout in LMS was considered as the total studying time in LMS. In addition, Piccoli, Ahmad, & Ives [28] argued that when learners login frequently into LMS, they become more satisfied with online learning. In addition, Kang, Kim, and Park [23] confirmed that total login frequency in LMS is positively related to learning performance and attendance rate. To generate the variable of total login frequency in LMS, these researchers totaled the amount of each student's login time. With respect to the (ir)regularity of learning interval in LMS, Jung, Jo, and Lim [20] introduced the (ir)regularity of learning interval in LMS as a significant factor that is positively related to a distance learner's learning outcomes with online courses. In their study, they used the standard deviation of average login time into the LMS to calculate the (ir)regularity of learning interval. Moore [26] also confirmed that the (ir)regularity of learning interval positively correlated with learning achievement even in the traditional face-to-face class setting.

In addition, Swan [30] found positive relationships existent between interactions with content, instructor, and peers and student satisfaction and perceived learning. Jung et al. [21] also insisted that academic, collaborative, and social interaction have an effect on learning satisfaction, participation, and attitude towards online learning. The positive correlations between attendance rate and learning outcomes have been supported by a number of studies [9, 10, 12, 13, 26, 27]. These studies verified that attendance rate has a significant effect on learning outcomes in both an online learning environment and the traditional face-to-face class setting. Last, but not least, assignments, assessment, and discussion composites are determined to be important components in the prediction of learners' academic achievements [5, 7, 32]. Since final grades tend to consist of a variety of assignments, assessment, and discussion composites, it is natural that these variables are considered as a significant factor with learning outcomes.

In sum, this study suggests eight controllable variables for learning analytics, as shown in Table 1. These controllable variables are more meaningful in terms of educational technology because these are actionable and changeable based on a learner's effort.

Table 1. Eight suggested controllable variables for learning analytics on the ground of the educational technology approach

Number	Suggested variables	Relations with learning achievement
1	Total studying time in LMS	Positive
2	Total login frequency in LMS	Positive
3	(Ir)regularity of learning interval in LMS	Positive
4	Interactions with instructor	Positive
5	Interactions with peers	Positive
6	Interactions with content	Positive
7	Assignments and assessment composite	Positive
8	Discussion composite	Positive

3 Research Questions

The purpose of this study is to suggest more meaningful components for learning analytics by which to assist learners improve their learning achievement continuously within an educational technology approach. The specific research questions that will be addressed in the study are:

1. What are the correlations among the eight suggested independent variables and learners' academic achievements?

2. Do the eight suggested independent variables (IV1: Total studying time in LMS, IV2: Total login frequency in LMS, IV3: (Ir)regularity of learning interval in LMS, IV4: Interactions with instructor, IV5: Interactions with peers, IV6: Interactions with content, IV7: Assignments and assessment composite, and IV8: Discussion composite) predict learners' academic achievements?

4 Methods

4.1 Research Context

The participants in this study were 41 undergraduate students who were participants in a face-to-face course entitled 'Organizing Behavior and Leadership' respectively. This course had the following features: a) it was a three credit core course for undergraduate students offered by the department of Science of Public Administration, b) the instructor taught the course during the spring semester 2013 for 16 weeks, c) 20% of the final grade was assigned for online discussion participation in the Learning Management System (LMS), and d) the students used LMS to download course materials, including the syllabus or assigned readings. All of these participants are female students since this is a women's university.

4.2 Data Collection

Seven independent variables among the eight suggested controllable variables. The entirety of the web-log data was collected by means of the Moodle-based Learning Management System (LMS), and the independent variables for this study, as shown in Table 2, were computed by an automatic data collection module embedded in the LMS. First, total login frequency in LMS was calculated by collecting the amount of each student's login time into the LMS. Second, total studying time in LMS was computed by calculating the total amount of time spent between login and logout. Third, the (ir)regularity of learning interval in LMS was computed by calculating the standard deviation of average login time into the LMS, which calculated through use of the same method that Kim [24] executed in her research. Fourth, interactions with content were computed by adding up the number of downloaded course materials. Fifth and sixth, interactions with the instructor and peers were calculated separately by counting the total number of each student's postings in response to the instructor and peers. Seventh, total assignments and assessments composite were computed by adding up all of the scores for assignments and assessment in the course, excluding the attendance rate. Last, to avoid using duplicated variables, discussion composites were also removed from the independent variables because the level of online discussion participation was computed by counting the total number of students' response postings to the instructor and peers.

Table 2. Data collecting methods for each independent variable

Number	Suggested independent variables	Data collecting methods
1	Total login frequency in LMS	Adding up the number of individual student's login time into the LMS
2	Total studying time in LMS	Calculating the total amount of time spent between login and logout
3	(Ir)regularity of learning interval in LMS	Calculating the standard deviation of average login time into the LMS
4	Interactions with content	Adding up the numbers of course materials downloaded
5	Interactions with peers	Counting the total number of student's postings when responding to peers
6	Interactions with instructor	Counting the total number of student's postings when responding to instructor
7	Total assignments and assessment composite	Adding up all scores for assignments and assessment in the course

Dependent variable. Final grades were collected as a dependent variable in this study. A data matching process between independent variables and final grades was executed automatically in the database system. The student's final grade was considered to be the same as that learners' academic achievement because it was synthetically computed from several course components, such as midterm and final exam scores, attendance score, case study report score, and participation score in online discussions.

4.3 Data Analysis

A multiple linear regression analysis was conducted by using Statistical Package for the Social Sciences (SPSS, version 21). Modeling the relations between the explanatory variables and response variables is the main purpose of conducting multiple linear regression [8]. In other words, multiple linear regression analysis is an appropriate statistical method to determine which factors influence changes to the dependent variable [11]. For this reason, this study implemented a multiple linear regression analysis with the seven independent variables, as described above, and with final grades as a dependent variable.

5 Results

5.1 Descriptive Statistics

Table 3 illustrates the descriptive statistics (i.e. the minimums, maximums, means, and standard deviations) for the six independent variables and the dependent variable in this study. It reveals that participating students logged into the LMS 252 times and studied for 34 hours in LMS on average in a semester. There were huge variations in the total login frequency in LMS (M=252.93, SD=110.99, Min=70, Max=604) and total studying time in LMS (M=123,776, SD=70,218, Min=33,389, Max=373.938) among students. The minimum of (ir)regularity of learning interval in LMS was 5.82, whereas the maximum was 72.84. The average number of downloads and the number of postings responding to peers was 36.41 and 2.51 respectively. The students' final grades were distributed between 43.97 and 89.37, and the mean was 81.95.

Table 3. Descriptive statistics of seven independent variables and a dependent variable

	Minimum	Maximum	Mean	S.D.
IV1: Total login frequency in LMS	70	604	252.93	110.99
IV2: Total studying time in LMS	33,389	373,938	123,776	70,218
IV3: (Ir)regularity of learning interval in LMS	5.82	72.84	18.27	10.53
IV4: Interactions with content	5	60	36.41	11.73
IV5: Interactions with peers	0	15	2.51	2.87
IV:6 Interactions with instructor	0	64	14.90	13.98
IV7: Total assignments and assessment composite	36.97	79.37	66.57	10.45
DV: Final grade	43.47	89.37	75.52	11.83

5.2 Multiple Linear Regression Analysis

A multiple linear regression analysis was conducted to develop a model for predicting students' academic achievement based on their total studying time in LMS, total login frequency in LMS, (ir)regularity of learning interval in LMS, interactions with instructor, interactions with peers, interactions with content, and total assignments and assessment composite. Results of this multiple linear regression analysis are illustrated in Table 4. The seven-predictor model provided justification for 99.3% of the variance in the final grade, $F(8, 32) = 547.424$, $p < .01$, $R2 = .993$. Total login frequency in LMS, (ir)regularity of learning interval in LMS, and total assignments and assessment composite had a significant ($p < .05$) correlation with final grades. However, total studying time in LMS (ß=.038, t=.868, $p > .05$), interactions with content (ß=-.004, t=-.240, $p > .05$), interactions with peers (ß=.015, t=.766, $p > .05$), and interactions with instructor (ß=.009, t=.354, $p > .05$) were not essential in the final grade prediction.

Table 4. Results of multiple linear regression analysis

	Unstandardized Coefficients		Standardized Coefficients		
	B	Std. Error	Beta	t	Sig.
(Constant)	11.741	1.787		6.572	.000
IV1	-.007	.002	-.064	-2.791	.009
IV2	.000	.000	.038	.868	.392
IV3	-.156	.025	-.139	-6.335	.000
IV4	-.004	.016	-.004	-.240	.812
IV5	.060	.079	.015	.766	.449
IV6	-.007	.021	.009	.354	.726
IV7	1.034	.023	.955	44.487	.000
R^2 (adj. R^2) =.335(.283), F=6.457, p = .000					

a. Dependent Variable: Final grade

6 Discussion

Based on the multiple linear regression analysis, total login frequency in LMS, (ir)regularity of learning interval in LMS, and total assignments and assessment composite were determined to be significant factors for students' academic achievement in an online learning environment. As the course selected for this study is a face-to-face course that used the Learning Management System for limited purposes, such as participating in online discussions or downloading course materials, these results present a positive potential for the variables to predict the students' academic achievements consistently. Moreover, the significant negative correlation between (ir)regularity of learning interval in LMS and final grade explains that students who study more regularly are likely to achieve higher learning outcomes. Since (ir)regularity of learning interval in LMS is computed by calculating the standard deviation of average login time into LMS, then a lower (ir)regularity of learning intervals in LMS indicates an increased regularity in the study pattern.

The findings of this study also confirm that total login frequency in LMS and tendencies toward regularly studying have a greater significant effect on students' academic achievement than does the total studying time. In addition, there is an interesting finding, which is that interactions with instructor, peers, and content have no significant correlation with the students' final grades. Student-instructor interaction has been empirically evidenced and theoretically supported by previous studies. However, since it was a student-centered discussion, and thus there were significantly low numbers of interaction researched between instructor and students, statistical analysis has failed to detect the potential effect in this study. Finally, the assignments and assessments, such as the mid-term and final exam, writing essays, and online discussion, compose the main components of final grades in this course. Thus, the highly significant relationships between the assignments and assessment composites and the students' final grades were natural.

7 Conclusion

The purpose of this study is to suggest more meaningful components for learning analytics to help learners improve their learning achievement continuously in terms of an educational technology approach. The regression model with only controllable variables that can be affected by learners' efforts was able to account for 99.3% of the variance in students' academic achievement. The main focus of learning analytics tends to focus on the prediction of the future learning outcome by adding geographical, demographical, or characteristic factors, such as high school GPA, SAT score, age, or residency. However, these factors are not controllable because they were fixed in the past and given to the instructional setting. For this reason, this study tested seven controllable variables for our learning analytics model and confirmed that three of them were significantly correlated with the learning final grade. Moreover, these three variables not only predict learning outcomes significantly but also can be improved if learners put more effort into the educational process. The advantage of learning analytics using big-data mining is to predict students' future performance. Yet since the subject is students and not financial profit, educators should pay more attention to improving the process of learners' achievement rather than predicting achievement itself. However, this study was merely conducted with a single face-to-face course within a women's university in South Korea. In addition, a discussion composite was not added as an independent variable for this study because of the research context. Thus, more research should be implemented using various course subjects, different learning environments, and diverse participants with different school settings, ages, sex, nationalities, and level of student-instructor interactions.

References

[1] Allen, D. 1999. Desire to finish college: an empirical link between motivation and persistence. *Research in Higher Education, 40*(4), 461-485.

[2] Arnold, K. E. 2010. Signals: Applying Academic Analytics. *EDUCAUSE Quarterly, 33*(1).

[3] Bach, C. 2010. *Learning Analytics: Targeting Instruction, Curricula and Student Support*. Office of the Provost, Drexel University.

[4] Brown, M. 2011. Learning Analytics: The Coming Third Wave. *EDUCAUSE Learning Initiative Brief*, Retrieved from http://www.educause.edu/Resources/LearningAnalyticsTheComingThir/227287.

[5] Campbell, J. P. 2007. *Utilizing student data within the course management system to determine undergraduate student academic success: An exploratory study*. Unpublished doctoral dissertation: Purdue University.

[6] Campbell, J. P., DeBlois, P. B., and Oblinger, D. G. 2007. Academic analytics: A new tool for a new era. *EDUCAUSE Review, 42*(4), 40-42.

[7] Campbell, and Oblinger, D. 2007. *Academic analytics*. Washington, DC: EDUCAUSE Center for Applied Re-search.

[8] Cohen, J., Cohen P., West, S.G., and Aiken, L.S. 2003. *Applied multiple regression/correlation analysis for the behavioral sciences*. (2nd ed.) Hillsdale, NJ: Lawrence Erlbaum Associates.

[9] deJung, J. E., and Duckworth, K.1986. Measuring student absences in the high schools. Paper presented at *The Annual Meeting of the American Educational Research Association*, San Francisco, CA.

[10] Donathan, D. A.2003. The correlation between attendance, grades, and the nontraditional student, *Business Education Forum, 58*(1), 45-47.

[11] Draper, N.R., & Smith, H. 1998. *Applied Regression Analysis* (3rd ed.). John Wiley. ISBN 0-471-17082-8.

[12] Druger, M.2003. Being there: A perspective on class attendance, *Journal of College Science Teaching, 32*(5), 350-351.

[13] Friedman, P., Rodriguez. F., and McComb, J. 2001. Why students do and do not attend classes: myths and realities. *College Teaching, 49*(4), 124-133.

[14] Elias, T. 2011, January. *Learning Analytics: Definitions, Processes, and Potential. Creative Commons*. Retrieved from http://learninganalytics.net/LearningAnalyticsDefinitionsProcessesPotential.pdf.

[15] Johnson, L., Smith, R., Willis, H., Levine, A., and Haywood, K. 2011. *The 2011 Horizon Report*. Austin, Texas: The New Media Consortium. Retrieved from http://www.nmc.org/pdf/2011-Horizon-Report.pdf.

[16] Jo, I. 2012. On the LAPA (Learning Analytics for Prediction & Action) Model suggested. *Future Research Seminar*. Korea Society of Knowledge Management. Seoul.

[17] Jo, I., Kang, Y., Yoon, M., and Kang, M. 2012, Fall. Development of cluster-specific learning prediction models: A learning analytics approach, Paper presented at *the HYCU International Conference*, Seoul, Korea.

[18] Jo, I., and Kim, J. H. 2013. Investigation of Statistically Significant Period for Achievement Prediction Model in e-Learning. *The Journal of Educational Information and Media, 29*(2), 285-306.

[19] Jo, I. and Kim, Y. 2013. Impact of Learner's Time Management Strategies on Achievement in an e-learning Environment: A Learning Analytics Approach. *The Journal of Educational Information and Media, 29*(2), 285-306.

[20] Jung, N., Jo, I., and Lim, K. Y. 2003. Study of Influential Factors on Student's Learning Management System (LMS) Usage and Achievement: Focused on Role of Student's Self-regulated Learning Ability and Reality of Assignments. Proceeding at *The Korea Society of Management Information Systems Conference*, Seoul: Korea.

[21] Jung, I., Choi, S., Lim, C., and Leem, J. 2002. Effects of Different Types of Interaction on Learning Achievement, Satisfaction and Participation in Web-Based Instruction. *Innovations in Education and Teaching International, 39*(20), 153-162.

[22] Kahn, J. H. and Nauta, M. M. 2001. Social-cognitive Predictors of First-year College Persistence: The Importance of Proximal Assessment. *Research in Higher Education, 42*(6), 633-652.

[23] Kang, M., Kim, J., and Park, I. 2009. The examination of the variables related to the students' e-learning participation that have an effect on learning achievement in e-learning environment of cyber university. *Journal of Korean Society for Internet Information, 10*(5), 135-143.

[24] Kim, Y. 2011. *Learning time management variables impact on academic achievement in corporate e-learning environment*. Master's thesis. Ewha Womans University, Seoul.

[25] McGrath, P. A., and Braunstein, A. 1997. The prediction of freshmen attrition: An examination of the importance of certain demographic, academic, financial, and social factors. *College Student Journal, 31*, 396-408.

[26] Moore, R. 2003. Attendance and performance: How Important is It for Students to Attend Class? *Journal of College Science Teaching, 32*(6), 367-371.

[27] Moore, R., Jensen, M., Hatch, J, Duranczyk, I., Staats, S., and Koch, L. 2003. Showing up: The importance of class attendance for academic success in introductory science courses. *American Biology Teacher, 65*(5), 325-329.

[28] Piccoli, G., Ahmad, R., and Ives, B. 2001. Web-based virtual learning environments: A research framework and a preliminary assessment of effectiveness in basic IT skill training. *MIS Quarterly, 25*(4), 401.426.

[29] Rau, W., and Durand, A. 2000. The academic ethic and college grades: Does hard work help students to "make the grade"? *Sociology of Education*, 19-38.

[30] Swan, K. 2001. Virtual interaction: Design factors affecting student satisfaction and perceived learning in asynchronous online courses. *Distance Education, 22*(2), 306-331.

[31] Thompson, J. M. 1998. Developmental students in higher education: Path analysis of a national sample. *College Student Journal, 32*, 499-510.

[32] Thurmond, V. A., Wambach, K., and Connors, H. R. 2002. Evaluation of student satisfaction: Determining the impact of a web-based environment by controlling for student characteristics. *The American Journal of Distance Education, 16*(3), 169.189.

[33] Van Barneveld, A., Arnold, K. E., and Campbell, J.P. 2012. *Analytics in Higher Education: Establishing a Common Language* (white paper). Boulder, CO: EDUCAUSE Learning Initiative.

Smart Learning Analytics

David Boulanger[1], Jeremie Seanosky[1], Vive Kumar[1], Kinshuk[1], Karthikeyan Panneerselvam[2], Thamarai Selvi Somasundaram[2]

[1] Athabasca University, Athabasca, Canada
david.boulanger@dbu.onmicrosoft.com
[2] Anna University, Chennai, India

Abstract. A smart learning environment (SLE) is characterized by the key provision of personalized learning experiences. To approach different degrees of personalization in online learning, this paper introduces a framework called SCALE that tracks finer level learning experiences and translates them into opportunities for custom feedback. A prototype version of the SCALE system has been used in a study to track the habits of novice programmers. Growth of coding competencies of first year engineering students has been captured in a continuous manner. Students have been provided with customized feedback to optimize their learning path in programming. This paper describes key aspects of our research with the SCALE system and highlights results of the study.

Keywords: SCALE framework · smart learning environment · programming · e-learning technologies · novice programming · big data learning analytics

1. Introduction

Smart learning could mean customized learning that optimizes learning pathways, engages learners in positive interactions and guides instruction in a goal-oriented fashion. While the why (optimal learning through customization), where (ubiquitous learning interactions), and how (technologies for goal-oriented learning) of smart learning environments are rather obvious at a coarser level, the degree of customization, the scalability of ubiquity, and the integration of learning-related data are still key challenges facing educational technologists. Smart learning environments encompass traditional classrooms as well as online and distance education. Taking learning anywhere and everywhere in a consistent fashion requires technologies that move such as the smart phones supported by 3G and 4G networks [4] as well as learning environments that move such as the flipped classrooms at homes. To provide context-aware learning, hardware and software sensors are necessary to recognize the context and the learning needs of the user to tailor learning content and activities. Smart learning environments are expected to be highly distributed and cloud-based to accommodate federated and goal-oriented study activities. To make a smart learning environment context-aware, technologies need to collaborate seamlessly and purposefully in order to recognize the context, translate the knowledge of the context in a proper learning recommendation and provide learning materials based on that recommendation. [9] provides an

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_39

interesting description of a context in e-learning: a user's prior knowledge, learning style, speed of learning, current activities, goals, available learning time, location and interests. In this paper, we will introduce the SCALE system and outline how it relates to smart learning environments following a short literature review on SLEs. Results of a preliminary study are described afterwards.

2. Literature Review

Smart learning environments involve context-awareness. However, context may involve almost anything. Different research projects on smart learning environments may analyze and focus on different aspects of a context. The precision with which a context is defined and recognized by an SLE will influence its overall performance significantly.

At Sookmyung Women's University, Seoul, South Korea, a smart cloud computing framework has been developed according to a model called E4S (elastic four smarts) to provide smart learning services [2]. This model consists of four basic services: pull, prospect, content, and push. The researchers rely on built-in sensors in mobile devices to define the user's behavior or environment. The pull service will extract the type of content to be delivered to the user. The prospect service is responsible for the preparation of the learning content to comply with the user's context. The content service generates the content and establishes the connection between the server and the target device. Finally, the push service performs the synchronized delivery of the generated content to the target device.

In order for systems to adapt to changes in environments, the Technical University of Cluj-Napoca designed a self-adapting algorithm for context-aware systems. *"The algorithm is characterized by a closed feedback loop with four phases: monitoring, analyzing, planning, and execution,"* [6]. This algorithm uses the RAP (Resources, Actions, Policies) context model to programmatically describe the sensed environment, a task which is part of the monitoring phase. The analyzing phase involves evaluating the changes in the context using the context entropy concept in order to determine how much the context follows a predefined set of policies. The planning phase explores all the system's states to select the proper adaptation action which the system should take to respond to context changes. The execution phase implements the adaptation action as defined in the planning phase to change the system's state accordingly.

Zhiwen Yu et al. [9] discuss about a semantic infrastructure, the Semantic Learning Space, for context-aware e-learning. The Semantic Learning Space *"supports semantic knowledge representation, systematic context management, interoperable content integration, expressive knowledge query, and adaptive content recommendation"*. [9] recognizes the need to adapt the learning content to the user's context which is a challenge distinct from flexible content delivery. It also defines the e-learning context as *"a user's prior knowledge, learning style, speed of learning, current activities, goals, available learning time, location and interests."* For example, in a smart learning environment, the system will track the knowledge gap between the current user's knowledge and the targeted learning outcomes and provide the user with the proper learning content to fill that gap taking into account the user's context. In another article, Zhiwen Yu et al. proposed an ontology-based approach for semantic content recommendation in order to get one step further toward sophisticated context-aware e-learning. The recommender takes into account knowledge about the learner, knowledge about content, and knowledge about the learning domain in order to offer the right thing to the right person in the right way at any time, at any place, and in the right form [10]. The recommender goes through the following sequence of steps: semantic relevance calculation, recommendation refining, learning path generation, and recommendation augmentation.

Kosba and his associates have developed the Teacher ADVisor (TADV) framework which uses LCMS tracking data to elicit student, group, and class models, and using these models help educators gain better understanding of their distance students [17]. It uses a set of predefined conditions to recognize situations that require educators' intervention, and when such a condition is met, TADV generates an advice for the educator, as well as a recommendation for what is to be sent to students. Whereas TADV is focused on the educators' day-to-day activities, our approach aims at helping them rethink the quality of the employed learning content and learning design. Our approach also helps students share their experience, reuse additional learning resources collected by their peers, and get fine-grained feedback about their progress.

3. SCALE Framework and Smart Learning

SCALE is a mixed-initiative learning analytics framework aimed at collecting learning traces from any learning domain and analyzing those learning traces to extract the underlying competency levels in the same learning domain. The SCALE framework has been designed for a full integration with a learning management system such as Moodle as well as a suite of automated grading and testing tools such as Web-CAT[1] to make sensed learning traces reliable and associable to learning outcomes. SCALE does not focus as much on the physical context of a student as it does with the student's learning context (i.e., background knowledge).

SCALE's layered architecture consists of a sensing layer, an analysis layer, a competency layer and a visualization layer. The sensing layer is implemented through the Hackystat[2] framework which provides a collection of preset and customized sensors embedded in learning analytics tools. The analysis layer consists of parsers and analysis tools pertaining to the learning domain. For instance, SCALE's analysis layer applied in the programming domain will consist of compilers and static/dynamic code analysis tools. The output of the analysis will then be converted and stored in a comprehensive competency ontology. The competency layer will associate competencies with learning outcomes and show the evidences that the student is progressing or not toward those learning outcomes. Ontologies, implemented using Semantic Web technologies, along with inference engines will pave the way towards discovering new patterns and trends in the learning styles and learning paths of students. Competency ontologies will hold and define the knowledge background of students, a prerequisite to offer customized

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[1] Web-CAT (http://web-cat.org/group/web-cat)
[2] Hackystat (https://code.google.com/p/hackystat/)

learning materials. Finally, the visualization layer will provide a graphical interface consisting of a set of visualization and communication tools to play back the student's performance, display the student's competencies in relation to the latest learning activities, provide an environment where all learning stakeholders (i.e., instructors, students, peers, parents, recruiters, etc.) can meet and discuss how to set new goals and how to reach them, and give the student the opportunity to comment his/her learning to optimize the system's understanding of the student. We have designed the framework with a plug-and-play architecture to allow any data-centric learning-oriented application to be plugged in to SCALE.

We aim at making SCALE context-aware in terms of user's prior knowledge, regulated learning (self-regulated and co-regulated), learning style, learning efficiency, current activities, goals, available learning time, location and interests, as partly defined by Zhiwen Yu [9]. Programming is by far one of those easily traceable (not necessarily analyzable) domains due to the availability of explicit data that identify stepwise progressions made by programmers as they complete their coding tasks. In other words, the number of sensing hours spent by the system to track and update the learning context of the student may be much greater than in a chemistry course (depending on how e-learning is applied to the chemistry field). Due to the great number of environments in which Hackystat sensors (one of the SCALE cornerstones) may be embedded, the system may have a better representation of the user context.

One important question concerns the degree of ubiquity of SCALE. This may be a tricky question to answer. Consider the Java programming domain as an example. We have integrated three different programming tools within the SCALE system to capture coding related activities of learners – Eclipse IDE sensor, Virtual Programming Lab[3] (VPL) IDE sensor, and MI-LATTE reflection and regulation sensor. The dilemma consists in reducing the physical learning environment to certain computing devices due to the specificity of the software to be used as well as the competencies that the student must develop to master coding habits and competencies. The mastery of the software may even be a learning outcome of the course so that the student may become proficient. Eclipse, which is a professional integrated development environment, cannot be run on mobile devices. However, in the setting of the experiments that will be conducted at Athabasca University and Madras Institute of Technology, students will have to work through the assignments and many of the programming exercises using Eclipse. On the other side, students may install Eclipse and work on as many computers as they wish. We intend to make the SCALE framework available everywhere on the planet where an Internet connection is available. The SCALE system will guarantee reliable data collection through the Hackystat sensors (contributing to context awareness) despite low-speed Internet connections and inevitable connectivity issues. On the other side, we have other tools which may be accessible through the Web (VPL and MI-LATTE). SCALE could offer programming exercises on smart phones through these alternative tool technologies. These programming tools will nevertheless support only small-scale programming exercises.

In the future, we plan to provide students with a gamut of recommendations about which learning paths to take, which course or career to select, how to prepare for job

[3] Virtual Programming Lab (http://vpl.dis.ulpgc.es/)

interviews, which students have similar cognitive profiles, and which steps to undertake to compete with top-level students. Currently, SCALE provides students with minimalist recommendations about the programming concepts that should be deepened in order to maximize their success in the upcoming assignments or exams. The SCALE framework is a work in progress and will implement more sophisticated recommendations as we develop the system further.

4. Experiment with SCALE Forerunner e-Learning Technologies

Athabasca University, Canada, and the Madras Institute of Technology (MIT), Anna University, India, have conducted an experiment to analyze the introduction of tracing-oriented learning technologies among first year engineering courses. The traces target enhancement of the student's learning experience and possibly his/her performance within a course. The experiment was conducted at the MIT campus in the setting of a C programming course among 767 participating students and 10 professors (one professor per classroom). Students belonging to nine different classrooms received traditional lectures while a randomly chosen 10th classroom received a traceable online learning environment in Moodle in addition to classroom lectures. The e-learning technologies introduced in the course include the Moodle learning management system, the Virtual Programming Lab, the Eclipse IDE sensor, and CTAT tutors. The CTAT tutors guide students to solve programming exercises at a finer level of one line of code at a time. The study content was presented to students using a quadrant-based framework [18,19,20,21,22]. The new design followed a four-step process: watching, discussing, conceptualizing, and trying out. It also provided guidelines to the student as to how to study instead of what to study. All of these technologies trace study habits of learners at finer levels of granularity. Further, collected data were integrated in a singular framework to associate datasets originating from different sensors.

The objective of this study consists in discovering new trends and examining how the student's performance behaves when elements of smart learning environments are part of his/her learning experience. Since this experiment did not occur in a controlled environment, the reader should note that we will not claim anything from the results of this experiment except that we will pay attention to potential patterns and confirm them in upcoming experiments which will include more state-of-the-art e-learning technologies and a cutting-edge design of the learning process oriented toward self-regulated and co-regulated learning.

The experiment involved 10 different classrooms. Approximately 75 students attended each classroom and each classroom had a distinct professor. Classrooms were numbered from classroom0 to classroom9. Classroom3 is the classroom of interest in this experiment. The performance of classroom3 will be compared to the average performance of all the other classrooms. All classrooms teach the same course using the same structure. The course consists of three assessments, one theory exam, and one practical exam. Assessment1 consisted of theoretical questions while Assessment2 and Assessment3 consisted of programming exercises. Hence, classroom3's students were not yet exposed to the Virtual Programming Lab tool in Assessment1 while they had access to the entire course content in Moodle (in which was implemented the new instructional design). We will analyze or rather observe the performance of classroom3 in comparison to the other classrooms at the end of the semester.

Figure 1 displays the average marks for each assessment for both classroom3 and the other classrooms. Figure 2 shows the percentages of students who passed the assessments. Both figures show that classroom3 seemed to perform less well in the first assessment. We elaborate some hypotheses which could partially explain the reason(s) why classroom3 got inferior average grade marks. 1) Did it take classroom3 students more time to adapt to the new instructional design? 2) Was the new instructional design not optimal for theoretical parts? 3) Would the new instructional design have been optimal if it had been supported by the proper e-learning technologies? We will strive to validate/invalidate these hypotheses in future experiments in more controlled environments. However, the graphs show that

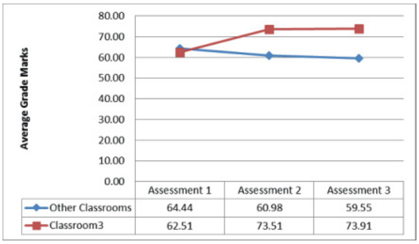


Fig. 1. Assessment Average Grade Marks

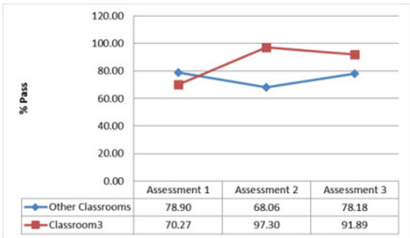


Fig. 2. Assessment % Pass

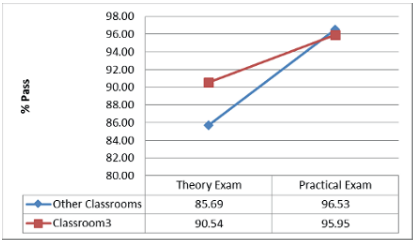


Fig. 3. Exam % Pass

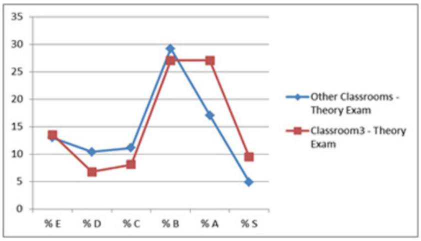


Fig. 4. Theory Exam % GPA

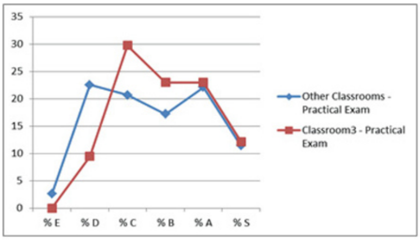


Fig. 5. Practical Exam % GPA

average marks and pass percentages of classroom3 are significantly higher than those of the other classrooms in Assessments 2 and 3. We would like to validate if classroom3's students started benefitting from the new instructional design and new e-learning technologies after Assessment1.

As for the theory and practical exams, Figure 3 denotes that the percentage of students in classroom3 who have passed the theory exam (almost 5% over) is greater than the percentage of students in the other classrooms. This observation may support the hypothesis that students took more time to adapt to the new instructional design but that this design optimized in some way the student's learning experience afterward. As for the practical exam, the percentage of students in the other classrooms who passed the practical exam is very slightly greater than classroom3's student pass percentage. However, both classroom3 and the other classrooms perform quite well in the practical exam. We may, nevertheless, observe that the pass percentage gap between the theory and practical exams is greater in the other classrooms.

Finally, in Figures 4 and 5 we see that fewer students in classroom3 have GPAs C, D, or E, and more students in classroom3 get GPAs S, A, and B. Note that the order of GPAs from best to worst is S, A, B, C, D, and E. All these are mere observations and suggest some trends. More experiments will be conducted in the near future in several universities across the world to understand the impact of smart learning environments on student performance and to confirm our hypotheses following this experiment's results.

5. Future Work and Conclusion

SCALE will also incorporate a Causal Learning Analytics (CLEAN) extension to determine the causes of various learning-related occurrences. This will include among other things identifying the causes of the successes and failures in learning outcomes and determining the impact that those factors have on the learning outcomes to name a few. Furthermore, SCALE will track the type and sequence of programming activities (debugging, compiling, testing, documenting, code writing, etc.) typical for every student category (at risk, average, and top students). SCALE will also look for the learning approaches and behaviors which are the most effective as well as the conceptual causes of student's errors. The CLEAN extension will be implemented as a rule-based subsystem using pattern-matching techniques (i.e., production rules). In summary, SCALE aims at tracking a student's competencies in as much learning activities as possible and at explaining the factors contributing to the strengthening of those competencies.

References

[1] Burghardt, C., Reisse, C., Heider, T., Giersich, M. & Kirste, T. (2008). Implementing Scenarios in a Smart Learning Environment. 2008 Sixth Annual IEEE International Conference on Pervasive Computing and Communications (pp. 377-382).

[2] Kim, S., Song, S.-M. & Yoon, Y.-I. (2011). Smart Learning Services Based on Smart Cloud Computing. Sensors 11, 7835-7850.

[3] Aion, N., Helmandollar, L., Wang, M. & Ng, J. (2012). Intelligent Campus (iCampus) Impact Study. 2012 IEEE/WIC/ACM International Conferences on Web Intelligence and Intelligent Agent Technology (WI-IAT), Vol. 3 (pp. 291-295).
[4] Lee, J., Jung, Y. J., Park, S. R., Yu, J., Jin, D.-s. & Cho, K. (2012). A Ubiquitous Smart Learning Platform for the 21st Smart Learners in an Advanced Science and Engineering Education. 2012 15th International Conference on Network-Based Information Systems (NBiS) (pp. 733-738).
[5] Huang, R., Hu, Y., Yang, J. & Xiao, G. The Functions of Smart Classroom in Smart Learning Age.
[6] Cioara, T., Anghel, I., Salomie, I., Dinsoreanu, M., Copil, G. & Moldovan, D. (2010). A self-adapting algorithm for context aware systems. 2010 Ninth Roedunet International Conference (RoEduNet) (pp. 374-379).
[7] Koo, D.-H. (2012). Trends and Revitalization of Smart-Learning in Elementary and Middle Schools. Asian Journal of Information Technology, 160-168.
[8] Mikulecký, P. (2012). Smart Environments for Smart Learning.
[9] Yu, Z., Zhou, X. & Shu, L. (2009). Towards a semantic infrastructure for context-aware e-learning. (pp. 71-86).
[10] Yu, Z., Nakamura, Y., Jang, S., Kajita, S. & Mase, K. (2007). Ontology-Based Semantic Recommendation for Context-Aware E-Learning. (pp. 898-907).
[11] Akiyoshi, M. & Nishida, S. (1993). A qualitative simulation-based learning environment: how to enhance causal understanding of complex phenomena in large-scale plants. 1993 Twelfth Annual International Phoenix Conference on Computers and Communications (pp. 531-537).
[12] Blikstein, P. (2011). Using Learning Analytics to Assess Students' Behavior in Open-ended Programming Tasks. In Proceedings of the 1st International Conference on Learning Analytics and Knowledge (pp. 110-116). ACM.
[13] Castro, F., Mugica, F. & Nebot, A. (2007). Causal Relevancy Approaches to Improve the Students' Prediction Performance in an e-Learning Environment. 2007 Sixth Mexican International Conference on Artificial Intelligence - Special Session (pp. 342-351).
[14] Fancsali, S. E. (2011). Variable Construction for Predictive and Causal Modeling of Online Education Data. In Proceedings of the 1st International Conference on Learning Analytics and Knowledge (pp. 54-63). ACM.
[15] Santos, J. L., Govaerts, S., Verbert, K. & Duval, E. (2012). Goal-oriented Visualizations of Activity Tracking: A Case Study with Engineering Students. In Proceedings of the 2nd International Conference on Learning Analytics and Knowledge (pp. 143-152). ACM.
[16] Yu, T. & Jo, I.-H. (2014). Educational Technology Approach Toward Learning Analytics: Relationship Between Student Online Behavior and Learning Performance in Higher Education. In Proceedings of the Fourth International Conference on Learning Analytics and Knowledge (pp. 269-270). ACM.
[17] Kosba, E., Dimitrova, V., Boyle, R. (2005). Using Student and Group Models to Support Teachers in Web-Based Distance Education. In Proceedings of the 10th International Conference on User Modeling, Edinburgh, UK (pp. 124-133).
[18] Lee, S., Barker, T., Kumar, V. (2014). Self-Directed Learning. Educational Technology & Society, in preparation.
[19] Lee, S., Barker, T., Kumar, V. (2011). Learning Preferences and Self-Regulation - Design of a Learner-Directed e-Learning Model. International Conferences ASEA, DRBC and EL 2011, Software Engineering, Business Continuity and Education. Communications in Computer and Information Science, Springer Link, Volume 257, pp. 579-589.
[20] Lee, S., Barker, T., Kumar, V. (2011). Models of eLearning: The Development of a Learner-Directed Adaptive eLearning System. In Sue Greener and Asher Rospigliosi (eds.), Proceedings of the European conference on e-learning held in University of Brighton, Brighton, UK, November 10-11, 2011 (pp. 390-398).
[21] Lee, S., Barker, T., Kumar, V. (2010). Approaches to Student Modeling in the Context of e-Learning 2.0. In Paula Escudeiro (ed.), Proceeding of the 9th European conference on e-learning, pp. 59-66.
[22] Kumar, V., Manimalar, P., Somasundaram, T. S., Sidhan, M., Lee, S., El-Kadi, M. (2009). Open Instructional Design. Technology for Education (T4E 2009) (pp.43-50).
[23] Seanosky, J., Boulanger, D., Kumar, V. & Kinshuk (2014). Unfolding Learning Analytics for Big Data. ICSLE 2014, in preparation.

[April 14, 2014]

Smartphone Addiction in University Students and its Implication for Learning

Jeongmin Lee[1,*], Boram Cho[1], Youngju Kim[1], & Jiyea Noh[1]

[1] Educational Technology Department, College of Education, Ewha Womans University, Seoul, Korea.
jeongmin@ewha.ac.kr

Abstract. As smartphones are getting popular, a concern for smartphone learner's addiction to their phones has been raised together with the possibility of Smart Learning. This research is focused on the level of university students' addiction to their smartphones and to understand the difference between self-regulated learning, learning flow, based on smartphone addiction level. After 210 students of university students in Seoul were participated in this research, it has been found that the higher the addiction level is, the lower level of self-regulated learning the students have, as well as low level of flow when studying. Further interview for smartphone addiction group was conducted, it has been found that the smartphone addict – learners are constantly interrupted by the other applications on the phones when they are studying, and does not have enough control over their smartphone learning plan and its process.

Keywords: smartphone addiction, Self-regulated Learning, Learning flow

1 Introduction

Since Smartphone came in Korea, the number of users exceeds 67% of the citizen and ha s become popular [19]. The information and communication environment changed rapidly a s appearance of Smart device such as Smartphone [13]. Now, People was able to connect in ternet anywhere and anytime using Smart phone. Furthermore, people could select best cont ents among the various apps and communicate in real time using social network service. Th e way of learning information in our daily life has been changed by feature of smart devices, as well as leisure, finance, and wide variety of the world at large. Especially, in education f ield, people used Smart device as instrumental in learning and then the term appeared 'Smar

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_40

t learning'. Smart learning's educational value emerged because learner able to study using s uitable level contents with others in real time in daily life and it gave a chance to remove bo undary between learning and daily life.

However, excessive use of Smartphone made an appearance of Smartphone addiction wit h social problem. The user of Smartphone addiction were nervous and anxious without Sma rtphone in daily life and they suffered the symptoms that people could not stop using a Sma rtphone and it leads problem in daily life. Actually, based on the research data for 10693 us er of Smartphone in National Information Society Agency (2012), Smartphone addiction rat e was 11.1% between age of 10 and 49. Hence, Smartphone addiction rate was really increa sing than last year rate (2.7%). Especially, there were high addiction rate on 20s who were u sually leaning in daily than other age. The 20s addiction rate was 13.6%. In response to the trend, recently, there were conducted research to investigate cause of Smartphone addiction level and effect for adolescent and undergraduate student and there were previous research t hat high Smartphone addiction had trouble with metal health and school life. Even though s martphone addiction level can affect learning for students who spent daily life most in study ing, there were no research on smartphone addiction level and learning. Therefore, this rese arch is focused on the level of university students' addiction to their smartphones and to und erstand the difference between self-regulated learning, learning flow, based on smartphone addiction level. Concrete research questions for this study are as follows:

Research question 1. Is there any difference on self-regulated learning based on the level of smartphone addiction (at-risk user group/general group)?

Research question 2. Is there a difference on learning flow according to the smartphone a ddiction level (at -risk user group/general group)?

2 Theoretical background

2.1 Smartphone addiction level

Smartphone addiction level researches were on the initial stage. There were common definition about smartphone addiction level but, recently, many researchers recognized that it was different concept internet addiction or mobile addiction and then, they tried to define smartphone addiction level. Hwang & Son & Choi(2011) defined that smartphone addiction level means dependence about smartphone and condition which used obsessionally and it caused daily life's inconvenience[27]. In other word, it was condition which made daily life's barrier because people were absorbed much time in Smartphone. In addition, Yoon et al.(2011) defined that it increased smartphone usage time gradually and if they don't have smartphone, they felt anxiety and nervousness and, they couldn't concentrate on their work[18]. National information society agency (2011) conducted that they developed smartphone addiction testing when increased smartphone addiction problem socially [22]. In this research explained that smartphone addiction concept was different with internet and mobile addiction. They added differential concept due to the smartphone characteristic on smartphone addiction testing. Thus, smartphone addiction level included internet addiction's common addiction concept such as withdrawal symptom, tolerance, disability of living and differential concept were addiction possibility with convenient access rate which touched once, easy portability and accessibility increase due to the push function, and various app and contents. Based on this media characteristic, smartphone addiction testing for adult was developed and it were consisted 4 sub-factors such as disability of daily living, virtual world intentionality, withdrawal symptom, and tolerance. Each sub factors were as follow. Withdrawal symptom meant that if people doesn't have smartphone or couldn't use smartphone, they felt anxiety and nervousness. In addition, tolerance meant they couldn't feel satisfaction when used this gradually due to increased smartphone frequency of utilization. Disability of daily living meant condition which caused smartphone overuse on home, school, and company. Finally, virtual world intentionality meant that it recognized that people preferred virtual world which used and made smartphone to connect interpersonal relationship than real world.

2.2 Smartphone addiction & self-regulated learning

Self-regulated learning is defined as a constructive and conative process which controlled and observed their behavior, motivation, and cognition to achieve their learning objective strategically [33]. Many previous researches were revealed that Self-regulated learning was important role in learning achievement. Self regulated learning were considered that it was essential on cyber environment [14][20] which conducted using learning resources to learn by learner on web and mobile learning environment which expanded space-time autonomy by specialized mobility to successful learning[34][35]. Recently, smart learning environment which took center stage, it has mobile learning's mobility and can access internet freely and various app and expanded use of learning resources. Therefore, smart learning environment were needed learner's initiative which investigated necessary resource to successful learning than cyber environment. Therefore, self regulated learning was learner's essential ability to fulfill the learning objective and outcome.

Meanwhile, it was difficult to find research which conducted correlation practically between smartphone addiction level and self-regulated learning in smart learning environment. However, there were research between mobile phone usage level and self-regulated learning in general learning environment. Excessive mobile phone usage levels were affected negatively on self-regulated learning [3]. Seong & Jin (2012) were also revealed that if person has high dependence on mobile phone, he/she had negative correlation on self-regulated learning[8]. In addition, Jin (2008) showed that the high internet addiction with high school student, the low self-regulated learning [29]. Therefore, in this study, we investigated relationship between smartphone addiction level and self-regulated learning.

2.3. Smartphone addiction & learning flow

Learning flow is defined that when participated activity, people fully concentrate on the process and feel pleasure [30]. In learning, flow means that learner concentrate on learning activity and feel joy and emotionally or behaviorally participated with effort [32]. Flow were felt joy on learning and then, learner had satisfaction and increased learning's quality and it assumed that it leaded have a high learning outcome [4]. Flow was factors which affected learning outcome because it caused that learner participated actively in virtual learning environment such as cyber environment [7]. The research showed that learning flow was essential factors for successful learning [15].

Meanwhile, it was difficult to find research between smartphone addiction level and flow. Most of previous researches is investigated regarding mobile phone addiction. These revealed that mobile phone addiction were affected negatively on learning flow [2][17]. Thus, if student highly used mobile phone, learning flow were goes down. Based on this, high mobile phone addiction student couldn't concentrate on class which controlled by external and couldn't flow on learning activity. In other word, a student with smartphone addiction might be difficult to have high learning flow because we used smartphone on learning and this was factor of smartphone addiction. Therefore, in this study, we investigated between smartphone addiction level and learning flow.

3 Research Methods

3.1 Research Subjects

214 students participated in these researches who are women at a university in Seoul. They are all 22years old. The self-report survey was used in this research and collected 214 survey and eliminated 4 untrustworthy answer. Finally, we chose 210 surveys for this research.

3.2 Measurement

Smartphone addiction level: To measure Smartphone addiction level, questionnaire developed by National Information Society Agency (2011) were used. This survey consisted 15 questions with 5 Likert scale and sub-factors were disability of daily living (5Q), withdrawal symptom (4Q), tolerance (4Q), and virtual world intentionality (2Q). In addition, the user group was categorized based on the diagnose result of addiction; high risk user group, potential risk user group, general user group. For this research, since we focus on comparison between risk group and general group in smartphone addiction, we combined potential high risk user group and high risk user group. The Cronbach's α was .92 in this research.

Self-regulated learning: self-regulated learning was measured by questionnaire developed by So & Kim(2012) but revised to adapt in this study[9]. It consisted 4 questions using 5 Likert scale and the The Cronbach's α was .85 in this study.

Learning flow: learning flow was measured by questionnaire developed by So & Kim (2012) but revised to adapt in this study[9]. It consisted 4 questions using 5 Likert scale and The Cronbach's α was .85 in this study.

3.3 Data analysis method

We used SPSS 18 to analysis the data. First, we classified the group based on the Smart Phone addiction level. We identified average, median, standard deviation, and standard error with related variables of Smartphone on each group. After then, we checked the equal varia nce assumption to compare with average of variables among group. This study satisfied the equal variance assumption. If the variable satisfied equal variance assumption, we conducte d Independent sample t-test When the variable unsatisfied the equal variance assumption, it was conducted Welch-Aspin test to test the significance of difference mean between two gr oups (at -risk user group/general group).

4 Results & Discussion

4.1. Difference of self-regulated learning and learning flow according to the Smartphone addiction level

According to the results (see Table 1 & 2), there were statistically significant differences on self-regulated learning and learning flow ($p<0.05$). Specifically, general user group (M= 3.03) has higher self-regulated leaning and higher flow than at-risk user group. This implied that students with higher smartphone addiction level might have lack of behavior control a mong self-regulated learning. It seemed that Smartphone addict tends to immediate satisfact ion than long-term satisfaction because of lack of control impulsivity and long-term efforts needed on self-regulated learning. These things led to go down in learning flow. Further int erview for smartphone addiction group was conducted, it has been found that the smartphon e addict learners are constantly interrupted by the other applications on the phones when the y are studying, and does not have enough control over their smartphone learning plan and it s process.

<Table 1> descriptive statistics by variables

Variable	Smartphone addiction level	sample (n)	mean (*M*)	standard deviation (*SD*)
self-regulated learning	at-risk user group	64	2.46	.74

	general group	146	3.03	.69
	Total	210	2.86	.75
learning flow	at-risk user group	64	2.58	.93
	general group	146	2.86	.74
	Total	210	2.78	.81

<Table 2> the difference of self-regulated learning and learning flow by smartphone addiction level

Variable	*t*	*p*
Self-regulated learning	-5.40**	.00
Learning Flow	-2.18*	.03

$^{*}p<.05$, $^{**}p<.01$

References

[1]Go, J. W.: Effect of smartphone addiction on youth's sociality development-with focus on the interpersonal relation, confidence, peer sociality. Daedong Philosophy, 63, 1-38 (2013)
[2]Kim, J. H.: (The) relationship among the extent of mobile phone usages, learning flow and academic achievement of high-grade elementary school students, Unpublished master thesis, Hanyang university, Korea (2010)
[3]Kim, U. K.: difference between self control and self-regulated learning ability based on the mobilephone usage level of high school students, Unpublished master thesis, Ahju university, Korea (2007)
[4]Kim, A. Y., Tak, H. Y., & Lee, C. H.: The development and validation of a learning flow scale for adults. Educational Psychology Research, 24(1), 39-59 (2010)
[5]No, G. S., Joo, S. W., & Jeong, J. T.: An exploratory study on concept and realization conditions of smart learning. Educational Information Media Research, 18(1), 51-75 (2012)
[6]Park, S. Y., & Nam, M. W.: An analysis of structural equation model in understating university students` behavioral intention to use mobile learning based on technology acceptance model. Educational Information Media Research, 18(1), 51-75 (2012)
[7]Park, S. I., & Kim, Y. K.: An inquiry on the relationships among learning - flow factors, flow level, achievement under on-line learning environment. Yeollin Education Research, 14(1), 93-115 (2006)
[8]Seong, U. M., & Jin, S. H.: The effects of cell phone use according to the adolescence gender differences on self-regulated learning and achievement, Educational information media research, 18(4), 441-461 (2012)

[9]So, W. G., & Kim, H. K.: A study on the influence of the motivational characteristics of m-learning on the learning outcome. Journal of Fisheries and Marine Sciences Education, 23(3), 368-377 (2012)
[10]Shin, G. G.: Effect on user's belief, choice intention and actual usage of HTS user's recognized security. Commercial Education Research, 25(4), 183-204 (2011)
[11]Shin, H. K. & Kim, Y. A.: A study on the factors affecting smart learning -focusing on the moderating effect of learning time. Korea Society of Industrial Information Systems, 16(5), 93-105 (2011)
[12]Ahn, K. H., & Lee, C. H.: Elementary school people's internet addiction and its relationship with their learning motivation and adaptation of school life. Korean Practical Arts Education, 12(4), 57-74 (2006)
[13]Oh, S. H., & Kwon, O. Y.: A study on smart learning service model. Journal of Practical Engineering Education, 5(1), 28-33 (2013)
[14]Lee, W. K., & Lee, J. K.: The influence of learning environment and learners' self-efficacy on the effectiveness in e-learning. Business Informatics Research, 16(1), 1-21 (2006)
[15]Lee, U. W., & Lee, J. Y.: Analysis on structural relationships of learner characteristics, interactions, flow, perceived usefulness and learning satisfaction in SMART education environments-with focus on elementary school. Educational Information Media Research, 19(3), 573-603 (2013)
[16]Lim, G.: Research on Developing Instructional Design Models for Enhancing Smart Learning. Journal of Korean Association of Computer Education, 14(2), 33-45 (2011)
[17]Im, S. I. & Kim, E. Y.: The relationship among mobile phone addiction and learning flow and academic achievement of male high school students. Korea Youth Research Association, 20(10), 315-337 (2013)
[18]Yoon, J. Y., Moon, J. S., Kim, M. J., Kim, Y. J., Kim, H. A., Heo, B. R., Kim, J. E., … Hong, H. J.: Smartphone addiction and health problem on university students. Journal of Korean Association for Crisis and Emergency Management, 3(2), 92-104 (2011)
[19]Jeon, B. Y.: Smartphone distribution rate Korean 67% as first ranked. Kyeong Hyang Newspaper(2013.06.25).http://news.khan.co.kr/kh_news/khan_art_view.html?artid=201306252201515&code=930201
[20]Joo, Y. J., Kim, N. Y., & Cho, H. K.: Relationship between self-efficacy, online task value and self-regulated learning, and satisfaction and achievement in cyber education. Educational Information Media Research, 14(3), 115-135 (2008)
[21]Choi, H. S., Lee, H. K., & Ha, J. C.: The influence of smartphone addiction on mental health, campus life and personal relations - focusing on K University Students, Journal of the Korean Data and Information Science Society, 23(5), 1005-1015 (2012)
[22]National Information Society Agency: Development and Validation of the Smartphone Addiction Inventory. NIA Ⅳ-RER-11051 (2011)
[23]National Information Society Agency: The Survey Research on Internet Addiction. NIA IV-RER-12082 (2012)
[24]Han, J. S., & Kim, S. Y.: A study on the difference in internet activities, self-control, self-regulated learning and academic achievement according to the level of internet addiction among middle school students. Educational Information Media Research, 12(2), 161-188 (2006)
[25]Hwang, K. H., Yoo, Y. S., & Cho, Y. H.: Smartphone overuse and upper extremity pain, anxiety, depression, and interpersonal relationships among college students. Journal of Digital Contents Society, 12(10), 365-375 (2012)
[26]Hwang, J. H., & Kim, D. H.: (An) Empirical study on the critical factors for successful m-learning implementation. Journal of Information Technology Applications & Management, 12(3), 57-80 (2005)
[27]Hwang, Ha S., Son, S. H., & Choi, Y. J.: Exploring factors affecting smart-phone addiction - characteristics of users and functional attributes. Korean Association for Broadcasting, 25(2), 277-313 (2011)

[28]Cheng, S. C., Hwang, W. Y., Wu, S. Y., Shadiev, R., & Xie, C. H.: A mobile device and online system with contextual familiarity and its effects on english learning on campus. Educational Technology & Society, 13(3), 93-109 (2010)
[29]Jin, J. K.: Relationship between internet addiction and self regulated learning of high school students. Unpublished master thesis, Dankkook university, Korea (2008)
[30] Csikszentmihalyi, M.: Flow: The psychology of Optimal Experience. New York: Harper Perennial (1990)
[31]Davis, F. D., Bagozzi, R. P., & Warshaw, P. R.: User acceptance of computer technology: a comparison of two theoretical models. Management Science, 35(8), 982-1003 (1989)
[32]Marks, H. M.: Student engagement in instructional activity: Patterns in the elementary, middle, and high school years. American Educational Research Journal, 37(1), 153-184 (2000)
[33]Pintrich, P. R.: The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), Handbook of Self-regulation (451–502). San Diego, CA: Academic (2000)
[34]Sha, L., Looi, C. K., Chen, W., & Zhang, B. H.: Understanding mobile learning from the perspective of self-regulated learning. Journal of Computer Assisted Learning, 28, 366-378 (2011)
[35]Terras, M. M., & Ramsay, J.: The five central psychological challenges facing effective mobile learning. British Journal of Educational Technology, 43(5), 820-832 (2012)

Students' Science Process Skills Diagnosis

Ming-Xiang Fan[1], Maiga Chang[2*], Rita Kuo[3], Jia-Sheng Heh[1]

[1]Chung-Yuan Christian University, Taiwan
[2]Athabasca University, Canada
[3]Knowledge Square, Inc., Taiwan
fs601254@gmail.com, maiga.chang@gmail.com, rita.mcsl@gmail.com, jsheh@ice.cycu.edu.tw
[*] corresponding author

Abstract. A virtual experiment environment was developed to provide students a virtual space to engage students learning science and practicing science process skills. To provide teachers information of their students' science process skills according to the actions and decisions students taken within the virtual experiment environment, a graph edit distance based diagnosis methodology was proposed. A small pilot in which 31 grade-10 students participated had been conducted. This short research study aims to verify whether or not the proposed method can correctly diagnose students' science process skills.

Keywords: Test of Integrated Science Process Skills (TIPS), Physics, Virtual Experiment Environment, Science Process Skills

1 Introduction

The research team designed a Virtual Experiment Environment which combines both of the gaming factors and the virtual experiment to engage students in science learning [1]. In the system, a graph edit distance method was proposed and developed to diagnose students' science process skills according to their actions and decisions taken in the virtual laboratory [2]. To verify if students perceived the virtual experiment environment is useful, a pilot had conducted [3]. In the pilot, thirty-one grade-10 students who had learnt basic Dynamics in Physics were recruited. All of them were asked to take the Test of Integrated Science Process Skills (TIPS) [4] which has 30 items developed to assess students' science process skills, before they started to use the system. Also, their actions and decision making within in the virtual environment were collected.

This short research study aims to use ANOVA to verify whether or not the scores of particular science process skills diagnosed by the proposed method are in line with the scores of correspondent TIPS items that students received. This paper is organized into three main sections. Section 2 introduces the virtual experiment environment and the graph edit distance based diagnosis method. Section 3 talks the hypotheses this research has and reveals the analysis results. At the end, Section 4 discusses the future works of this research.

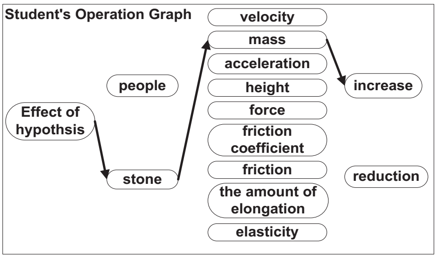
G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_41

2 Virtual Experiment Environment and Diagnosis Method

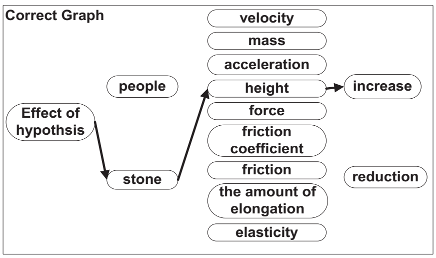
This research integrates story element into the virtual experiment environment proposed by Kuo et al. (2000) [5]. When students use the system, the system first prompts a story (include animation and text-based narration) and asks students to solve the problem involved in the story. For example, students role play an adventurer in a scene of the story, where they arrive at a valley and have to find a way to cross the valley by using a vine to swing to the other side where is higher than the cliff at this side.

Students then may make a hypothesis to solve this problem. For example, students can assume that when the adventurer runs faster, he or she may swing higher and reach the higher cliff at the other side of the valley. To verify the correctness of the hypothesis, students can choose one of the Java simulations [6] to preview the correspondent follow-up story scene when their assumption is applied. They have to find out which object in the story animation (such as the adventurer) is the corresponding object in the Java simulations (such as the bullet in a shooting simulation). They also need to consider which physical quantities (such as mass or speed) they may need to operate and to observe in the simulation.

Students need to consider what are independent, dependent, and control variables. In the above-mentioned story, students may think the running speed of the adventurer is an independent variable and the height that the rock can reach when it swings to the other side is the dependent variable. Next, students run the simulation by adjusting the values of the independent variables and record the values of the dependent variables via observation. After the experiment data is collected, students can examine the data and interpret the relations between the independent and dependent variables. At the end of the experiment, students need to assess the experiment results and to determine whether or not the results confirm the hypothesis they made earlier. If the hypothesis is not supported by the results, students can go back to previous stages to refine their experiment design.



(a)



(b)

Fig. 1. Graphs of choosing physical quantities.

The research team uses graph edit distance [7] to diagnose students' science process skills by converting actions taken by the students (as Figure 1a shows) and actions that students supposed to do (as Figure 1b shows) into two graphs and using the graph edit distance to calculate the difference in-between the two graphs [2]. Currently the method can diagnose students' integrated skills of identifying variables, constructing hypotheses, defining variables operationally, describing relationships between variables, constructing graphs, and interpreting data.

Three operations in graph edit distance are insertion, deletion, and relabeling for both nodes and edges. Different from the error-correcting graph matching algorithm [8], the proposed method doesn't take node costs into consideration due to the two graphs in this research have identical node sets. Also, the cost of substituting an edge does not take into consideration either due to the graphs are undirected graph and there is no different meaning attached on the edges. More details of the proposed diagnosis method can be found in [2].

In order to verify the diagnosis results' correctness, this research wants to find the relation between the diagnostic score and TIPS score of three science process skills: choosing physical quantities, identifying variables and graphing and interpreting data. Three hypotheses are then made:

- H1. There is a relationship between students' diagnostic scores and TIPS scores of choosing physical quantities.
- H2. There is a relationship between students' diagnostic scores and TIPS scores of identifying variables.
- H3. There is a relationship between students' diagnostic scores and TIPS scores of graphing and interpreting data.

3 Results

This research uses ANOVA to verify the three hypotheses. For hypothesis H1, at very beginning, the researchers find that there is no significant relationship (i.e., $p > 0.05$). When the researchers examine the data further, a special case (i.e., student #18), is found – the student's TIPS score is high but his/her diagnostic score is low. After review the actions he/she took for choosing physical quantities, we find him/her chose many quantities that the object doesn't even have. When we temporarily remove his/her data, the ANOVA result shows there is relationship existed (i.e., $p < 0.05$); therefore, hypothesis H1 is supported.

For hypothesis H2, similarly, at first round, the ANOVA result shows no significant relationship. When we examine the data further, we find four students have either high TIPS score with low diagnostic score (i.e., student #9, #16, and #31) or low TIPS score with high diagnostic score (i.e., student #6). By reviewing their learning log, we find that these students were either confused the meanings of independent and dependent variables or failed to choose exactly amount of variables. On the other hand, from student #6's responses toward TIPS items, we find that he/she jumped to next item immediately by choosing the first option he/she thought it is correct without reading all options completely.

For hypothesis H3, as too many students didn't finish graphing and interpreting data and received zero for the diagnostic score of this particular skill, the ANOVA result also shows no significant relationship. The reason that students didn't practice this skill probably is because they had only 50 minutes in the pilot and before they could start graphing they need to collect data first – phenomena observation and data recording are time consuming tasks no matter in real or virtual experiments.

4 Future Works

Although not all diagnostic scores of three science process skills have relationships found with the TIPS scores, the proposed diagnosis method is capable of grading students' science process skills properly when the special cases are ignore. Before we can confidently say the proposed diagnosis method is effective and has acceptable accuracy rate, two tasks need to be done: (1) new TIPS should be re-designed and in line with the concepts that virtual experiments cover – currently the TIPS the pilot uses is adopted directly from [4][9]; (2) a bigger and longer pilot is needed – so students can have enough time in practicing all science process skills.

References

1. Fan, M.-X., Chang, M., Kuo, R., Heh, J.-S.: Using Story-based Virtual Experiment to Help Students Building Their Science Process Skills. AACE 22th World Conference on Educational Multimedia, Hypermedia & Telecommunications, (ED-MEDIA 2010), Toronto, Canada, June 29-July 2, 2010, 3350-3355.
2. Fan, M.-X., Chang, M., Kuo, R., Heh, J.-S.: Using Graph Edit Distance to Diagnose Student's Science Process Skill in Physics. 5th International Conference on E-Learning and Games, (Edutainment 2010), Changchun, China, August 16-18, 2010, 307-316. (2010).
3. Fan, M.-X., Chang, M., Kuo, R., Heh, J.-S.: Story-based Virtual Experiment Environment. Smart Learning Environments. Springer Lecture Notes in Educational Technology. (in press).
4. Dillashaw, F. G., Okey, J. R.: Test of Integrated Science Process Skills for Secondary Science Students. Science Education, Vol. 64, No. 5, pp. 63-70. (1980).
5. Kuo, L.-P., Dong, D.-X., Hsu, C.-K., Heh, J.-S.: Design an Enhanced Virtual Experiment Environment Using Science Process Skills on WWW. 12th AACE World Conference on Educational Multimedia, Hypermedia & Telecommunications, (ED-Media 2000), Montreal, Canada, June 25-July 1, 2000, p. 1785. (2000).
6. Hwang, F.-K., Dsquembre, F.: Easy Java Simulation: An Interactive Tool for Conceptual Learning of Science. 15th AACE World Conference on Educational Multimedia, Hypermedia & Telecommunications, (ED-Media 2003), Honolulu, Hawaii, USA, June 23-28, 2003, pp. 791-794. (2003).
7. Sanfeliu, A., Fu, K.-S.: A distance measure between attributed relational graphs for pattern recognition. IEEE Transactions on System, Man, and Cybernetics, Vol. 13, pp. 353-362. (1983).
8. Bunke, H.: On a relation between graph edit distance and maximum common subgraph. Pattern Recognition Letters, Vol. 18, pp. 689-694. (1997).
9. Myers, B. E., Dyer, J. E.: Effects of investigative laboratory instruction on content knowledge and science process skill achievement across learning styles. Journal of Agricultural Education, Vol. 47, No. 4, pp. 52-63. (2006).

Tablet Interface Design for Elder Users' Newspaper Reading

Hui-Chun Lin[1], Yueh-Chi Luo[1],Weijane Lin[2], Hsiu-Ping Yueh[1],

[1]Department of Bio-Industry Communication and Development, National Taiwan University, Taipei, Taiwan, R.O.C.
[2]Department of Library and Information Science, National Taiwan University, Taipei, Taiwan, R.O.C.

{r00630002, r00630008, vjlin, yueh}@ntu.edu.tw

Abstract. This study recruited 12 elder users to evaluate a mobile newspaper reading app. Content-oriented and operation-oriented tasks were assigned to understand their performance and preferences of mobile newspaper reading. The preliminary results showed that active news searching was the most challenging task for the elder users who had difficulty navigating between categories and hierarchies. It is suggested that real-time push notification with printed-alike page layout should be considered in tablet interface design.

Keywords: Elder users, Tablet PC, APP

1 Introduction

Facing the rapid aging speed of Taiwan society, elder users have gained significant attention recently from various fields including societal, educational, research and industrial sectors. ICT as the daily accessible vehicle of information, and as an adaptive instrument to leverage multiple purposes and user populations, has been valued as a critical solution to meet both users' and market needs. However, with the physical and functional degradation, to use technological product could be challenging for elder users [1,2]. Findings from the previous studies have suggested more attention on task-specific assistance instead of general support for interface design [3], this study therefore focused on elder users' newspaper reading experiences with the mobile devices in order to develop task-specific principles for tablet interface design.

Newspaper grants users more freedom in terms of reading pace and content choices, which makes newspaper reading the major leisure activities for the elderly people in Taiwan. In our previous studies we have explored elder users' performance and preferences with touch screen in general, and in this study we focused on small-screen newspaper reading on carry-on devices including smart phones and tablets specifically. A usability evaluation of a newspaper reading app, UDN Plus, was conducted to examined elder users' reading behaviors and performances with iPad.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_42

2 Methods

Twelve participants of 65 years old and above were invited to take part in the user experiments. Quantitative measurements as well as qualitative observation and interviews were conducted to collect users' experiences and opinions. Two kinds of user tasks, both consisted of 5 steps to accomplish, including content-oriented and operation-oriented were assigned. Content-oriented tasks required elder users to search and read the news stories, and operation-oriented tasks asked users to adjust the font size.

3 Preliminary Results

The results suggested that active news searching was the most challenging task for the elder users. Inherited from their printed paper reading experiences, the elder users reported difficulty in searching and navigating between news segments especially when multiple levels of categories were involved. The current instruction provided by UDN Plus was not informative and effective enough since it required the users to recall all the icons on the interface. Based on the preliminary findings, we suggested that push notification should be adopted in newspaper reading app with simple layout in order to leverage elder users' difficulty of navigation. However the elder users relied heavily on the editorial designs of the printed newspapers, critical elements including the headlines, white spaces and the typography should be preserved and adopted in the page layout of mobile apps in order to reduce errors. In addition, real-time navigation support instead of overall tutorial was preferred and perceived as more helpful by the elder users. Simple and direct hints, such as "next step" and "zoom-in" text shown on the icons helped users quickly identify and follow to proceed reading. Reducing their cognitive loading also improved elder users' satisfaction toward the experiences significantly. On the basis of this exploratory study, we also continued to conduct more rigorous analysis such as cross-context and cross-devices comparison to develop systematic design principles for elder users' newspaper reading apps. In the long term, we are hoping to construct a mobile learning environment of newspaper for elder users.

References

[1] Asano, Y., Saito, H., Sato, H., Wang, L., Gao, Q., & Rau, P.-L.: Tips for designing mobile phone web pages for the elderly. LNCS 4550, pp. 675-680. Springer, Heidelberg (2007)

[2] Lee, B., Chen, Y., & Hewitt, L.: Age differences in constraints encountered by seniors in their use of computers and the internet. Computers in Human Behavior, 27(3), 1231-1237 (2011)

[3] Lagana, L.: Enhancing the attitudes and self-efficacy of older adults toward computers and the internet: Results of a pilot study. Educational Gerontology, 34, 831–843 (2008)

The Design and Development of Electronic Schoolbag System Based on Educational Cloud Service Platform

Fati Wu, Zhijia Mou

School of Educational Technology, Faculty of Education
Beijing Normal University, Beijing, China
wft@bnu.edu.cn, ambitionyt@163.com

Abstract. The related concepts and definition of electronic schoolbag are sorted and defined firstly in this paper. According to surveying different schools and learners' need, we design and develop an electronic schoolbag system which is called Cloud Bag. The system includes four modules which are infrastructure, base interface, educational cloud service platform, terminal application. Then, we describe the core functional design of Cloud Bag electronic schoolbag which includes three parts, that is pre-application, custom application and the third party application. Finally, we introduce the functional display of platform software which includes the function of educational cloud platform management, the function of instruction and learning, and the function of basic resources construction. Among basic resources construction, we present the production and management of e-textbooks, the adding and production interactive micro-video, and the construction and management of examination content. The system primarily provides personal online learning space for students in the primary school to carry out formal learning and informal learning.

Keywords: electronic schoolbag; educational cloud service; electronic textbooks; interactive micro-video

1. Introduction

Currently, the development of educational informatization in mainland China is transitioning to a new stage with its key purpose to support effective teaching and learning to promote student's personality development. An educational information technology development level framework is raised in "The Development Plan within 10 Years of Educational Informatization (2011-2020)," it claims that pedagogic methods in schools should make a breakthrough both in terms of student diversity and personalized learning [1]. As an advanced tool for updating the traditional form of textbooks, electronic schoolbag receives worldwide concern in the educational

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_43

field. The electronic schoolbag has its own advantages in supporting students' personalized and mobile learning. It also provides a means to promote the personalized development of students.

2. The related concepts and definition of electronic schoolbag

In the present, there isn't a unified understanding for the concept of electronic schoolbag yet. Professor Zhiting Zhu considered that electronic schoolbag is a personal portable mobile terminal from the hardware perspective and it's a personalized learning environment from the system function framework of education and instruction for electronic schoolbag [2]. Dongming Qian considered that electronic schoolbag is a personal portable information terminal which can support reading e-textbook, managing learning resources, recording personal learning profile and provide personal learning tools and interactive learning tools for a variety of effective learning styles [3]. Bin Wang thought that electronic schoolbag is a digital learning space which can support mobile learning. And it is based on web and mobile devices as well as architecture for promoting students' meaning learning [4]. Although there are various perspectives for the definition of electronic schoolbag, we can make a conclusion from various definitions that personalization and mobility are common features of electronic schoolbag. It has a unique advantage in the aspect of personalized learning and mobile learning. Therefore it can support the development of students' personality.

The electronic schoolbag appears in the background of development of the educational information technology in mainland China. It can satisfy multiple learning methods in new situations, solve the problems in today's instruction and learning, and fulfill the needs of educational information technology from elementary to higher levels. We define the electronic schoolbag as a personal learning environment, based on the educational cloud, in which students can read interactive electronic textbooks, manage personal learning resources, and communicate with other students, complete exercises, while the students' personal learning files are recorded. It consists of the electronic textbook system, digital resources system, the assignment and examination system, exchange and communication system, and electronic learning files system.

3. The design and development of electronic schoolbag

3.1 The system architecture of electronic schoolbag

Based on our definition for the electronic schoolbag, we design and develop an electronic schoolbag system which is called Cloud Bag. The system regards the platform of educational cloud service and personal terminal application as the core and provides instructional support services of "cloud plus client" for primary and secondary education scene which is based on the basis of infrastructure and interface. The basic system architecture is shown in figure1. Among them, the basic infrastructure mainly solves the basic problems which include data storage, network communications and user data relationships. Educational cloud service platform offers two major services including instructional support and digital publishing. The former one provides the appropriate instructional process support for relevant participants that include instructors, students, parents and school administrators. The latter one provides service including the processing, managing, distribution and operation of digital content for the publishing. As to terminal application which includes the basic application of personal terminal electronic textbook reader, resource library, assignment and examination and e-portfolio and custom applications, it can be served for instruction and learning models.

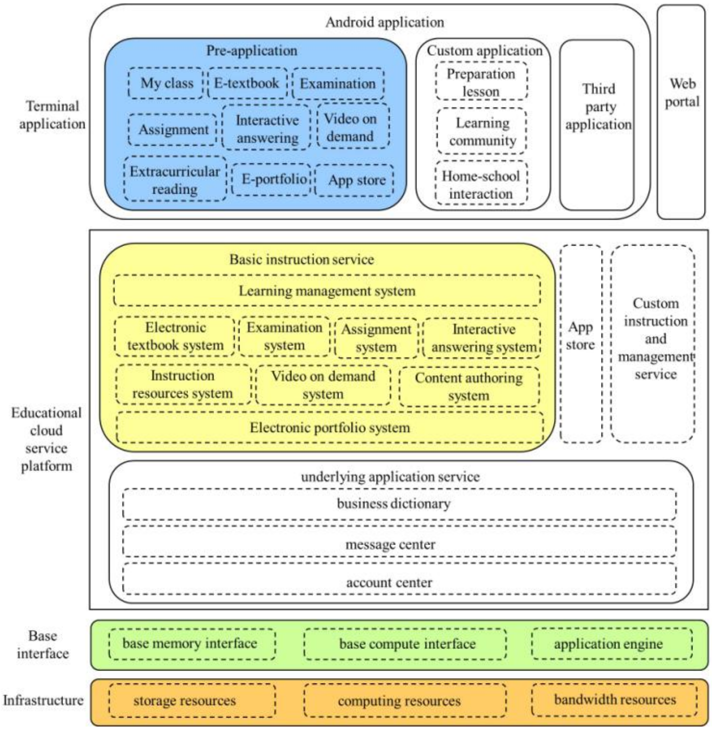


Fig. 1. The system architecture of Cloud Bag electronic schoolbag

3.2 The core functional design of Cloud Bag electronic schoolbag

The based applications of Cloud Bag electronic schoolbag terminal should be able to assist and support the basic instruction and learning activities. Meanwhile, it will meet the needs of learners more personalized and flexibility through the introduction of custom applications and third-party applications. These basic applications which are on the basis of based instruction service provided by cloud service platform form core functional module of Cloud Bag system which include e-textbooks, resource library, assignment and examination as well as electronic portfolio. And these core functional modules will support the most common instruction and learning activities. The specific features of the system are shown in figure 2. It includes three sections which are pre-application, custom application and third party application. Pre-application provides basic terminal service for instruction and learning. Custom application provides customized service according learners needs. Third party application mainly provides some free applications from online for learners.

Fig. 2. The function of Cloud Bag electronic schoolbag system

4. The functional display of Cloud Bag platform software

The function of Cloud Bag platform software includes the management of educational cloud platform, instruction and learning, as well as construction of basic resources. All functions are shown in figure3. The software has six characteristics. Firstly, it has universal terminal characteristics. It can be used in various terminal devices which include smart phone, tablet pc, laptop, and personal computer. Also, it can adapt to different operating systems that include Win7, Win8, android, IOS and other operating system. Secondly, it has level of universality. The platform is based on cloud computing technology and the function modules which are applicable to school and municipal as well as central level can be selected. It can be used as a school private cloud service platform or mixed service platform. Thirdly, it adapt to various stages of educational information technology. Due to the different levels of educational information technology, this platform can satisfy the needs of electronic schoolbag with different stages of educational information development. Fourthly, the electronic textbook distribution system in the platform is based on intelligent knowledge base technology. And it can issue the same kind of content to different terminal equipment as well as various operating system and can automatically adjusted to fit the terminal display. Fifthly, it can support for all kinds of digital resources so as to enable instructors to create digital lesson plans and school-based electronic learning materials. Sixthly, it has the continuity of traditional instruction habits characteristic. The platform supports the existing instruction and learning activities and can be used with current paper-based materials.

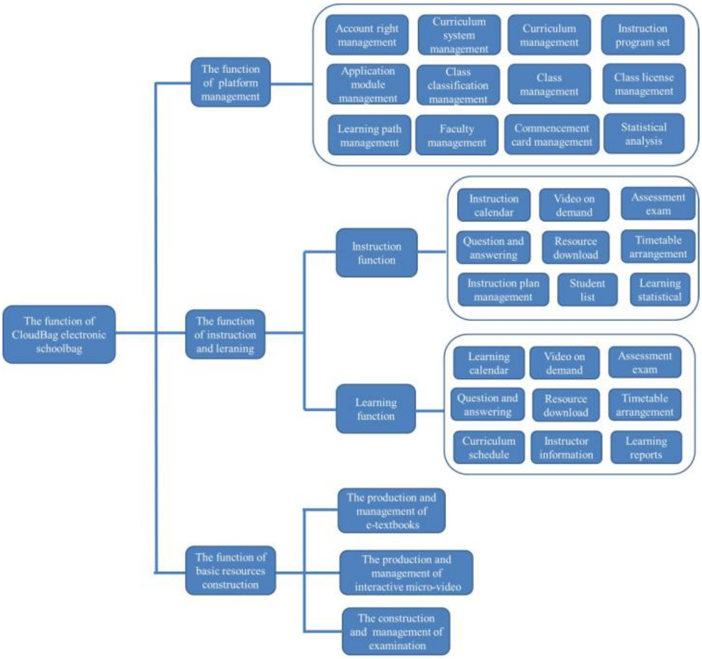


Fig. 3. The function of Cloud Bag platform software

4.1 The function of educational cloud platform management

The objective of educational cloud platform management is to achieve different management which includes right management for administrators, management of class and curriculum, as well as the management of various instruction and resources. The specific features include account right management, curriculum system management, curriculum management, instruction program set, application module management, class classification management, class management, class license management, learning path management, faculty management, commencement card management, and statistical analysis.

4.2 The function of instruction and learning

The function of instructor's terminal is to provide support for various teaching processes of instructors. The specific features include instruction calendar, video on demand, assessment exam, question and answering, resource download, timetable arrangement, instruction plan management, student list, and learning statistical. The function of student's terminal is to provide support personalized learning for various students. The specific features include learning calendar, video on demand, assessment exam, question and answering, resource download, timetable arrangement, curriculum schedule, instructor information, and learning reports.

4.3 The function of basic resources construction

Cloud Bag platform provides rich construction and management of basic resources, so that it can facilitate quality educational resources' management, use and share. There are three types of functions which include the production and management of e-textbooks, the production and management of interactive micro-video, the construction and management of examination.

4.3.1 The production and management of e-textbooks

The convenient e-textbook authoring tool is provided by Cloud Bag and it support editing for the text's catalog and content. In the e-textbook, we can add six interactive segments which include interactive texts, interactive images, interactive slides, interactive videos, interactive subjective questions, and interactive groups. These interactive segments make e-textbooks' content and forms of media more diverse. In addition, the authoring tools provide collaborative editing functionality which greatly improves the efficient of the e-textbook editing.

4.3.2 The production and management of interactive micro-video

The cloud platform of Cloud Bag provides a tool for producing interactive micro-video which supports for the operation of adding interaction points. In the dialog box, you can fill in the interaction points which include point's name and time, selecting the event scenes. According to the video content and specific activities, we can add corresponding type of video interactivities, so that the video content can be achieved accurately identified. In addition, for the purpose of improving the production efficient of the interactive micro-video, the tool provides the function of collaborative editing. And it provides a locking function of the video for preventing repetitive editing the same video.

4.3.3 The construction and management of examination content

The features of Cloud Bag examination include basic management of exam, subject management, as well as examination paper management. Among them, the basic management of exams is for different disciplines and it can achieve unified management of interdisciplinary exam. Subject management support for the exam in the subject title of classified in accordance with the kinds of questions. Currently, it can support four types of questions which include one choice question, multiple choices question, essay question, complex question. As to examination paper management, it supports creating the papers for instructors' own needs and it can be screened for specific questions, specific difficulty, specific knowledge, specific types of questions, so that instructors can make personalized exam papers.

5. Future work

As we design electronic schoolbag system based on educational cloud service platform, we will cooperate with more than three electronic schoolbag experimental schools and conduct pilot applications with this system. We hope to find the problem of the system in the practice and improve its' function by design-based research. At the same time, we select the backbone of the pilot school disciplines, such as language, mathematics, as well as English as the research object, and explore the effective instruction pattern and format a number of demonstration lesson through continued use. Then, we will analyze the applied effect of different instruction pattern, so that it can provide theoretical guidance for academic resources, academic instruction instrument as well as the design of learning environment with the electronic schoolbag.

References

[1] The Development Plan within 10 Years of Educational Informatization (2011-2020). Retrieved from:http://www.moe.gov.cn/publicfiles/business/htmlfiles/moe/s3342/201203/xxgk_133322.html.
[2] Zhu, Z.T.& Yu, X.H.(2011). Electronic schoolbag system and its functional modeling [J]. Electronic Education Research, (4), 24-27.
[3] Qian, D.M& Guan, Y.Q.(2012). The design research of terminal technology rule about electronic schoolbag [J]. East China Normal University (Natural Science), (2), 91-98.
[4] Wang, B& Zhu, S.Y.& Liu,M.M.(2011). The discussion of the related problem with the development of electronic schoolbag [J]. Electronic Education Research, (9), 88-94.

The Development of the Haiku Application Corresponding to Specification Changes and its Evaluation

Nobuhiko Takada*1), Issei Yoshida*1), Masami Suzuki*2), Ryoichi Yanagisawa*1)
Kanazawa Gakuin University*1) , KDDI R&D Laboratories, Inc. *2)

Abstract. In recent years, the progress of smartphones has been remarkable and expanded at an explosive pace around the world. Moreover, a lot of applications in smartphones have been also developed every year. But we comprehend that papers about Haiku applications have been hardly reported. We tried to build the environment which could perform Haiku activity with only one smartphone outdoors. This time, we newly developed the Haiku application in the Android OS ver.4.2 and we experimented in the students of the Japanese department at our university.

Keywords: Smartphone・ Haiku・AR・Android OS・ubiquitous

1 Introduction

Now, applications in smartphones have been developed briskly. Functions of smartphones are closer to personal computers and smartphones can also offer an environment where they operate in some added values in executing applications. We developed a haiku application in smartphones last time [2]. This time, we tried to improve the environment where we could compose haiku poems with only one smartphone outdoors. In order to make young students with smartphones have an interest in Haiku, we the development environment focusing on Android OS and extracted functions required to support haiku activity. We newly developed this haiku application in Android OS ver. 4.02 and experimented in it to the students of Japanese Literature. (Fig.1).

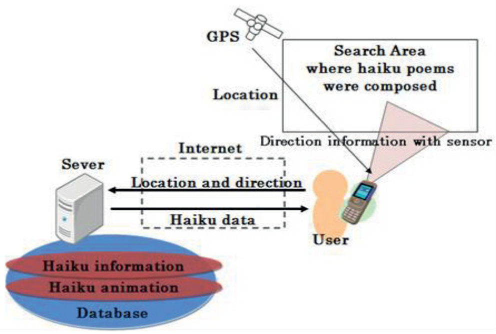


Fig.1: Overall view of the system supporting Haiku Activity with a smartphone

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_44

2 Related Studies

Google distributes Android SDK for nothing, and offers tools and APIs required for an application development in the Android OS platforms in the Java language now. In the application development on Android OS, there are a lot of practical application programs more than papers based on Android OS. In Haiku, there is "Sazareishi" (in Japanese), which is an application supporting to compose haiku poems [2]. It means that they do not have to search words and verses by a book, which is a compendium of seasonal words about Haiku. In the paper with smartphones, there is an "Environmental monitoring system Chu-lingual which can be contributed with the smartphones using an insect sound" which proposed the discernment technique with the sound of an insect in the field of natural science [3]. In recent years, the papers about Android OS have increased quickly in some fields. However, applications for supporting the Haiku Poem Activity with high technology have been hardly reported yet.

3 Development of Haiku Application

3.1 Comparison of Traditional Method and New One

We clarified the required functions and compared the difference with the traditional method and this new one to develop this Haiku application. We asked the professors, who were in our department of literature, about needed tools in the case of composing haiku poems by the traditional method of not using high-tech info tools. The result is shown in Table 1 [4].

Table 1: The list of the conventional method and the method using high-tech info tools

New tool	Traditional tools (Without mobile phones)
Smartphone	・Kigo dictionary（Saijiki）：to kook up kigo etc. ・Pens or Pencils etc.: to use to compose haiku poems ・Notepad: to write down haiku poems ・Related books: to refer information when composing haiku poems ・Maps: to check the destination ・Bag : to bring the above things

4 Functions of Haiku Application

4.1 Summary of Application

We developed the Haiku application in Java language based on the functional design of Chapter 3. As the result, We realized the following 4 functions such as ” the function to search words and phrases”, “the function to submit haiku poems”, “ the function to search the destination search”, and “the function to search the detailed destination”, in a native application which could operate on a smartphone as shown in Fig. 2.

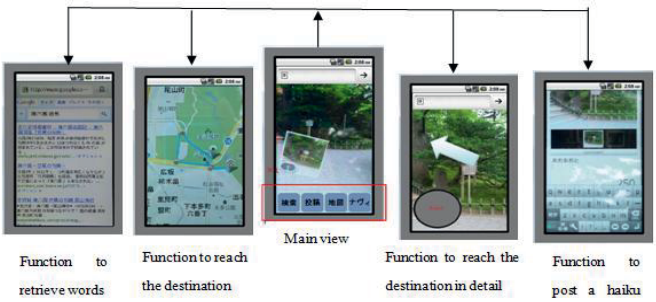


Fig 2. Relations of Haiku Application

5 Experiment of Haiku Application

5.1 Purpose and Experiment Environment

We experimented focusing on the operation and operability of functions, utilizing the smartphone developed in Android OS ver.4.2. Subjects were 22, who were fourth graders of the Japanese literature department at our university. The equipments were seven sets (one group consisted of 3-4 persons) of the smartphones. We asked them to move from our school to the Kenrokuen Garden operating a smartphone, and to reach the destination. After reaching there, they input and submitted their haiku poems. Then, we asked them to describe a questionnaire.

5.2 Experimental Result and Consideration

Figure 3 shows the experimental result.

No.	Items
A	Collecting information to compose haiku poems
1	Was it easy to search information?
2	Was it quick to search information?
3	Was the searched information useful?
4	Was it all right only with a smartphone?
5	Was it possible to search information while moving?
B	Movement to the destination
6	Could you arrive at the destination only with a smartphone
7	Was the map on the screen easy to look?
8	Was it all right only with a smartphone?
9	Was the function to arrive at the destination useful?
10	Could you arrive at the destination without being at a
C	Creation of haiku poems
11	Could you compose a haiku?
12	Could you compose a haiku only with the smartphone?
13	Were a paper and a pencil not necessary?
D	Input and submission of a haiku
14	Could you input a haiku exactly?
15	Could you input a haiku smoothly?
16	Could you correct a haiku exactly?
17	Could you correct a haiku smoothly?
E	Total
18	Is it better to use a SP?
19	Do not carry books related to compose a haiku?
20	Do you want to compose a haiku with a SP ?
21	Is it meaningful to compose a haiku with a SP ?
22	It is easier to compose a haiku with a SP?

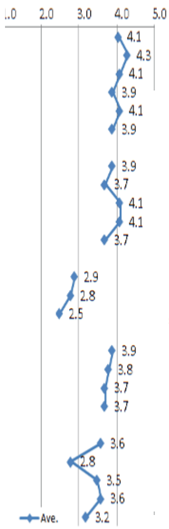


Fig.3 Result of a questionnaire

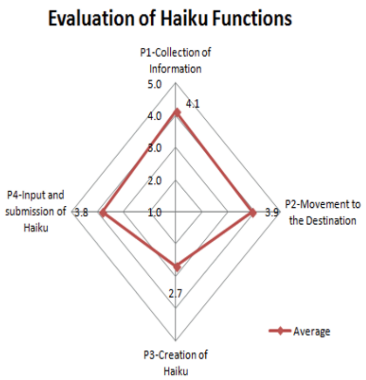


Fig.4 Evaluation of Haiku Functions

This evaluation consisted of 22 items in five groups. We adopted standard five-step evaluation to evaluate the questionnaire. Since there were 22 subjects, it was difficult for us to take enough objective data. Therefore, we asked them to do free description about each item and also summarized qualitative opinions carefully.

Fig 4. shows the evaluation of Haiku function. Since all of P-1, P-2, and P-4 had approximately 4.0 average marks in evaluation of each group, it could be said to be high evaluated as shown in Fig. 3. However, in composing haiku poems of P-3, the average mark was not so high as 2.7, there were several opinions that it was a little inconvenient to use only a smartphone, so it was better to use writing materials such as a notebook and pencils. Although a smartphone had a function for correcting one piece of haiku poem, in case of selecting only one haiku from some composed haiku poems, it was difficult only by this function.

6 Conclusion and Future

This time, we newly developed the Haiku application in the Android OS ver.4.2, which had been developed in the ver2.2 last time. We experimented in this haiku application on the fourth graders of the Japanese literature department at our university. As a result, it became clear that the improved haiku poem application was fully able to respond to them. However, in the stage of composing haiku poems, it was hard to respond only with a smartphone. As the result, we discovered the following problems.

- There are no functions of choosing one from some composed haiku poems now.
- It is better to polish some composed haiku poems after handwriting in order to conceive freely.
- Although they are used to compose haiku poems with paper and pencil, we should consider a function to replace in a smartphone.

As mentioned above, although it can respond enough to complete one haiku poem, it is impossible to secure the size of an about note (A4). Since the display screen (4.7 inches) of a smart phone is small, we would to try an experiment next time using the size of iPads etc.

This research has received the support of Sciences Research Grant (Base Research (C)) as (subjecnumber: 23501180) in 2013.

References

[1]Takada,N.,Suzuki,M.,Yanagisawa,R.,Asami,K.: Construction of Haiku Application on Android OS, jSiSE Research Report,vol.25.no.5.pp.3-10(2011)

[2]Saiseki,http,//product.hscnet.jp/sazareishi/index.html

[3] Wada,T.,Akita,J.,Kitagawa,A.: Environmental Monitoring System in Cooperation with Smartphones by Automatic Identification of Insect Sounds － Chu-lingual, IPSJ Jounal,53(3),pp1017-102(2012).

[4]Takada,N.,Suzuki,M.,Yanagisawa,R.:Construction of a new user experience support environmental system for Haiku with Smartphone, conference of the Society for Information Technology and Teacher Education(2012)

The Strategies for Designing Collaborative Scripts

Qian Zhao[1], Guang Chen[2] and Liang Yu[3*]

[1] School of Foreign languages, Chongqing College of Humanities, Science & Technology, China
jullyzhao@qq.com
[2] Faculty of Education, Beijing Normal University, China
[3]College of Computer and Information Science, Southwest University, China
{teastick, toliangyu}@gmail.com

Abstract. Collaborative script is a kind of design, program and description for collaborative learning process. Teachers control the collaborative learning process invisibly by designing collaborative script and facilitate the occurrence of collaborative learning. This paper systematically constructs the four strategies of designing collaborative script, which are task analysis, timing arrangement, role definition and resource allocation.

Keywords: collaborative learning, scripts, cooperative skills, knowledge construction

1. Introduction

Collaborative learning is widely taken as an effective instructional method. The effect of it mainly depends on the richness and intensity of interactions engaged in by group members during collaboration [1]. However, when learners are left to their own devices, they hardly engage in productive interactions such as asking each other questions, explaining and justifying their opinions, articulating their reasoning, or elaborating and reflecting upon their knowledge [2]. Collaboration scripts are activity models that aim to facilitate collaborative learning by specifying activities in collaborative settings, sequencing these activities, and assigning the activities to individual learners. Through specifying a sequence of learning activities, together with the appropriate roles for the learners, collaboration scripts can be designed to trigger the engagement of students in learning activities that would otherwise occur rarely or not at all. Collaboration scripts can inspire students to take part in learning activities energetically, result in better knowledge building and facilitate collaborative learning [3, 4, 5, 6, 7, 8]. Collaboration script consists of four basic elements: tasks, sequence, role and resources. The following introduces the scripted strategies.

2. Task analysis

*Corresponding author: Liang Yu
Email: toliangyu@gmail.com

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_45

The task analysis for designing collaboration scripts aims at the following two purposes: first, we should analyze the applicableness of collaboration task, that is, we should analyze the learning tasks that suit to collaborative learning or not; second, we should ensure to build the interdependence among tasks and interdependent relationship among subtasks, and this kind of interdependent relationship is advantageous to the cooperation among the team members and the more active participation of group members. In this article, we take two methods from Jonathan's task analysis classification which including 5 categories and 21 kinds of analysis methods for reference, then amend them by combining with the characteristics of collaborative learning task. The task analysis can be guided by the two methods for designing collaborative learning script. One is Analytic Hierarchy Process, by which we can analyze the applicableness. The other is dependence analysis and it is the effective method to establish interdependence.

3. Timing arrangement

Timing arrangement is often combined with task analysis, and it is the description of task in the time dimension. Besides, timing arrangement is a way for designers to manage collaborative time. The structure of timing arrangement is similar to the basic structure of program design which including sequence, circulation and branch. Timing arrangement is often combined with task analysis which confirms the relationship among subtasks. Timing arrangement should follow this relationship and establish the sequence for subtask time.

4. Role Definition

Role setting can guide individual behaviors, manage the interaction in teams, improve the group cohesion and enhance the sense of responsibility of members. The sense of individual responsibility and group cohesion correspond with "individual responsibility" and "positive interdependence" in collaborative learning. Individual responsibility is the consciousness of responsibility which teammates show in some aspect to improve the collective performance and undertake certain tasks when they want to finish the work. Positive interdependence is that the development of members' function and the achievement of learning outcomes both depend on the good performance of teammates. Both individual responsibility and positive interdependence are fundamental elements of collaborative learning. As role setting can effectively motivate the sense of individual responsibility and build the positive interdependence among teammates, it is helpful for collaborative learning activities' implementation to achieve learning goals [9]. There are four typical macro-roles in the traditional classroom of collaborative learning activities: caption, over-rider, Free riders and ghost [10]. These four roles can be analyzed from two dimensions as the effort level and target-oriented shown in Figure 1.

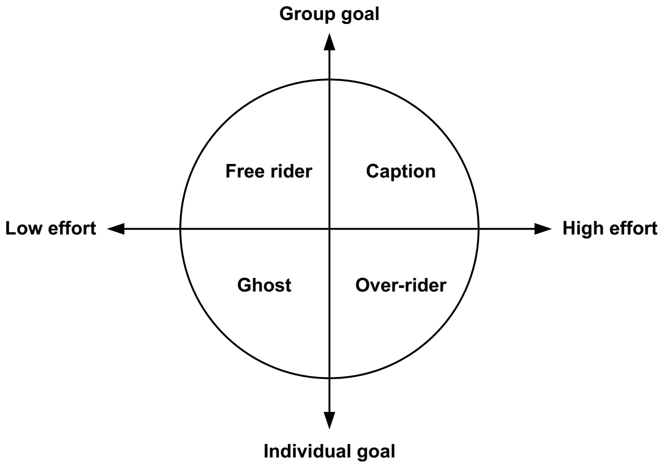


Fig. 1. The 4 typical macro-roles

The effort refers to the degree of labor that learners devote in the learning process. The left arrow points to the low degree of effort and the right arrow points to the high. Target-oriented indicates learners are guided by individual goal or group goal. The upward arrow points to the group goal and the downward arrow refers to the individual goal. Free riders agree with the group goal, but they seldom participate in group activities and their degree of effort is low. Captions are group target-oriented. Their high degree of effort leads them to organize collective tasks actively and create an atmosphere to guide group work. Although high degree of effort over-riders have, they are individual target-oriented. They try to control other members and make things towards the plans they set. For Ghosts, they are strongly individual target-oriented, but degree of effort low. Their negative effect on collaboration learning performance is maximum. It will seriously affect the implementation of group tasks. Aiming to motivate the sense of responsibility and build the interdependence relationship among learners, we introduce roles into collaborative scripts designing to help collaborative activities implement effectively.

5. Resource Allocation

Resources are the sum of elements relating to learning contents, which are used by learners in the process of learning activities for achieving learning objectives. It includes learning materials, learning tools, intermediary symbols and so on.

Resources are one of the core elements of collaborative learning activities. According to the collaborative learning goals, resource allocation means that we organize and distribute resources reasonably within the scope of the group in order to build interdependent relationship among learners. The allocation of resources can facilitate different degrees of interaction, stimulate learners' debates, interpretations and managements, and promote the learners' knowledge construction and the achievement of collaborative skills goals.

The aim of resource allocation is to construct interdependent relationship between learners based on the learning objectives, build collaborative learning environment, and ensure the collaborative learning activities carried out effectively. We believe that the allocation of resources has the following four kinds of typical structure: independent structure, aggregation structure, parallel overlap structure, and sequence overlap structure.

Acknowledgements: This work was supported by Fundamental Research Funds for the Central Universities under Grant No. XDJK2014A002, and the Doctoral Fund of Southwest University under Grant No. SWU111036l.

References

[1]Dillenbourg, P., Baker, M. J., Blaye, A., &O'Malley, C. (1995). The evolution of research on collaborative learning. In E. Spada & P. Reiman (Eds.), Learning in humans and machine: Towards an interdisciplinary learning science (pp.189-211), Oxford: Elsevier.

[2]Barron, B. (2003). When smart groups fail. The journal of the learning sciences, 12(3), 307-359.

[3]Antonio R. Anaya and Jesús G.Boticario(2009).Reveal the Collaboration in a Open Learning Environment. J. Mira et al.(Eds.):IWINAC 2009,Part I, LNCS 5601,PP.464-475.

[4]Baruch B.Schwarz, Christa S.C.Asterhan, Julia Gil(2009). Human Guidance of Synchronous E-Discussions: The Effects of Different Moderation Scripts on Peer Argumentation. Paper presented at the Proceedings of the 9th international conference on computer supported collaborative learning (CSCL 2009), Aegean, Greece.

[5]Pantelis M. Papadopoulos, Stavros N.Demetriadis,Ioannis G.Stamelos. Analyzing the Role of Students' self-Organization in a Case of Scripted Collaboration(2009). Paper presented at the Proceedings of the 9th international conference on computer supported collaborative learning (CSCL 2009), Aegean, Greece.

[6]Rummel,N.,Spada,H.,Hauser,S.(2009).Learning to collaborate while being scripted or by observing a model. International Journal of Computer-Supported Collaborative Learning, 4, 69–92.

[7]Schellens,T.,Van Keer,H.,De Wever,B.,Valcke,M.(2007).Scripting by assigning roles: Does it improve knowledge construction in asynchronous discussion groups?. International Journal of Computer-Supported Collaborative Learning, 2(3), 225–246.

[8]Schoonenboom, J.（2008）. The effect of a script and a structured interface in grounding discussion. International Journal of Computer-Supported Collaborative Learning, 3(3), 327–341.

[9]Mudrack, P.E., & Farrell, G.M.. An examination of functional role behavior and its consequences for individuals in group settings[J]. Small Group Research, 1995,26(4):542-571.

[10]Strijbos, J.W., & De Laat, M.F.. Developing the role concept for computer-supported collaborative learning: An explorative synthesis [J]. Computers in Human Behavior, 2010, 26(4):495-505.

Thinking of Everyone: Responsive Web Design for a Math OER Project

Hongxin Yan[1] and Lawrence Poon[2]

[1] Centre for Learning Design and Development, Athabasca University, Athabasca, Canada
hongxiny@athabascau.ca
[2] Faculty of Health Disciplines, Athabasca University, Athabasca, Canada
lawrence@athabascau.ca

Abstract. Presenting mathematical symbols and equations for online learning has been a challenge for educators and web developers. An open educational resource (OER) math website called Math Support for Calculus was built in 2008 at Athabasca University with the goal of supporting learners in first year undergraduate calculus courses. In the project, Flash was used to develop learning activities, for computer users. As the online learning environment is becoming diverse and ubiquitous, this OER project requires a new website with responsive design and a cross-browser mathematical display engine. In this paper, the problems that learners encountered while accessing the current website are described, the rationales for choosing Drupal, MathJax and MathML as the framework to develop this new site are discussed, and the advantages of using MathJax over Flash are analyzed.

Keywords: Responsive Web Design • Mobile Learning • Drupal • MathJax • MathML • Flash • Accessibility • OER

1 Introduction

Introductory calculus is a prerequisite for higher studies in many disciplines, but it is among the introductory level courses that have the lowest completion rates in North America [1, 2, 3]. An Inukshuk-funded math OER project to provide learning support in this area was initiated in 2007 at Athabasca University, Math Support for Calculus (MSC). In the project, a website [4] with five standalone modules was developed in 2008 to offer just-in-time learning support for students registered in calculus courses requiring a refresher in algebra. At that time, presenting interactive mathematical equations was a big challenge for the project. Based on the project scope and available technical resources, the MSC website was

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_46

developed using HTML + MathML + Flash. The target students are those online learners using desktop or laptop.

With the development of new Internet technologies and mobile devices, the learning environment is becoming more and more diverse and ubiquitous. People are learning any time and from anywhere. In this stream, mobile learning (m-Learning) is growing very rapidly. According to Vantage Path, 47% of organizations are now using mobile devices to support formal learning, and by 2017 it is expected that tablets and smartphones will outsell PCs and laptops [5]. According to Brandingbrand [6], mobile visits increase every year, from less than 10% in 2010 to 48.1% in April of 2014. Smart phones, tablets, iPhones, iPads and even Google Glasses are providing a new online learning environment.

2 Limitations of the Original MSC Website

When the project began in 2008, mobile learning was not as advanced as today. As a result, mobile learners were not considered in the project scope of the MSC. The learning experience on the MSC website was built mainly for computer users. The page layout, navigation, and web structure look exactly the same on any device. Because of the smaller screen on mobile devices, the structure of the site created navigating difficulties for learners on the go.

Secondly, for the original MSC website that is still running live, Flash™ and ActionScripts were used to create the interactive exercises and assessments. Now, however, iOS does not support Flash, so iPad or iPhone users are unable to fully access this learning website.

Thirdly, math data used for exercises and assessments is stored in XML files, which are read by Flash and rendered in the browsers. Creating or editing these XML files is a challenge for educators without XML coding skills who wish to make changes to course content. Moreover, because of the limited capacity of Flash MathML API, not all MathML markup can be rendered by this Flash-based mathematical displaying tool.

3 New Website Needed

To overcome the limitations of the original MSC website, a better framework must be investigated to build a new version of Math Support for Calculus website (MSC2.0), which can reach everyone with math support needs – mobile learners as well as computer learners.

3.1 Responsive Web Design Approach

Responsive Web Design is an approach aimed at designing sites that can adapt themselves to any devices and screen size for optimal viewing experience at layout level [7]. Marcotte [8] defines three distinct parts of responsive design: a flexible grid; flexible images and media queries. According to Top 10 Design Trends for 2014, Responsive Web Design is a must and will become standard as smartphone and tablet adoption rapidly increases [9]. "Responsive web design is recommended by Google, it allows one website to provide a great user-experience across many devices and screen sizes, and it also makes managing your SEO strategy easier. For these reasons, responsive web design is the best option for your mobile SEO strategy [10]."

3.2 Mathematics Display Requirement

Another requirement for building the MSC2.0 website is the adoption of a mathematical display engine that can be supported by any browser on any device. For users of the current MSC website, Flash player plugin has to be installed in browsers in order to display the interactive activities that were created in Flash, and for users of iOS devices, those learning activities are simply invisible. The new mathematical display engine is expected to display math equations without any plugin installation requirement. Also, since in the MSC website the math contents were built on MathML data, it would be ideal if the new engine supports this math markup language so that the content can be reused.

4 The Framework for the New Website

After researching and testing, a framework to build the MSC2.0 website was decided: Drupal as the website building platform, MathJax as the mathematical display engine, and MathML as the math markup language for content.

4.1 Why Drupal?

Drupal is an open source content management platform that is used to easily organize, manage and publish the content. It has the capacity for an endless variety of customizations and has thousands of add-on modules [11]. Also it is actively used and supported by a community of people around the world. This flexibility in customization and functionality can make the MSC2.0 website in any way needed. Drupal has the following advantages to build this new site:

Responsive Design. The first reason to choose Drupal is that it has many professional responsive web themes available. With the responsive theme, web developers can create a single website that adapts layout and content to viewing contexts across a spectrum of digital devices [12], and the appearance of the entire website can be tailored to different screen size for optimal learning experience. With the theme, web developer can quickly set up a responsive website without any programming.

User Friendly Interface for Content Creation. In the MSC website, all the data is stored in XML file, limiting the editing ability for educators without xml coding skills. While in Drupal, the data is stored in a database, and a WYSIWYG editor module can be used for data input. To create learning activities for exercises and assessments, the Drupal Quiz module can be used with a template for data input.

Interactivity Capability. Learning activities such as exercises and assessments in the MSC website provide practicing opportunities for learners. The Drupal Quiz module is the tool that can create such learning activities very easily. According to the Quiz module documentations, questions created can be Multiple Choice, Drag and drop, Scale, Matching, Short Answers, etc. Also, the Quiz module provides results reporting, randomization, and learning tracking. It has many feedback options and learners can take as many attempts as they like. [13].

Searching. Drupal Search function is a built-in feature. For a website that is offering just-in-time learning support, the search function would be very useful for users as they can quickly locate a concept or some content that they need from the website.

4.2 Why MathJax?

Some browsers now offer the native support for MathML to display mathematical equations. However, most browsers have a long way to go. The recent versions of Firefox can render MathML, but it needs more work for complex equation content. Internet Explorer relies on MathPlayer to render MathML, and Google removed the MathML rendering feature from Chrome last February [14].

Therefore, another solution is necessary. As Google claimed, “Google's browser will rely on a JavaScript workaround, not native support, for showing math equations” [13]. As a matter of fact, many mathematical display engines do exist, such as MathJax, jsMath, jqMath, MathTex, and Mathquill. After comparing [15, 17] and testing, MathJax seems the best option at this stage for MSC2.0 website building because of the following features [16].

a. High-quality typography. MathJax uses modern CSS and web fonts, so equations scale with surrounding text at all zoom levels in high-quality display result.
b. Simple integration. It is worth noticing that MathJax can be easily integrated with Drupal as a module.
c. Works in all browsers. This allows the math content to be seen clearly by all readers from any devices without the need of installing any plugin and fonts.
d. Supports MathML. In the MSC website, MathML has been created for math content. It would save tremendous time if the already existing MathML data can be reused for the new website MSC2.0.
e. Also, “MathJax is compatible with screen readers used by people with vision disabilities, and the Zoom feature allows all readers to see small details like scripts, primes and hats. ”

Among these math rendering engines, jqMath also gets lots of attention from users because of its faster rendering speed. However, jqMath mostly relies on local fonts and browser support, therefore it has trouble dealing with more complex content because browsers are not reliable enough [17, 18]. Therefore, MathJax seems the best option.

5 Building The New Website

5.1 The Drupal Theme Adopted

The first thing to build this website is to choose a Drupal theme. Because of the responsive design requirement, the theme used for the project website is called Premium Responsive, which was developed by Davsaran.com. Premium Responsive is claimed to be a fully responsive mobile-friendly theme with four distinct configurable layouts and multi-level dropdown menus. It supports HTML5 and multilingual. After testing, we found it works well as expected.

5.2 The Drupal Modules Installed

The project is using the following Drupal contributed modules:

- MathJax - is the engine to render MathXL
- CKEditor – is the online HTML editor for the content provider. As the MathXML can only be rendered through Drupal PHP Code Filter at this stage, CKEditor is mainly for non-MathXML content.

- Quiz and Quiz Question– is the framework for creating exercise and assessment questions. Most of the questions in the project are multi-choice questions.

In order to make those modules work best for this MSC2.0 website, certain configuration has been done for these modules.

5.3 The Navigation Menu of the Demo Website for MSC2.0

With a certain Drupal theme, it is easy to create a navigation system for a website. When creating navigation for a responsive website, developers should always keep in mind of the constraints of mobile devices. Some best practices of creating navigation for mobile are considered [21], and the W3C Mobile Web Best Practices [20] as well. On the demo site of MSC2.0, a drop-down menu in the header and a tree-like menu at the bottom were designed for mobile screen. While for computer screen, it only has a tree-like menu on the right column of the web pages. In order to do so, the original CSS files in the theme had been customized. The screenshots in the next section illustrate the responsive feature of the navigation system for different devices.

5.4 Screenshots of the Demo Website

The following screenshots are taken from different devices and screen size to show the responsive design feature, the mathematical display quality, and the look of the learning activities.

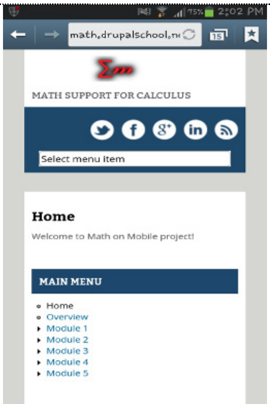


Fig. 1. Home Page on Smartphone (Sumsung Galaxy S III)

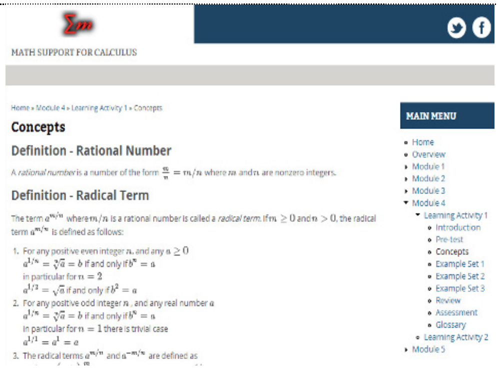


Fig. 2. “Concepts” Page on Desktop

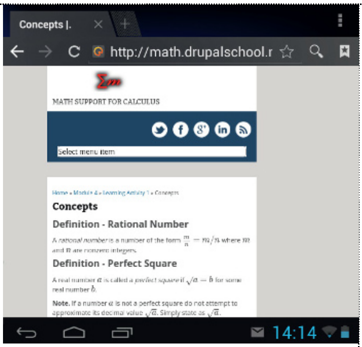


Fig. 4. "Concepts" Page on on 7-inch Tablet (Portrait View)

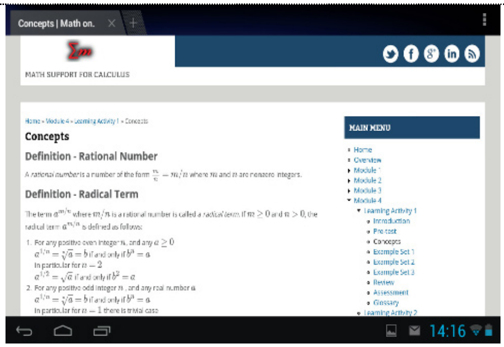


Fig. 3. "Concepts" Page on 7-inch Tablet (Landscape View)

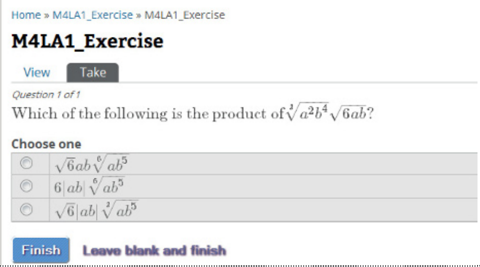


Fig. 5. Exercise activity

6 Work to Do for the Next Step

For faster mathematical rendering on mobile: MathJax is powerful and capable of displaying most of the mathematical equations. However, its big disadvantage is the slow rendering speed on mobile devices, especially for formula-heavy pages. MathJax is working on this issue [22]. In the meantime, the possibility of breaking those formula-heavy pages into multi-pages for mobile devices will be considered.

Implementing a visual math editor: To make data input easier in Drupal, an interactive equation plugin editor, Wiris, is possible to be integrated with the CKEditor installed on the MSC2.0 website [23]. For the next step, how to install Wiris plugin will be explored so that users with no technical skills can create equations by using Wiris visual math editor.

Project Evaluation: At current stage, only one module out of five is being built for a sample. Once it is accomplished, we would like to conduct a peer-review and learner testing observation. Then, by referring to the feedback, we will finish the whole project. We also would like to set up a Google analytics tracking profile with this site and hope to gather the user learning data that would give us some hints on how to further revise the project.

7 Conclusion

Displaying mathematics online has been a challenge for educators and developers. As mobile learning rapidly expands, and the number of the iOS device users is growing fast, Flash-based learning resources built for computer screen brought big challenges to mobile learners. A new framework that embraces the responsive web design approach was chosen to develop the MSC2.0 website for this math OER project. The new framework provides learners with the opportunities to learn on any devices, from anywhere and at any time. Further research for the MSC2.0 website includes how to integrate the Wiris plugin into Drupal CKEditor for visual math editor, how to render MathML without using PHP Code Filter inside Drupal and how to optimize the mathematical rendering speed on mobile devices.

References

[1] Weber, K. (2001). Students' difficulty in constructing proofs. Educational Studies in Mathematics, 48, 101-119.
[2] Wood, L. (2001). The secondary-tertiary interface. In D. Holton (Ed.), The Teaching and Learning of Mathematics at University Level: An ICMI Study (pp. 87-98).
[3] Brandel, G., Hemmi, K. & Thunberg, H. (2008), The widening gap – a Swedish perspective, Mathematics Education Research Journal. 20(2), 38–56.
[4] Math Support Calculus, http://ocw.lms.athabascau.ca/
[5] Mobile Learning Facts, http://www.learndash.com/9-surprising-mobile-learning-facts/
[7] Harb, E., Kapellari, P., Luong, S., & Spot, N. Responsive Web Design.
[8] Marcotte, E. (2011). *Responsive web design*. Editions Eyrolles.
[9] Top 10 Web Design Trends for 2014, http://99designs.com/designer-blog/2014/01/22/
[10] Responsive Web Design for SOE Reason, http://searchenginewatch.com/article/2253965/
[11] Drupal, www.drupal.org.
[12] Gardner, B. S. (2011). Responsive Web Design: Enriching the User Experience. *Connectivity and the User Experience*, *13*.
[13] Drupal Quiz Module, https://drupal.org/project/quiz
[14] Google Subtracts MathML from Chrome, http://www.cnet.com/news/
[15] Math Rendering, http://www.intmath.com/blog/wp-content/math-rendering-comparison.php
[16] MathJax, http://www.mathjax.org/
[17] MathJax vs. jqMath http://programming.oreilly.com/2013/11/mathml-forges-on.html
[18] jqMath vs. MathJax, http://mathscribe.com/author/jqmath-mathjax-perf.html.
[19] Loading and Configuring MathJax, http://docs.mathjax.org/en/latest/configuration.html
[20] W3C Mobile Web Best Practices 1.0, http://www.w3.org/TR/mobile-bp/
[21] Best Practices on Mobile Navigation (p.5), http://www.webdesignerdepot.com/2012/11/
[22] Understanding mathjax performance, https://github.com/mathjax/MathJax
[23]Wiris for Drupal, http://www.wiris.com/en/news/plugins/informal-instructions-plugin-drupal [March 23, 2014]

Toward Recommending Learning Tasks in a Learner-Centered Approach*

Hazra Imran[a], Mohammad Belghis-Zadeh[a], Ting-Wen Chang[b], Kinshuk[a], Sabine Graf[a]

[a] Athabasca University, Edmonton, Canada
{hazraimran,kinshuk,sabineg}@athabascau.ca;mobelghis@yahoo.ca
[b] Beijing Normal University, China
tingwenchang@bnu.edu.cn

Abstract. Learner-centered education becomes more and more popular. One way of offering learner-centered education is to have assignments where learners can select from a pool of learning tasks with different difficulty levels (e.g., many easy tasks, few challenging tasks, etc.). However, a problem that learners can face in such assignments is to select the tasks that are most appropriate for them. In this paper, we introduce a rule-based recommender system that supports learners in selecting learning tasks. Such recommendations aim at helping learners to select the tasks from which they can benefit most in terms of maximizing their learning.

Keywords: Recommender system, personalization, learning management system

1 Introduction

The demand of online learning is growing quickly as it provides learners with many advantages such as learning wherever and whenever they want, at their own pace. There are two main pedagogies for learning: teacher-centered and learner-centered. In teacher-centered learning, the teacher directs the learning process and decides what a learner has to do during a course. While this pedagogy has been very common, nowadays, a shift can be seen towards learner-centered learning [1]. Learner-centered learning [2] is an approach where a learner chooses what and how to learn. The benefits of such paradigm are that it motivates learners, promotes active learning, and can enhance their performance [3, 4]. When it comes to selecting what to learn, learners can base their decision on their knowledge and interests. However, in some situations, selecting the right topics, materials, and/or tasks can be difficult. In such situations, recommender systems can help making appropriate selections. Several recommender systems have been implemented in e-learning [e.g., 5, 6]. However, most of these recommender systems focus on recommending learning objects or learning material.

In this paper, we introduce a rule-based recommender system that aims at recommending learning tasks. Following a learner-centered approach, more and more

* The authors acknowledge the support of Mitacs, NSERC, iCORE, Xerox, Athabasca University and the research related gift funding by Mr. A. Markin.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_47

courses have assignments that allow learners to select from a pool of learning tasks with different difficulty levels (e.g., a learner can choose to complete many easy tasks, a few challenging tasks, etc.). The proposed rule-based recommender system supports learners by providing them with recommendations on which learning tasks are most suitable for them, considering their performance, the performance of other similar learners, and which tasks the learners selected initially.

The remainder of the paper is structured as follows: Section 2 presents related work. Section 3 describes the rule-based recommender system. Section 4 presents the validation of the approach. Finally, Section 5 concludes the paper by summarizing the main contributions of our approach and presenting future directions.

2 Related Work

Recommender systems help users in making decisions from available choices. Recommender systems for e-learning platforms use techniques such as clustering and/or learner ratings to find other similar learners and provide recommendations based on what worked well for those other similar learners. For example, Tang & McCalla [6] developed an e-learning system to recommend technical articles like conference papers and book chapters to learners in a course. They used clustering approach to find similar learners based on learners' interests, background knowledge and recommendation goals. The recommendations were based on the usage and ratings of the papers.

Some recommender systems consider the difficulty level, for example, of a learning object in their recommendations. For instance, Chen et al. [7] proposed a personalized system to recommend course material to learners. Their system uses item response theory to estimate the abilities of learners based on their responses to questions related to the difficulty and content of course material. Based on a learner's response, the system re-evaluates the learner's ability, tunes the difficulty parameters and then recommends appropriate course materials. Another example is given by Kumaran & Sankar [5], proposing a recommender system to recommend a "topic of study" to learners. The system uses a semantic network to represent learner profile and domain knowledge. The recommendations are based on rating and performance of the learner.

Our work is different from existing research works in several ways. First, while most recommender systems focus on recommending learning objects or materials, our system aims at recommending learning tasks. Second, while many recommender systems depend on learners' ratings, our system is based on the actual performance of similar learners, which is automatically gathered by the system. Third, we consider the difficulty level of learning tasks in a detailed manner, where our approach first identifies priorities for difficulty levels and then selects tasks within the difficulty levels that are most suitable. Fourth, many recommender systems build groups of similar learners using clustering. Instead of clustering, our recommender system uses a neighborhood approach to find similar learners, which provides the advantage that the number of clusters and the number of learners within a cluster do not have to be predefined and therefore, ensures that only very similar learners are grouped together.

3 Architecture of a Rule-based Recommender System

In this section, we introduce a rule-based recommender system that provides recommendations of learning tasks within a course. The system has been designed to be integrated in any learning management system. Fig 1 depicts the architecture of the system. In the next subsections, the four main modules of the rule-based recommender system are discussed in further detail.

3.1 Learner Modelling Module

The Learner Modelling Module aims at gathering information about the learner. At this point, this module considers four types of information: learning styles, prior knowledge, expertise level and performance. Learning styles indicate a learner's preferences and approaches towards learning. To identify these learning style preferences, a well-investigated and commonly used questionnaire called Index of Learning Styles (ILS) [8] is provided to learners during the registration process. Furthermore, prior knowledge about the topics in the course and expertise level related to the course is gathered during the registration process. In addition, the module gathers learners' performance data throughout the course, whenever learners receive marks on tasks. All gathered data are stored in the Learner Model.

3.2 Neighborhood Generation Module

The Neighborhood Generation Module aims to find the neighbors of a target learner (a learner for whom a recommendation should be calculated). To find such neighbors, an algorithm is used that describes each learner, L_i (i =1,…,m) as a vector consisting of a learners' characteristics (i.e., learning styles, expertise level, prior knowledge and performance). The similarities between learners are computed based on the commonly used distance measure, Euclidean distance. In order to ensure the equal effect of each characteristic, the data are normalized to values between 0 and 1. Euclidean distance (L_i, L_j) is the distance between the vectors representing the two learners L_i and L_j. The formula to calculate the Euclidean distance between two learners is shown in Formula (1).

$$Euclidean\_distance\ (L_i, L_j) = \sqrt{\sum_{k=1}^{n}(L_{ik} - L_{jk})^2} \quad , \qquad (1)$$

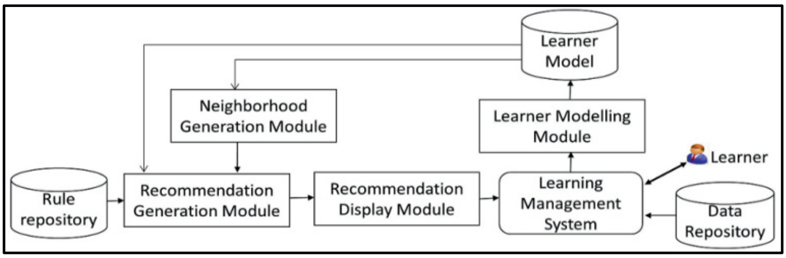


Fig. 1. Architecture of rule-based recommender system

where L_{ik} denotes the characteristic k of learner i and n denotes the number of characteristics considered. In order to calculate the neighbors, a threshold t is used as radius. Accordingly, for a target learner L_i, we consider every other learner L_j (j=1 … m and j != i) as a neighbor if *Euclidean_distance* $(L_i, L_j) <= t$. To determine a suitable value for a threshold t, we assume that two learners can be considered as similar if the difference between each characteristic is on average equal or lower than 0.25 (on a scale from 0 to 1). Accordingly, the Euclidean distance between two such learners would be 0.66. Therefore, we consider 0.66 as threshold to calculate the neighborhood.

3.3 Recommendation Generation Module

The Recommendation Generation Module aims to generate suitable recommendations for a target learner. Each learning task can have one of three difficulty levels: Easy (E), Moderate (M), and Challenging (C). The recommendations are based on (1) the target learner's previous performance on tasks of each difficulty level within the whole course, (2) the average performance of the neighbor learners on tasks of each difficulty level in the unit where a recommendation has to be provided and (3) the selection of learning tasks proposed by the target learner to complete within the unit where a recommendation has to be provided. Since information about the target learner's performance is essential to provide a proper recommendation, the system does not provide a recommendation for the target learner's first unit. The recommendation generation process is based on following two steps:

Ranking of difficulty levels. This step aims to determine how well each difficulty level suits a target learner and accordingly determine a ranking of difficulty levels. Each difficulty level is associated with one of three priority levels: highest priority level (HPL), medium priority level (MPL) and low priority level (LPL). HPL indicates that the respective difficulty level (can be easy, moderate or challenging) is most appropriate for a target learner and will be recommended with highest priority. Each difficulty level is assigned to one priority level, where each priority level can be assigned only once. Table 1 shows the rules to identify HPL. If there is no information available about the target or neighbor learners' performance on tasks with certain difficulty level, then this difficulty level is ignored in the part concerning the target and neighbor learners' performance.

Table 1. Rules to identify HPL

	Target Learner' Performance (whole course)		Neighbors' Performance (respect. unit)		HPL
If	E > M & C	AND	E > M & C	Then	Easy
If	E > M & C	AND	M > E & C	Then	Moderate
If	E > M & C	AND	C > E & M	Then	Easy
If	M > E & C	AND	E > M & C	Then	Easy
If	M > E & C	AND	M > E & C	Then	Moderate
If	M > E & C	AND	C > E & M	Then	Challenging
If	C > E & M	AND	E > M & C	Then	Challenging
If	C > E & M	AND	M > E & C	Then	Moderate
If	C > E & M	AND	C > E & M	Then	Challenging

Table 2. Example to show how MPL and LPL are assigned

	Moderate	Challenging
Average target learner's performance (on all previously conducted task within the course)	70%	N/A
Average neighbor learners' performance (on the tasks in the unit where recommendation is sought)	80%	50%
Combined average performance of target learner and neighbor learners	75%	50%

Once HPL is identified, the module next determines which difficulty levels should be assigned to MPL and LPL. In order to do that, again, the average performance of the target learner on previously conducted tasks and the average performance of neighbor learners on tasks in the particular unit are considered. A combined average is built for both performances (from the target learner and the neighbor learners) and the difficulty level with the higher result is assigned to MPL and the difficulty level with the lower result is assigned to LPL. Table 2 shows an example where the difficulty level *easy* is already assigned to HPL and no information about the performance on challenging tasks is available for the target learner. Based on the results of the combined average performance of the target learner and neighbor learners (shown in Table 2), the difficulty level *moderate* is assigned to MPL and the difficulty level *challenging* is assigned to LPL. As a result, the overall ranking in this example shows that, easy tasks are more suitable than moderate tasks and moderate tasks are more suitable than challenging tasks.

Selection of learning tasks based on the ranks of difficulty levels. The aim of this step is to select the learning tasks that work best for the target learner based on the priority levels identified in the previous step, the average performance of the neighbor learners on the respective tasks (*Avg_N_Perform*) and what tasks the target learner chose initially. Twelve rules are used (shown in Table 3) and these rules are applied in the sequence shown in Table 3. The rules are applied until enough tasks are selected (e.g., until a maximum mark or number of tasks is reached). If *Avg_N_Perform* of a task is below a certain threshold *T*, this task is not selected since neighbor learners performed poorly on this task.

Table 3. Rules for the selection of learning tasks

1	Select HPL tasks where *Avg_N_Perform* > *T* and is SELECTED by target learner
2	Select HPL tasks where *Avg_N_Perform* > *T* and is NOT_SELECTED by target learner
3	Select HPL tasks where *Avg_N_Perform* is UNKNOWN and is SELECTED by target learner
4	Select HPL tasks where *Avg_N_Perform* is UNKNOWN and is NOT_SELECTED by target learner
5	Select MPL tasks where *Avg_N_Perform* > *T* and is SELECTED by target learner
6	Select MPL tasks where *Avg_N_Perform* > *T* and is NOT_SELECTED by target learner
7	Select MPL tasks where *Avg_N_Perform* is UNKNOWN and is SELECTED by target learner
8	Select MPL tasks where *Avg_N_Perform* is UNKNOWN and is NOT_SELECTED by target learner
9	Select LPL tasks where *Avg_N_Perform* > *T* and is SELECTED by target learner
10	Select LPL tasks where *Avg_N_Perform* > *T* and is NOT_SELECTED by target learner
11	Select LPL tasks where *Avg_N_Perform* is UNKNOWN and is SELECTED by target learner
12	Select LPL tasks where *Avg_N_Perform* is UNKNOWN and is NOT_SELECTED by target learner

This threshold is set at 60% by default but can be changed by users (e.g., teacher or administrators) if needed. Furthermore, a task is considered as *SELECTED* if a target learner has chosen this task initially in his/her plan and considered as *NOT_SELECTED* otherwise. As a result of this step, the most appropriate learning tasks are selected for recommendation and then passed to the recommendation display module.

3.4 Recommendation Display Module

This module displays the recommendations to the learner. When a learner visits a unit the first time, the recommendations are shown in a pop up window. The target learner can accept them or ignore them. In any way, the recommendations are saved and can be accessed at any time through a button "Your recommendation" at the top of every page within the unit.

4 Validation

To evaluate our approach we have implemented it into the learning management system Moodle and applied it to a university-level course on Interactive Technologies. The course consists of four units that can be completed in any order. Each unit has one assignment and each assignment consists of several tasks. In order to achieve full marks on an assignment, learners need to get 22 points. However, learners can select different sets of tasks in order to reach these 22 points (e.g., completing many easy tasks, completing few challenging tasks, etc.). Before learners start to learn in the course, they are asked to read through all tasks of all units and select which tasks they plan to do. Then learners have to submit their plan of selected tasks. However, learners are free to alter the plans later.

In the following paragraphs, we present a case study to illustrate how our approach for providing learners with recommendations for personalized plans works. Let us consider a learner named Mary. When Mary registers for the course, besides providing regular information in the registration process, she is asked to fill out a learning style questionnaire as well as provide information about her expertise level and prior knowledge related to Interactive Technologies (as shown in Fig. 2).

Before starting to learn in the course, Mary submits a plan showing what tasks she plans to complete in each unit. Then, Mary completes Unit 1 and performs better in moderate tasks than easy ones, and has not tried any challenging tasks.

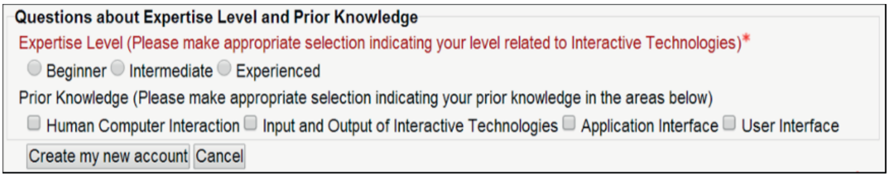


Fig. 2. Interface for gathering additional information about a learner

Table 4a. Average performance of Mary and neighbor learners

	Easy	Chal-lenging
Average performance of Mary in Unit 1	86%	N/A
Average performance of neigh-bor learners in Unit 2	78%	67%
Combined average performance of Mary and neighbor learners	82%	67%

Table 4b. Mary's initial plan

Task	Diffi-culty level
2.2	M
2.4	C
2.5	C
2.6	C

Table 4c. Average performance of neighbor learners in Unit 2

Task	Difficulty Level	Average Perform.
2.1	E	78%
2.2	M	81%
2.3	M	87%
2.4	C	70%
2.5	C	74%
2.6	C	59%
2.7	M	76%

Once Mary starts the next unit, the system provides her with a personalized plan. In order to do so, the system looks for neighbors of Mary based on her characteristics and then the system calculates the average performances of neighbors for tasks in each difficulty level. The system finds that, on average, Mary's neighbors performed better on moderate than easy and challenging tasks in that particular unit .According to the rules in Table 1, moderate tasks are the most appropriate difficulty level for Mary in this unit. In the next step, the ranking of the other two difficulty levels is determined. Table 4a shows the average performance of Mary on previously conducted easy and challenging tasks, the neighbor learners' average performance on easy and challenging tasks in Unit 2, and the combined averages of these two performances for easy and challenging tasks. According to Table 4a, for Mary easy tasks fit better than challenging tasks. Overall, this means that moderate tasks fit best for Mary, then easy and then challenging tasks. After that, the system checks Mary's initial plan (shown in Table 4b), the ranking of difficulty levels and the average performance of Mary's neighbors on tasks of each difficulty level in Unit 2 (shown in Table 4c), and applies the rules for selecting individual tasks (shown in Table 3). Accordingly, the first rule in Table 3 is triggered and leads to the selection of task 2.2. Subsequently, the second rule is triggered and leads to the selection of tasks 2.3 and 2.7. After that, the sixth rule is triggered and task 2.1 is selected. With these four selected tasks, Mary can score 22 points. Therefore, the stop condition is reached and no further tasks are selected. The final recommendation displayed to Mary is shown in Fig. 3.

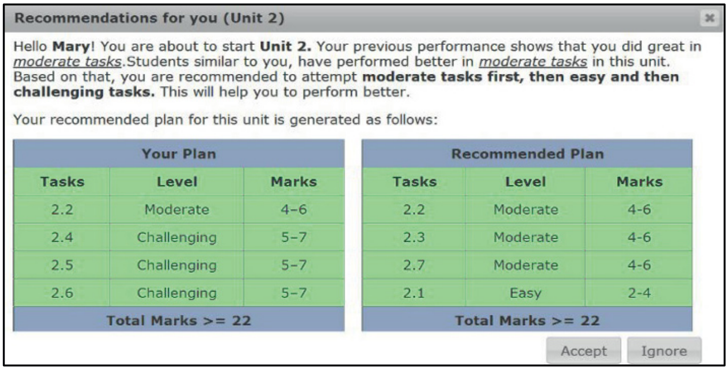


Fig. 3. An example of a displayed recommendation

5 Conclusions and Future Work

This paper presents a rule-based recommender system to provide recommendations of learning tasks to learners in a learning management system. A recommendation is based on the previous performance of the learner, the performance of neighbor learners, who have similar characteristics, and the selected learning tasks by the learner, considering the difficulty level of learning tasks for each of these criteria. The proposed recommender system supports learner-centered learning and helps learners to select tasks that are most suitable for them, with the focus on maximizing their learning. Furthermore, the system requires very little effort from learners. While many traditional recommender systems require learner ratings (e.g., of learning objects, etc.), the proposed system uses actual performance of other similar learners to identify which tasks worked well for those similar learners. In addition, the proposed recommender system uses an advance neighborhood approach to find similar learners. The neighborhood approach considers different characteristics of learners such as their learning styles, prior knowledge, expertise level and performance within the course and finds neighbors based on a distance measure. This enables our system to generate more suitable recommendations that support learners more effectively, leading to a better selection of learning tasks from which learners can benefit most. Currently, our recommender system requires teachers to label tasks based on their difficulty level. As future work, we will extend our approach to automatically identifying the difficulty levels of tasks and labelling tasks respectively. This would, on one hand, reduce the work required from teachers when using our system and, on the other hand, provide teachers with valuable feedback about how difficult their tasks are for their learners.

References

1. Rich, J. D., Colon, A.N., Mines, D., Council, C.: Learner-centered assessment strategies for greater student retention. Universal Journal of Education and General Studies, 2(6), 196-199 (2013)
2. Overby, K.: Student-Centered Learning: ESSAI: The College of DuPage Anthology of Academic Writing across the Curriculum, 9(32), 109-112 (2011)
3. O'Neill, G., McMahon, T.: Student-centered learning: What does it mean for students and lecturers? In O'Neill, G., Moore, S., McMullin, B. (eds.),Emerging Issues in the Practice of University Learning and Teaching, 1, 27-36, Dublin, Ireland (2005)
4. Armbruster, P., Patel, M., Johnson, E., Weiss, M.: Active learning and student-centered pedagogy improve student attitudes and performance in introductory biology. In: CBE-Life Sciences Education, 8(3), 203-213 (2009)
5. Kumaran, V. S., Sankar, A.: Recommendation system for adaptive e-learning using Semantic Net. International Journal of Computer Applications, 63 (7), 19-23 (2013)
6. Tang, T., McCalla, G.: Smart recommendation for an evolving e-learning system- Architecture and experiment. International Journal on E-learning, 4(1), 105-129 (2005)
7. Chen, C. M., Lee, H. M., Chen, Y. H.: Personalized e-learning system using Item Response Theory. Computers & Education, 44(3), 237-255 (2005)
8. Felder, R.M., Soloman, B.A.: Index of Learning Styles Questionnaire. North Carolina State University (1996). Available at http://www.engr.ncsu.edulearningstyles/ilsweb.html.

Towards an ICT Framework for Providing Inclusive Learning Objects for Indigenous Learners

John Loewen[1], David Loewen[2], Kinshuk[3], and Jarkko Suhonen[1]

[1] University of Eastern Finland, Joensuu, Finland
[2] Independent Researcher, Canada
[3] Athabasca University, Athabasca, Canada
johnl@student.uef.fi, jarkko.suhonen@uef.fi,
kinshuk@athabascau.ca, dloewen@mac.com

Abstract. There is a lack of a suitable formal standardization for compiling culturally contextual learning materials, creating learning objects from this material, and delivering them to indigenous learners. Indigenous learners in this context may refer to any community that emphasizes ecological and rural associations, referred by many as a holistic way of thinking. Alternate pedagogical approaches based in indigenous thinking methodologies, indigenous world-views are required. A model that delivers a way in which to create learning objects from this epistemological perspective would provide great utility. A proposed model is rationalized and presented, using ontological/folksonomic and fuzzy-logic concepts. The innovativeness of this work lies in the ability of the framework to bridge the gap between western educational pedagogy and indigenous holistic thought. The solution aims to provide relevancy in the learning objects used by indigenous communities. Future research includes an empirical study involving a pilot implementation of the model in a controlled environment.

Keywords: culture, indigenous, education, fuzzy logic, ontology, folksonomy

1 Introduction

Many researchers are questioning the validity of western-imposed educational pedagogy [1]. In a global context, many indigenous communities emphasize ecological and rural associations. [2] refers to this as following a place-based pedagogy, which is needed so that the education of citizens may have an effect on the well being of the social and ecological places that these people actually inhabit. Indigenous knowledge (IK) views communalism as a mode of thought, emphasizing the sense of belongingness with a people and the land they share, not disconnected from the land as a mere observer individualized and disconnected into a universal abstract, as is the case in Western scientific thinking. IK systems seem to build holistic pictures of the environment by considering a large number of variables qualitatively, while science tends to concentrate on a small number of

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_48

variables quantitatively [3]. What this means is that any learning model that is developed must take into account this difference in logic. [4] review how these two ways of thinking have been linked in the literature, especially the case for presenting IK as a holistic approach with parallels to adaptive management and fuzzy logic. What is missing in the literature is the establishment of a framework to incorporate this relationship into an educational system that may be used to create learning objects for learners. The purpose of this paper is to provide the justification for, and initial framework, incorporating fuzzy logic thinking into the creation of learning objects for holistic-thinking learners. This is the first step in a multi-step approach to developing a functioning system that fully incorporates this model.

2 Relevant Literature

As IK and western Euro-centric knowledge are different, it is important then to try and determine how they are different. From this position of knowledge, one can then make determinations on how this knowledge may be inclusive, and how this knowledge may be used in an educational context.

2.1 Indigenous Knowledge and Ways of Thinking are Different

According to [5], IK is part and parcel of the culture and history of any local community. Using knowledge and perspectives from the community level can help build a more complete information base than may be available from scientific studies alone [6]. [7] identifies that researchers have played a major role in knowledge co-production in these areas, always preceded by trust-building, development of working relationships, and respect for areas that should not be researched. IK evolves all the time and involves constant learning-by-doing, experimenting and knowledge-building. The fact that IK provides local-level understanding is particularly important because it complements science precisely at the level where information is scarce [3]. Human–environment relations for many groups have been characterized by knowledge and resource use systems that are holistic. Indigenous scholars are in agreement that it is imperative to include this way of thinking in to the learning systems of indigenous learners [7]. How this should be done is not as clear. A small but growing body of research has pointed to the power of engaging communities to elicit and create their own classifications in the knowledge and information systems they utilize [8].

2.2 Ontologies/Folksonomies – Top Down vs. Bottom Up Approaches

Ontologies and folksonomies have been used as a means in which to classify knowledge. Both have been applied in some way into indigenous knowledge systems. [9] states that ontologies are useful when the domain to be organized has a "small corpus, formal categories, stable entities, restricted entities and clear edges", with participants who are "expert cataloguers, authoritative source of judgment, coordinated users, expert users". [10] identify that previous work with indigenous peoples attests to the difficulties, both epistemological and political, of formalizing IK into written and digital forms. One of the main difficulties with ontologies is in their lack of flexibility; once the scheme has been created it is difficult to change. Additionally, there are the concerns of who decides the categories and what goes in each category. Issues encountered include formalizing the conceptual ontology as well as synonymy of terminology. On the other end of the spectrum, a folksonomy may be described a as a user-generated classification coming from the bottom-up. It is a "collaborative grass-roots approach where "relationships naturally emerge". It is important to note that folksonomies are inclusive; it thus promotes the forming of a social network among web users [5]. [11] use folksonomies to allow contributions to an indigenous digital library. The major advantage of using a folksonomy in this way is that it is open-ended and can respond quickly to changes in the way users categorize content. Disadvantages include a lack of precision (ambiguity), scalability issues, and a lack of hierarchy.

2.3 Gaps in the Research – Towards a Formalized Approach

How is this all relevant to a holistic system? Knowledge is of major importance for the development and deployment of learning technology. Content, learning objects, and learning technology system components are different notions of parts of a learning technology system [12]. If we are looking at a framework that will function as a tool that allows for the creation of holistic knowledge, the top-down approach (for example ontologies) proves to be too rigid and inflexible for an evolving set of knowledge whereas the bottom-up approach (for example, folksonomies) lack in precision, quantification, as well as a lack of scalability. What is needed then is a system that will provide the "glue" that is lacking in folksonomic classification, that is to say a way of providing quantification to this web of knowledge that has been created by a community or communities. This is where the work of [3] provides some key insight in to what kind of approach may work. IK, as an integral part of culture, tends to have an explicit social context; science does not. Indigenous scholars are often baffled by the preoccupation of western scientists to measure, count, and quantify everything. There is little to no accountability in western science for the relationship that the human plays in the environment. IK systems seem to build holistic pictures of the environment by considering a large number of variables qualitatively, while science tends to concentrate on a small number of variables quantitatively [3]. So to move forward, any framework that is created must provide a level of quantification for a knowledge system that has a high level of qualitative data.

3 Creating a Framework

It is important that a learning system, and the learning objects within take in to account both western epistemology, shown in Fig. 1 as World View "A" and indigenous epistemology, shown as world view "B".

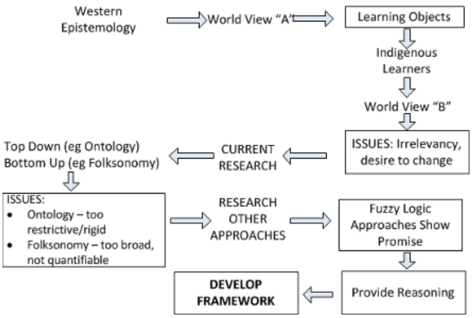


Fig 1. Progression of thinking

The issue with many learning systems is that the learning objects are created for world view "A" are used to teach to learners who are world view "B" thinkers". A new framework is needed. As an example of this type of progression, [13] propose that indigenous people (in this case, the knowledge of local fisherman) have an applied knowledge system that can be described as an expert system, a branch of artificial intelligence (AI) that provides theories and methods for automating intelligent behavior. These theories and methods are provided in the form of heuristic rules (expressed as IF-THEN clauses) are consistent with fuzzy logic thinking. As [3] observe, IK approaches complex systems by using simple prescriptions consistent with fuzzy logic. Logically, from this perspective, the place to start is to clarify how fuzzy logic may be leveraged to develop a framework that is inclusive of both ways of thinking.

3.1 The Fuzzy Picture

The key in the ability of IK systems to deal with complexity might be the use of 'rules of thumb,' simple prescriptions based on IK and understanding backed up by religious belief, ritual, taboos and social conventions [4]. It is well known in the theory of complex adaptive systems that complexity can emerge from simple rules [14]. Fuzzy logic shows promise in providing the glue that is missing to assist in bridging two very distinct epistemological ways of thinking. In the most broad of strokes, providing a "quantitative" measure to a "qualitative" way of thinking. With fuzzy logic, things need not be precisely defined or quantified before they can be considered mathematically; the model does not need precise inputs. Fuzzy logic puts together related objects into categories in such a way as to reduce the complexity of the processing task [3]. This concept is applied using linguistic variables in place of (or in addition to) numeric variables. For example, if "abundance" is the linguistic variable, then the linguistic values would be "plentiful, moderate, sparse", etc. Qualifying terms such as "and", "or, "not" are called linguistic connectives. Fuzzy conditional variables are defined as IF a THEN b, an ordered set of instructions. Using this logic over time with a set of observations, fuzzy models are able to quantify (by assigning values and weights) the qualitative judgments of a set of peoples (a community) based on their observations and expertise. The advantage of organizing in such a way is that "rule of thumb" thinking may be quantified and modeled in such a way as to provide learning opportunities for learners in a world-view that is familiar.

3.2 Providing the Glue

As identified by [15], the definition of the categorization of the data in a reusable way is a missing step in previous literature, and one in which providing a solution is not a simple process. What is needed then is a method, or framework, that will aid/assist in creating a comprehensive knowledgebase that is "quantifiable". In other words, creating a framework for the mapping, or establishing a baseline, of a holistic way of thinking. From this set of quantified knowledge it is then possible to create culturally relevant learning objects that may be applied in a useful manner to the learning system(s) of a community of learners. Local knowledge experts provide "practical data", data that is relevant to their environment.

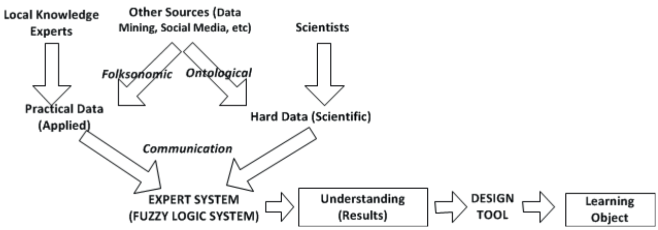


Fig 2. Model of proposed framework (Revised from Mackinson, 2001)

Other sources of data include data mining, various social media sources etc. The depth/breadth of this knowledge will depend on the communities involved. As an example, practical data that comes out of this process may include oral knowledge, in the form of stories and observations as well as folksonomic data. Hard data may include a formalized ontology or ontologies. From this, with consultation from stakeholders, using fuzzy logic terminology, the linguistic variables, linguistic connectives, and conditional variables for a given domain are then defined, as outlined by [8] and the expert system created. Once the system is initiated, the outputs may be determined, and from this, learning objects may be created using a design tool that incorporates standards to allow for reusability (for example IMS-LD or SCORM). Following a standardized approach also allows for scalability of the model, to reach a larger audience of learners, for example, mobile device users.

3.3 The Application of Fuzzy Logic – Towards a Model/Framework

There have been few applications of fuzzy logic in habitat studies. As stated previously, IK systems are holistic in nature, emphasizing ecological relationships, so there are parallels between these applications and a comprehensive learning system. One important feature of fuzzy approaches is that they allow for the consideration of uncertainty. Of the work done in the area of fuzzy logic expert systems, the majority is that of scientific data. Research by [8] stands out in the way that it incorporates knowledge from alternative sources, such as that of indigenous peoples, including what is referred to by the author as "hard data" (scientific data) and "practical data" which refers to the knowledge provided by First Nations people. Information may be gathered (for example through interviews of local knowledge experts, as well as other data sources) to add to a knowledge base about an area of interest/concern.

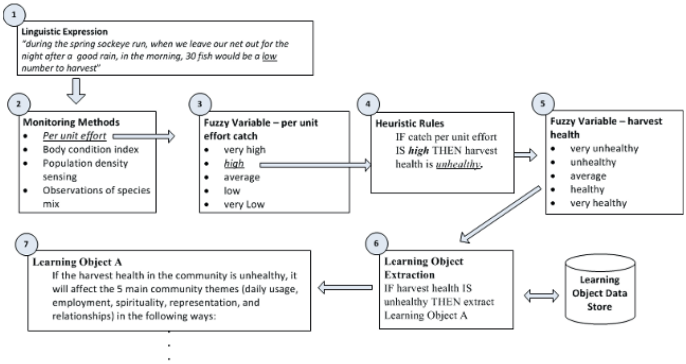


Fig 3. Simple framework example

For example, to show proof of concept, [16] identifies salmon as one of the cornerstone species for coastal First Nations peoples of British Columbia with 5 main themes; daily uses, employment, spirituality, representation, and relationships. A useful learning tool would effectively simulate how the level of salmon stocks within the traditional harvesting zone of a community affects each of these themes. The resulting expert system takes input values from the learner (through participatory design techniques) regarding the state of salmon as identified by all stakeholders.. These observations are then quantified using fuzzy modeling techniques, simulating outcomes based on the inputs. [16], using participatory design research, identifies how salmon brings communities together and is an irreplaceable process for many indigenous communities. Therefore, it is very important to conserve stocks in a long-term sustainable way. Example methods that may be relevant to salmon include catch per unit effort, body condition index, population density sensing, and observations of species mix ("rules of thumb"). Using fuzzy modeling techniques identified by [8], relationships may be established and heuristic rules written in natural language from the relationship between attributes affecting salmon stocks and the effect on the community. The heuristic rules capture knowledge contained in linguistic expressions given by stakeholders. An example linguistic expression may be "during the spring sockeye run, when we leave our net out for the night after a good rain, 30 fish would be a good number to catch". From this statement, it may be determined that the catch per unit effort is *high* (a range for the values of *very high, average, low* and *very low* are quantified). Per unit catch effort is referred to as a fuzzy variable with the resulting values). This fuzzy variable is included as the input into the expert system. Additional fuzzy variables are also defined separately as part of the output. In this simple example, the output fuzzy variable is defined as "harvest health" with values of *very unhealthy, unhealthy, average, healthy,* and *very healthy.* From this, then, heuristic rules may be created. A simple example of a rule set would be IF catch-per-unit-effort IS ***high*** THEN harvest health is ***unhealthy.*** Predictive modeling is used to determine the health of the harvest, which is given as the output. Based on the output of the system, learning objects may be created on the fly that are relevant to the "state" of the predictive analysis and ach state may have a resulting effect on the 5 main themes identified earlier. An individual learning object may be created for each effect. For example, if the harvest health is "unhealthy", a learning object may be created that provides insight on how an unhealthy harvest affects employment within the community.

3.4 Format of Learning Objects

The next step in the model/framework is to formalize the process on how to incorporate the feedback and learning opportunities in the process of creating reusable learning objects. The content of the learning object may be complemented from all relevant data sources, such as folksonomic, ontological, and scientific sources. The format of the outputs of the expert system may be interpreted (for example, using IMS-LD Level B to map the decisions made in the expert system to learning objects) and displayed in a graphical 2d or 3d format, showing the resulting effects in a place-based format which has been shown to be effective for indigenous learners [17], allowing the learner to navigate through these places, showing the relationships to the rest of the "holistic" system.

4 Conclusions and Future Research

Technological innovation using this model provides a culturally inclusive model for indigenous learners education that is both contextual to the user, providing cultural relevance for indigenous learners. The significance and originality of the solution lies in the fact that it provides a model of how to bridge the gap between remote rural and indigenous communities and educational resources by providing a method in which to apply relevant value and meaning, using the terminology and language of the learner, to learning content. Further research may include the development of the components of the framework, including a definition of the fuzzy logic linguistic variables, linguistic connectives, and conditional variables for a given domain, resulting in a system that will provide understanding (in the form of results) that may be incorporated into learning objects (for example, IMS-LD level B learning objects) as well as extending the schema of a well known LMS to incorporate cultural context for a system user. Empirical studies may be undertaken with pilot groups to determine the viability of the proposed solution.

References

[1] B. Sen, "Indigenous knowledge for develompent: Bringing research and practice togther," *International Information & Library Review,* vol. 37, pp. 375-382, 2005.
[2] D. A. Gruenewald, "The best of both worlds: A critical pedagogy of place," *Educational researcher,* vol. 32, pp. 3-12, 2003.
[3] F. Berkes and M. K. Berkes, "Ecological complexity, fuzzy logic, and holism in indigenous knowledge," *Futures,* vol. 41, pp. 6-12, 2009.
[4] C. Peloquin and F. Berkes, "Local knowledge, subsistence harvests, and social–ecological complexity in James Bay," *Human Ecology,* vol. 37, pp. 533-545, 2009.
[5] E. H. Greyling, "Content development in an indigenous digital library: a model for community participation," in *Proceedings of the IST-Africa 2009 Conference, Kampala, Uganda*, 2009.
[6] F. Berkes, J. Colding, and C. Folke, "Rediscovery of traditional ecological knowledge as adaptive management," *Ecological applications,* vol. 10, pp. 1251-1262, 2000.
[7] F. Berkes, "Indigenous ways of knowing and the study of environmental change," 2009.
[8] S. Mackinson, "Integrating local and scientific knowledge: an example in fisheries science," *Environmental Management,* vol. 27, pp. 533-545, 2001.
[9] C. Shirky, "Ontology is overrated--categories, links, and tags," 2007.
[10] C. C. Wellen and R. E. Sieber, "Toward an inclusive semantic interoperability: the case of Cree hydrographic features," *International Journal of Geographical Information Science,* vol. 27, pp. 168-191, 2013.
[11] E. Greyling and S. Zulu, "Content development in an indigenous digital library: A case study in community participation," *IFLA journal,* vol. 36, pp. 30-39, 2010.
[12] C. Pahl and E. Holohan, "Applications of semantic web technology to support learning content development," *Interdisciplinary Journal of E-Learning and Learning Objects,* vol. 5, 2009.
[13] S. Grant and F. Berkes, "Fisher knowledge as expert system: A case from the longline fishery of Grenada, the Eastern Caribbean," *Fisheries Research,* vol. 84, pp. 162-170, 2007.
[14] S. A. Levin and J. A. Harvey, *Fragile dominion: complexity and the commons*: Perseus Reading, MA, 1999.
[15] J. Loewen, "The need for technological innovations for indigenous knowledge transfer in culturally inclusive education," in *Advanced Learning Technologies (ICALT), 2012 IEEE 12th International Conference on*, 2012, pp. 577-578.
[16] H. E. Castleden, *As Sacred as Cedar and Salmon: A Collaborative Study with Huu-ay-aht First Nation, British Columbia Into Understanding the Meaning of'resources' from an Indigenous Worldview*: ProQuest, 2007.
[17] G. S. Aikenhead and M. Ogawa, "Indigenous knowledge and science revisited," *Cultural Studies of Science Education,* vol. 2, pp. 539-620, 2007.

Towards Flipped Learning Using Ubiquitous Learning Log System in L2 Learning Class

Noriko Uosaki[1], Hiroaki Ogata[2], and Kousuke Mouri[3]

[1] Center for International Education and Exchange, Osaka University, Japan
uosaki@ciee.osaka-u.ac.jp
[2] Faculty of Arts and Science and the Graduate School of Information Science and Electrical Engineering, Kyushu University, Japan
ogata@artsci.kyushu-u.ac.jp
[3] Graduate School of Information Science and Electrical Engineering, Kyushu University, Japan
mouri.kousuke.868@s.kyushu-u.ac.jp

Abstract. In this paper we have explored flipped learning. Flipped learning was classified into four types according to the facility we can afford. How we can encourage students to learn outside-class is a key issue in flipped learning. In our previous study it was found that our system called SCROLL (System for Capturing and Reminding Of Learning Log) contributed to the students' more involvement in outside-class learning. SCROLL is expected to play an important role in its effective implementation. A pilot evaluation was conducted to examine the effectiveness of our proposed learning scenario using SCROL and SNS. It enhanced the students' outside-class learning. Timing of posting outside-class task was also examined and the period of two weeks was found to be appropriate.

Keywords: flipped learning · L2 learning · mobile-learning · ubiquitous learning

1 Introduction

The emergence of Internet technology and telecommunications technology accelerated the dramatic change of learning environments over the decades. Various kinds of learning supports were made into a reality. These technologies allow learners to learn anytime, anywhere, and provide them with multiple ways of learning throughout the day, and it came to be called ubiquitous learning.

The progress of these ubiquitous technologies and realization of one device or more per learner have facilitated us to implement a new learning environment called

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_49

"flipped learning". In flipped learning, how we can encourage students to learn outside-class is a key issue. In our previous study, SCROLL contributed to the students' more involvement in outside-class learning [1]. Therefore we expect our system will be able to play an important role in effective implementation of flipped learning.

2 Related Works

2.1 Flipped Learning

According to Flipped Learning Network, it is defined as "a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter." [2]. It is often defined more simply as "school work at home and home work at school".

As one of the advantages of flipped learning, it can be "a means to increase interaction and personalized contact time between students and teachers" [3]. It is also expected that it can be a means to increase interaction not only between students and teachers but among students. Thus it enables us to realize a student-interactive collaborative learning, which is reported one of the most effective way of learning in L2 class [4].

2.2 Mobile and Ubiquitous Learning

Mobile and ubiquitous learning has generally been defined as learning with its use of mobile and wireless technologies. Its notion tends to include the mobility of the learner [5]. It has been recognized as one of the natural directions toward which computer-assisted learning is heading [6] [7] [8]. Especially, ubiquitous technologies have been expected to foster shifting from classroom-based learning to the one that is free from time and space boundaries.

Up to now, mobile and ubiquitous technology has been applied to a wide range of learning fields such as science, history, sports [9] [10] [11], and most often language learning [12] [13] [14]. Since it is a fast-evolving, constantly advancing field, its infinite potential is inevitably expected to contribute to implementation of flipped learning.

3 Motivations

One of the motivations for introducing flipped learning is to make use of class time for collaborative activities. The students felt it was the most useful to talk with international students among various activities [15]. It is regarded as one of the best ways to learn the target language to mingle with those who speak it. Since one of the authors' L2 learning class consisted of international and Japanese students, it fitted in order to make most use of class time with collaborative activities.

The other motivation is that L2 learning time at school is far from sufficient in Japan and there is a strong necessity to boost up outside-class learning time [1]. In order to solve this problem, flipped learning was expected to be one of the key contributors.

4 Flipped Rate

Flipped rate, a new term coined by the authors to indicate the rate how we can flip our class. It depends on the facility we can afford in a large part. There are some other influential factors such as instructors' competence, and quality of learning contents, but a technological aspect is focused in this study. Fig. 1 shows the correlation between enhancement of ubiquitous rate and flipped rate (ubiquitous rate: the rate of internet-connectivity plus mobility which enable us to learn anytime anywhere). The higher the ubiquitous rate, the higher the flipped rate we attain in our learning environment.

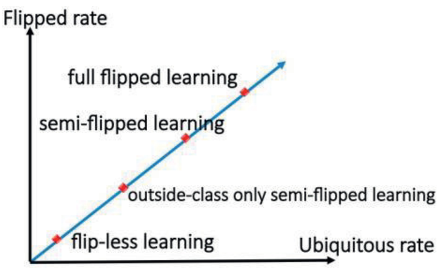


Fig. 1. Correlation between flipped rate and ubiquitous rate

Table 1. Type of Flipped Learning.

Flipped rate	In-class Mobile	In-class Fixed	Outside-class Mobile	Outside-class Fixed	Type of Flipped Learning
High	✓	✓	✓	✓	full flipped learning
	✓	✓	✓		
	✓		✓	✓	
	✓		✓		
		✓	✓	✓	semi-flipped learning
	✓	✓		✓	
		✓	✓		
	✓			✓	
		✓		✓	Outside-class only semi-flipped learning
			✓	✓	
				✓	
			✓		
	✓	✓			flip-less learning
low	✓				
		✓			

Table 1 shows types of learning available according to each mobile/fixed condition. There are four types of flipped learning based on the flipped rate: 1) full flipped, 2) semi-flipped 3) outside-class only semi-flipped, 4) flip-less learning.

When "mobile" is available for both in- and outside-class, flipped learning can be carried out seamlessly, thus we call it "full flipped". Mobility was emphasized because it enables learning anytime anywhere and it expands learning possibility as they do not have to stick to classroom and it also enables "niche learning" such as learning while in the train or in-between class. When either mobile or fixed computers are available for both in and outside-class, we call it "semi-flipped" because ubiquitous rate getting lower, still in- and outside-learning can be connected seamlessly through either internet-connected fixed or mobile devices. If there is “mobile” or “fixed” available only outside-class, they can still learn in a flipped way (outside-class only semi-flipped). If there is mobile/fixed available only in-class or nothing available for both in- and outside-class, it is virtually impossible to carry out flipped learning. Thus we call it flip-less learning.

5 SCROLL

5.1 System Design

SCROLL is a learning log system which allows learners to log their learning experiences with texts, photos, audios, videos etc., and to share and reuse them with others [16]. It runs on different platforms such as Android mobiles, PCs, and other smart phones and tablets (Fig. 2). Users register what they have learned, which we call “ubiquitous learning log objects (ULLs)”, to the system and view ULLs uploaded by themselves and others. The system automatically generates quizzes to help learners to recall their past ULLs and to shift them from short-term memory to long-term one.

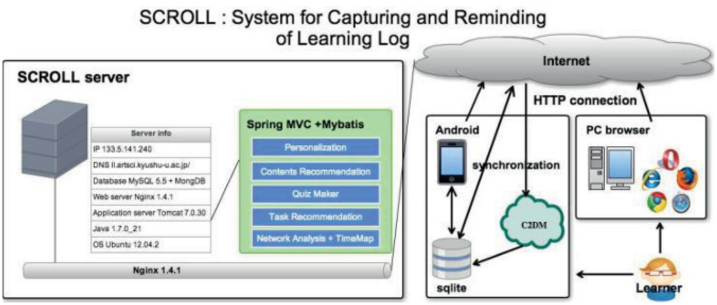


Fig. 2. System Configuration of SCROL

It is expected that the sharing function that we can share ULLs with others could give a great deal of support for implementation of flipped learning. Furthermore, its quiz function could support reinforcement of their learning, which is also expected to contribute to a successful flipped learning. In this study, SCROLL was used for an instructor’s uploading terms to be learned for viewing before class and terms which they learned during class for reviewing after class.

6 Pilot Evaluation

6.1 Participants

Eleven university students of computer assisted L2 learning class at Osaka University participated in the experiment. They were 5 international students (two from Netherland, two from Brazil, and one from Germany) and 6 Japanese students. They all reported that they had Internet-connected PCs at home and were mobile phone owners. Therefore we conducted class in a "full-flipped learning environment" (cf. Table.1).

6.2 Flipped Learning Scenario

The objectives of the subject class were 1) to improve their target language abilities: either English or Japanese and 2) to enhance cultural understanding by discussion and other collaborative activities. In order to make much use of class time, lecture part such as learning new terms, they were assigned to view contents on SCROLL as outside-class tasks. In addition, in order to encourage students' outside-learning, they created their own blog site and were given home assignment of composing essays using their target language. Furthermore, in order to promote their interaction outside-class, Facebook group was created. Learning procedures were shown in Fig. 3.

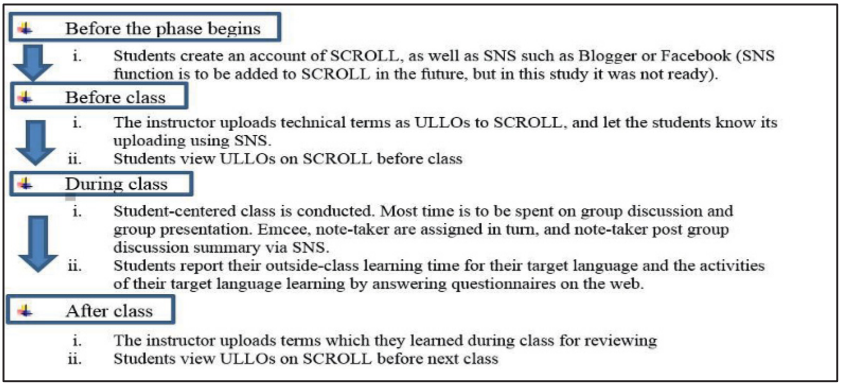


Fig. 3. Learning procedures

6.3 Results and Discussion

6.3.1 The average outside-class learning time for the target language learning

As mentioned, since it is a key issue how we can encourage students to get involved in learning outside-class in flipped learning, the participants were asked to report their outside-class learning time and what kind of activities were included on the questionnaire site. The average outside-class target language learning time for three months was shown in Table 2.

Table 2. Average outside-class learning time for the target language learning (per day)

	Outside-class Learning Time (min) Mean (SD)	Max	Mini.
Participants (n.11)	53.9 (27.6)	116.8	15.7

In our previous study, we had conducted an evaluation which lasted three weeks in university freshmen English class (non-flipped class) to find out whether SCROLL could contribute to the solution of lack of learning time [1]. Table 3 shows the average outside-class learning time for both groups per day: SCROLL group, 10.07 minutes, without-SCROLL group, 6.6 minutes. Both group hardly studied outside-class. Though SCROLL group had a little more committed to outside-class learning, the t-value (1.28) did now show its statistical significance.

Table 3. Average outside-class learning time in our previous study [1] (per day)

	Outside-class Learning Time (two weeks)	t	Effect Size (d)
With SCROLL	10.07 (SD:151)	1.28*	0.37 (Small)
Without SCROLL	6.6 (SD:115)		

*$p = 0.11$

Compared with our previous study, outside-class learning time dramatically increased, but there should be considered various factors which contributed to boosting up outside learning time. The interview session was conducted for the hardest worker whose average outside-class target language learning time was 116.8 per day. She reported that she had studied hard because she had intended to take IELTS (International English Language Testing System). Apparently it was IELT test that boosted up her outside-class learning time. Therefore it is too early to say flipped learning was one of the contributors.

6.3.2 Timing of posting an outside-class task

The students were assigned to view ULLs before class. Figures 3 and 4 show the questionnaire results on whether they learned a new term, ‘flipped classroom’. The first questionnaire result shows only 33% answered ‘yes’ to the question whether they knew it. In fact the exact the same 33% said ‘yes’ to the question whether they viewed it. Next class, the instructor encouraged them to view it and the second questionnaire conducted one week later shows 100% of the students answered ‘yes’. It seemed it was unlikely for them to do their outside-class task during the first week. Their performance was highly improved after the teacher pushed them to view it. Therefore it is recommendable to give them at least two weeks to view ULLs as an outside-class task.

(1) 1st time (2) 2nd time (one week later)

Fig. 4. Do you know what 'flipped classroom' means?

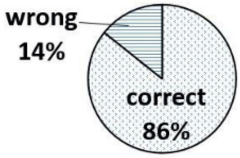
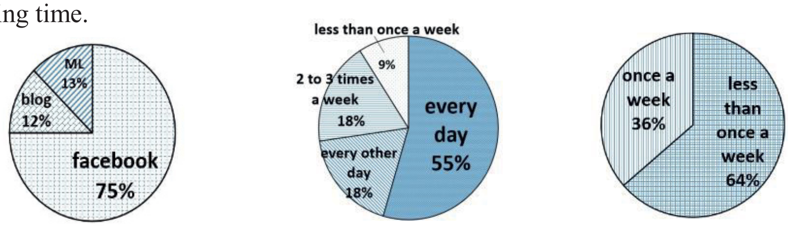


Fig. 5. What does 'MOOC' stand for?

The students were assigned to view a 4.5 minute introduction video of MOOC as an assignment. The instructor gave them a reminder the next class and a multiple-choice quiz was conducted two weeks later. Fig. 3 shows its result. 86% gave a correct answer. The result also endorsed it was adequate to give them two weeks to view an assignment video.

6.3.3 SNS contribution to outside-class learning

Since SNS function of SCROLL is yet to be ready, all the participants created their own blog including the teacher and became readers each other and Facebook group and a mailing list were also created in order to encourage outside-class interaction. According to the survey, 75% of the students used Facebook as a means of getting messages from the teacher (Fig. 6(1)). 55% of the students viewed Facebook posts every day, while 64% of the students viewed blog posts less than once a week (Fig.6(2)(3)). Therefore blog sites did not work as a means of communication outside-class, while Facebook group functioned as a group forum and they interacted each other using their target language outside-class, which, we believe, one of the contributors to boosting up their outside-class target language learning time.



(1) Means of getting messages (2) FB viewing frequency (3) Blog viewing frequency

Fig. 6. SNS contributions

7 Conclusion and Future Works

In this study, we explored flipped learning and conducted a pilot evaluation. It was found that outside class learning time increased in our proposed learning scenario, but still more examination was necessary to conclude its contribution. Timing of posting outside-class task was examined and found out that the period of two weeks is appropriate as far as this pilot is concerned. Full evaluation is scheduled to be conducted in the near future to examine whether these findings are replicated.

Acknowledgements. This research work was supported by PRESTO from Japan Science and Technology Agency, and the Grant-in-Aid for Scientific Research No. 26350319 from the Ministry of Education, Culture, Sports, Science and Technology in Japan.

References

[1] Uosaki, N., Ogata, H., Li, M., Hou, B., Mouri, K.: Enhancing Learning Time Using Learning Log System. In: *Workshop Proc. of ICCE2013*, pp.90-99, Bali, Indonesia (2013).
[2] Flipped Learning Network http://flippedlearning.org/domain/46
[3] Bergmann, J., Overmyer, J., and Willie, B.: The flipped class: What it is and What it is not. *The Daily Riff.* (2011). Retrieved from http://www.thedailyriff.com/articles/the-flipped-class-conversation-689.php
[4] Chen, T. X.: Interactive Learning of a Foreign Language. *Journal of Acoustic Society of America*, Vol.114, pp.30-30 (2003).
[5] Sharples, M. (ed.): *Big Issues in Mobile Learning: Report of a workshop by the Kaleidoscope Network of Excellence Mobile Learning Initiative*, University of Nottingham, UK. (2006).
[6] Chinnery, G. M.: Emerging technologies. Going to the mall: mobile assisted language learning, *Language Learning and Technology*, Vol. 10, No. 1, pp.9–16 (2006).
[7] Stockwell, G.: Vocabulary on the move: Investigating an intelligent mobile phone-based vocabulary tutor, *Computer Assisted Language Learning*, Vol. 20, pp.365–383 (2007).
[8] Thornton, P.,Houser, C.: Using mobile phones in English education in Japan, *Journal of Computer Assisted Learning*, Vol. 21, pp.217–228 (2005).
[9] Hwang, G.-J., Chu, H.-C., Shih, J.-L., Huang, S.-H., Tsai, C.-C.: A decision-tree-oriented guidance mechanism for conducting nature science observation activities in a context-aware ubiquitous learning environment, *Educational Technology & Society*, Vol. 13, No. 2, pp.53–64 (2010).
[10] So, H.-J., Kim, I. Looi, C.-K.: Seamless mobile learning: possibilities and challenges arising from the Singapore experience, *Educational Technology International,* Vol. 9, No. 2, pp.97–121 (2008).
[11] Gotoda, N., Matsuura, K., Hirano, T., Nabeshima, T., Kanenishi, K., Yano, Y.: Supporting Skill Awareness for Runners through Wireless Sensor Network. In: *Pro. of the 17th International Conference on Computers in Education*, Hong Kong, pp. 618–622 (2009).
[12] Levy, M.,Kennedy, C.: Learning Italian via mobile SMS, In: Kukulska- Hulme, A. and Traxler, J. (eds.) *Mobile Learning: A Handbook for Educators and Trainers.* London: Taylor and Francis, pp.76–83 (2005).
[13] Underwood, J., Luckin, R.,Winters, N.: m-iLexicon: Harnessing resources for personal and collaborative language inquiry. In: *Pro.* of ITEC2010, Kortrijk, Belgium, pp.87–98 (2010).
[14] Wong, L.H.,Looi, C.K.: Mobile-assisted vocabulary learning in real-life setting for primary school students: two case studies. In: *The 6th IEEE International Conference on Wireless, Mobile, and Ubiquitous Technologies in Education*, pp.88–95 (2010).
[15] Uosaki, N., Ogata, H.: Supporting communicative English class using mobile devices. In: *Proceedings of mLearn2009*, Orlando, USA, pp.94–102 (2009).
[16] Ogata, H., Hou, B., Li, M., El-Bishouty, M. M., Uosaki, N.,Yano, Y.: What if we can log our ubiquitous learning? In: *Proceedings of ICCE2010*, Putrajaya, Malaysia, pp.360–367 (2010).

Towards Smart Asynchronous Discussion Activity: Using Social Network Analysis to Investigate Students' Discussion Patterns

Jeonghyun Kim[1], Hyeyun Lee[1], Yesom Yoo[1], Hanall Sung[1], Il-Hyun Jo[2], and Yeonjeong Park[2*]

[1] Department of Educational Technology, Ewha Womans University, Seoul
{naralight, hyeyun521, aettom77, hanohl0212}@naver.com
[2] Department of Educational Technology, Ewha Womans University, Seoul
{ijo, ypark78}@ewha.ac.kr

Abstract. This study analyzed students' interaction patterns in asynchronous online discussion forums by using log files left in the LMS. In taking Social Network Analysis (SNA) and Learning Analytics (LA) approach, the centrality of participants, their networking patterns, characteristics of networks among multiple topics, and changed patterns by time were reviewed within a case study. Additionally, this study found that the instructor's initiation, students' autonomy to select topics, together with the use of sample essays influenced the online discussion patterns, which is effectively illustrated by SNA results. Finally, this study discussed that not only the use of SNA as an analytics tool but also the display of the SNA outputs as a presentation tool can facilitate their smart and effective discussion activity.

Keywords: Asynchronous Online Discussion, Social Network Analysis, Learning Management System, Learning Analytics

1 Introduction

Throughout the data extracted from LMS, especially from the discussion boards, a number of researchers have investigated various instructional issues including the students' interaction and communication patterns, the level of contributions from their group tasks and the relations between the discussion activity and students' learning achievements. Theoretically and practically, the online discussion activity has been recognized as an effective instructional method which facilitate students' critical thinking, argumentation skill, knowledge construction, and social interactions, within the well-executed design as well as the instructor/teachers' proper facilitations [1]. In addition, tracking and visualizing real-time data concerning students' learning processes dragged out from online behaviors is an emerging role of LMS for educational subjects.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_50

Ultimately, our study aims to utilize the outputs of SNA in a way to display the dynamic visualization of interactions in a dashboard format where each student is able to monitor their own contributions and thus, are motivated to participate in online discussions. As a basis for it, we took Social Network Analysis (SNA) and Learning Analytics (LA) approach, and the centrality of participants, their networking patterns, characteristics of networks among multiple topics, and changed patterns by time were reviewed within a case study.

We expect that such a Learning Analytics application can support students' smart learning environment where they monitor their behaviors timely, reflect themselves, and utilize the network information for more effective and smart discussion and interaction activity.

2 Literature Review

2.1 Learning Analytics

Learning Analytics (LA) is an emerging area that explores the measurement, collection, analysis and reporting of data which are associated with students' learning and their environment [2, 3]. LA focuses on the treatment for students' academic achievement by presenting the useful information extracted from the big data [4, 5]. The background of recent emergence of LA is fundamentally related to the 'evaluation'. Since evaluation of both students and instructors typically occurs at the end of course, the opportunity that students try to improve their performance is limited. However, if the information based on learning analytics is provided to students and teachers at the early or middle of course, students are able to attempt to improve their performance. Consequently, the potentials of LA has get attentions and attractions from many researchers and practitioners.

As an example, SNAPP (Social Networks Adapting Pedagogical Practice) presents students' social interaction on the discussion board of virtual classroom such as Blackboard, Web CT, or Moodle [6]. As seen in Fig. 1 and 2, the visualized interaction data is based on SNA. This analysis and display tool allows to identify isolated students and key actors in their discussion activity, network patterns, group malfunction, and students' networking patterns [7, 8].

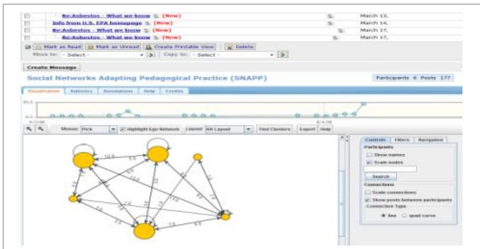


Fig. 1. Sample screen capture of SNAPP (Source: http://www.snappvis.org/)

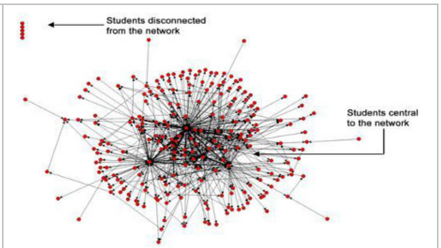


Fig. 2. Sample outcome of SNA (Source: Dawson [8])

2.2 Online Discussion Forum

Most previous studies on online discussion forums have attempted to carry out the content analysis in order to generalize and obtain the main points from the complexity of original messages in online discussions [9]. The process, for example, is to 1) review students' messages and communications on boards, 2) to develop several codes as the unit of meaning based on the researchers' analytic framework, 3) to assign the codes to the messages based on semantic ways, and 4) to analyze the coded messages quantitatively.

However, this process has a limitation of observing overall students' participations and interaction patterns. Moreover, counting the number of postings according to the several sub thematic categorizations and assessing students' participations are significantly challenging to analyze manually [10]. Also, the previous methods depending on the numbers of postings to assess students' participation in discussions have been criticized as it does not account for the quality of messages and role of students in their group works or discussion activities. Consequently, a SNA technique has been recognized as a proper strategy to form a synergy through the mix of contents analysis [9].

2.3 Social Network Analysis

SNA is a powerful method to observe students' interactions on discussion board [9, 11]. As peer influence where active social interaction is pointed out to be one of the most influential factor affecting online collaborative learning [12, 13], and analyzing such an interaction to achieve academic success of students participating in online interaction is a meaningful step. Since SNA allows us to review the students' social aspects on the individual level, group level, and even whole community level, the results suggest who the central actors are, how the actors interact with each other, what kind of roles the actors undertake in the forum, and how the interactions change by the actors' participations.

Furthermore, the SNA can be considered as a tool of social awareness [14, 15]. Predictions of at-risk or advanced students based on the relationship between academic achievement records and social network factors results from the SNA [11, 16]. It mainly involves educational data mining which is to discover meaningful knowledge by analyzing raw materials such as log data accumulated from every online activity of the target students.

3 Method

3.1 Research Setting and Questions

The venue of this study was a 2^{nd} semester course tilted as "Administration, legislation, and politics" with 43 students and 1 instructor from September to December in 2013 in A university of Korea.

In this case study, the online discussion activity, which is based on Moodle, has several unique steps. First, an instructor provided sample essays which facilitated students' discussions. Second, there was a strict rule that students have to write messages only related to the discussion topics, the messages should be more than 60 words, and greetings or simple expressions on agreements or disagreements were not allowed. Third, students can choose to participate among 12 different discussion forums.

Online discussion was analyzed by focusing on 1) how students participate in the discussion forums, 2) how students' discussion patterns are changed according to the discussion topics and the flow of time, and 3) how students' participation characteristics (centrality) impact their learning achievements.

3.2 Data Analysis

Basic content analysis was firstly performed to recognize what the major discussion topics were and to what extent the students participated in each discussion topic. Log data which presents who initially posted the messages and who responded to initial messages was extracted from the Moodle LMS. In addition, the number of messages that students have uploaded were extracted. The UCINET program was employed to analyze social network patterns. Researchers with educational technology background have attended this analysis. Finally, regression analysis, in using SPSS figured out what extent the factors such as degree centrality predict the final score of this course as well as all related variables.

4 Results

4.1 Overall Analysis

In this case study, the discussion forums had 1,373 messages. 98 discussions in 12 forums with different topics were proceeded in 12 weeks. Table 1 shows major themes and quantitative characteristics of 12 forums. Around 29 out of 43 students were participated in one forum discussion. Themes of forum were chose and structured throughout the instructor's initiation. However, students were allowed to decide their participation among 7-8 discussion topics in one forum. Consequently, the number of messages and number of participants indicate students' attentions and interests in the discussion topics and themes of forum.

Overall, the network graph as shown in Fig. 3 shows high centrality degree of instructor as the initiator of the topic and leader of each discussion forum.

Table 1. Themes and quantitative characteristics of 12 forums

Forums	Themes of Forum	Number of Discussion Topics	Number of Messages	Number of Participants
1	The public interest and publicity	8	109	30
2	Administration, law, politics and public interest	6	77	29
3	Administration value and administrative procedure	6	86	28
4	Representative system, government bureaucracy and public interest	11	135	32
5	Iron triangle and public interest in the policy procedure	9	100	30
6	Administrative ethics, critical reflection and public interest	5	70	29
7	Political neutrality of public interest and government official	9	130	31
8	The institutional control over the administration and public interest	5	79	27
9	A political party and the media in its policy procedure and public interest	8	119	28
10	Citizen participation and public interest in political process	11	168	29
11	The government is the problem	16	233	32
12	The quality of citizen and public interest	4	67	24
	Overall (Sum / Average)	**98** / 8	**1373** / 114	349 / **29**

However, as mentioned earlier, when the instructor opened the new discussion topics, he uploaded students' sample essays, which are selected every week among what students submitted as their assignments. As a result, when we converted the postings uploaded by instructor into the original writers of the sample essays, the network patterns were significantly changed. As shown in Fig. 4, most of students, except those who are positioned outside of network, participated in the discussion activity and interacted each other.

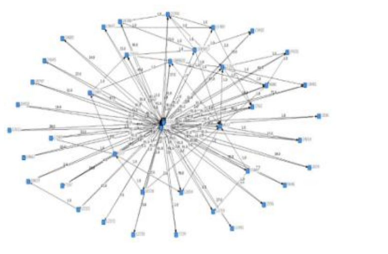


Fig. 3. Instructor-Centered Interaction Pattern

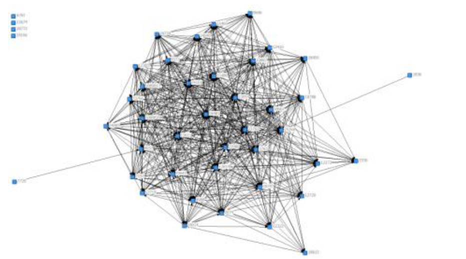


Fig. 4. Student-Centered Interaction Pattern

4.2 One-mode Time Series Network Analysis

The discussion period of the course in this case study was operationally divided into three stages: ‘early (September 10 to October 10) –middle (October 11 to November 11)-late (November 12 to December 15)’ in order to examine the time sequential change of discussion. As seen in Fig. 5 to 7, network patterns were appreciably changed and students’ interactions were increased dramatically.

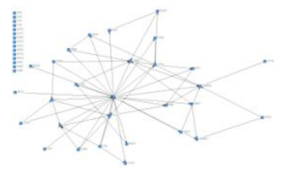


Fig. 5. Interaction Pattern of the early stage

Fig. 6. Interaction Pattern of the middle stage

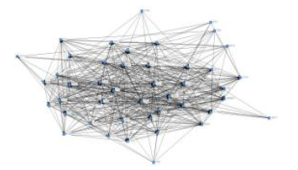


Fig. 7. Interaction Pattern of the late stage

The SNA not only allows us to presume the overall figures of networks throughout the NetDraw function, but also provide numeric measures of networks such as degree centralization and density. While *degree centralization* looks at the extent to which one actor in a network is holding all of the ties in that network, *density* measures the extent to which all the ties are actually present. According to Prell [17], the degree centralization and density are similar to the concept of *mean* as a central tendency and the *standard deviation* as a spread or variance. Therefore, in this study, we reviewed two important concepts to investigate the patterns of networks: degree centralization and density.

As shown in Table 2, the degree centralization score is decreased from early to late stage. The overall degree centralization at late stage was 8.53% and it corresponded to about one-third of the score at the early stage. The indegree network centralization scores at the middle and late stages (12.35% and 11.60%) were almost doubled compared to the score at early stage (5.81%). However, the density is increased from 0.034 at early stage, to 0.116 at middle stage, to 0.334 at late stage.

Table 2. Changes of network centralization and density

Network Centralization	whole stages (12 weeks)	early stage (4 weeks)	middle stage (4 weeks)	late stage (4 weeks)
Degree	13.57%	22.67%	12.33%	8.53%
Outdegree	16.53%	20.88%	14.73%	8.26%
Indegree	14.39%	5.81%	12.35%	11.60%
Density	0.401	0.034	0.116	0.334

The statistical significance of the change was verified by conducting BOOTSTRAP PAIRED SAMPLE T-TEST in UCINET. Technically, we need a statistical model for measuring the changes of three groups mean or density in time series. However, finding out which statistical method is able to compute the right results was seriously challenging. Therefore, we decided to split the stochastic procedure in two times as an alternative method to solve the problem that we had faced.

First, we compared the densities between the early and middle stages, and after that, the comparison between the middle and late stages was followed. As shown in the Table 3 below, the density of middle stage was greater than the early stage. Similarly, at the second comparison, the late stage is showing more social integrations in comparison with the middle stage. In both two times bootstrap tests, *p* value is less than 0.05. This means that the integration was changed noticeably to have more interaction among students in this class under certain probability.

Table 3. Bootstrap paired sample t-test of early-middle-late stages

	Density	Standard Deviation	*p* value
Early stage (T1: 0-4 weeks)	0.0391	0.2218	
Middle stage (T2: 5-8 weeks)	0.1263	0.3657	
Difference	-0.0872		<.05
Middle stage (T2: 5-8 weeks)	0.1263	0.3657	
Late stage (T3: 9-12 weeks)	0.5412	0.9636	
Difference	-0.4149		<.05

4.3 Two-mode Thematic Network Analysis

Unlike one-mode networks that show the interaction among students, two-mode networks present not only students' communication but also interactions between students and different discussion topics. For example, it presents 1) which kind of discussion topics has more interests and attentions from students, 2) to whom the students discussed topics deeply, and 3) who the key actors (discussers) were.

Fig. 8 illustrates the two-mode network where all of students (marked as red circle) were interacting with 92 discussion topics (marked as blue square). Interestingly, this two-mode network presents three distinct groups of students. The first group is those who are in center of network. This means that these students participated in most of all discussions. On the other hand, the second group who are positioned at the peripheral area participated in several discussions only. The last group is three isolated students located outside of network. These students were never participated in any discussion, so that facilitator and instructor may need to contact to them and ask what problems they have or provide an alert for their no participation.

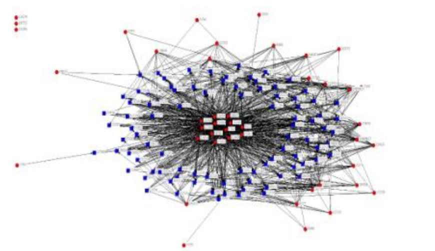


Fig. 8. Two-mode network for 12 weeks

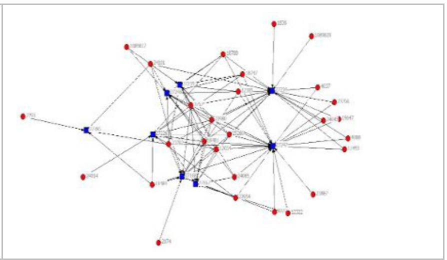


Fig. 9. Two-mode network in the 1st Week

Fig 9 helps to review the detailed relations between students and discussion topics since it depicts only the first week discussion. In this graph, we can find 28 students participated in 8 different discussions. This network presents who are interested in particular topics.

4.4 Centrality of Participants and Relations with Learning Outcome

In addition to the network-level analysis, an individual-level analysis was conducted in order to investigate the relations between individual students' discussion participation and their final learning achievement. Previously, the level of students' participation was measured by the number of postings in discussion boards. However, centrality, which measures what extent an actor is involved in the network, is more meaningful than the number of postings in assessing students' contribution to the discussion forum.

Here, in this study, individual actors (discussers)' centrality value was calculated through based on the matrix created by actors' communication data. As mentioned early, the instructor had most high indegree and outdegree centrality in this star-graph network (see fig. 1). However, we converted his alternative actions (uploading students' discussion essays) into the original students' actions. Using the converted data, the multiple regression result indicates that indegree and outdegree centrality predict their final score with the explanation of around 70% (F=47.631, P=0.000)

Table 2. Regression result for actors' centrality and academic achievement

Model	Unstandardized		Standardized	F	Sig.
	B	Std, Error	Beta		
(constant)	29.202	1.808		16.151	.000
Indegree Centrality	.240	.038	.582	6.381	.000
Outdegree centrality	.233	.048	.441	4.836	.000

a. N=43

b. Dependent Variable: Final Score

c. R^2(adj.R^2)=.839 (.704), F=47.631, P=.000

5 Discussion and Conclusion

In this study, we have investigated students' discussion activity in the approach of SNA and LA.

One-mode time series network patterns present the decreased centralization and increased density level, which implies most of students participated in discussion activity and their discussions were getting active as the discussion went the end. Two-mode network analysis also provides meaningful implications by allowing students to know their colleagues who had common interests in discussion topics. Finally, the individual level analysis figured out that individual students' centrality is an important factor to predict their final learning achievement.

We anticipate that presenting these SNA outcomes (sociograms and students' centrality levels) to students would impact on their increased participation and smart learning since they can monitor their contributions to the discussion visually. So the researchers are developing a visualized dashboard containing these SNA results, and investigations of the dashboard effectiveness would be our one of the further researches. Because this study did not include a text mining, interpretations in some parts were somewhat superficial, and this study did not consider the influences of instructor intervention differences. We are preparing to enhance these two aspects for more in-depth analyses, and we anticipate it would contribute to facilitate students' more active participations and to improve their learning achievements.

References

[1] P. Goodyear, C. Jones, and K. Thomson, "Computer-Supported Collaborative Learning: Instructional approaches, group processes and educational designs," in *Handbook of research on educational communications and technology*, J. M. Spector, M. D. Merrill, J. Elen, and M.J.Bishop, Eds., 4th ed New York: Springer, 2014, pp. 439-451.

[2] M. Brown, "Learning analytics: the comming thrid wave," *EDUCAUSE Learning initiative,* 2011.

[3] M. A. Chatti, A. L. Dyckhoff, U. Schroeder, and H. Thüs, "A reference model for learning analytics," *International Journal of Technology Enhanced Learning,* vol. 4, pp. 318-331, 2012.

[4] E. Elias, "Learning analytics: definitions, processes and potential," *Creative Commons,* 2011.

[5] I.-H. Jo, M. Yoon, and K. Ha, "Analysis of relations between learners time management strategy, regularity of learning, and learning performacne: A learning analytics approach," in *e-learning korea 2013*, Seoul, COEX, 2013.

[6] S. Dawson, A. Bakharia, and E. Heathcote, "SNAPP: Realising the affordances of real-time SNA within networked learning environments," in *Proceedings of the 7th International Conference on Networked Learning*, 2010, pp. 125-133.

[7] A. Bakharia and S. Dawson, "SNAPP: a bird's-eye view of temporal participant interaction," in *Proceedings of the 1st international conference on learning analytics and knowledge*, 2011, pp. 168-173.
[8] S. Dawson, "'Seeing'the learning community: An exploration of the development of a resource for monitoring online student networking," *British Journal of Educational Technology,* vol. 41, pp. 736-752, 2010.
[9] M. de Laat, V. Lally, L. Lipponen, and R.-J. Simons, "Investigating patterns of interaction in networked learning and computer-supported collaborative learning: A role for Social Network Analysis," *International Journal of Computer-Supported Collaborative Learning,* vol. 2, pp. 87-103, 2007.
[10] R. Rabbany, M. Takaffoli, and O. R. Zaïane, "Analyzing participation of students in online courses using social network analysis techniques," in *Proceedings of educational data mining*, 2011.
[11] C. Palazuelos, D. García-Saiz, and M. Zorrilla, "Social Network Analysis and Data Mining: An Application to the E-Learning Context," in *Computational Collective Intelligence. Technologies and Applications*. vol. 8083, C. Bădică, N. Nguyen, and M. Brezovan, Eds., ed: Springer Berlin Heidelberg, 2013, pp. 651-660.
[12] I. Liccardi, A. Ounnas, R. Pau, E. Massey, P. Kinnunen, S. Lewthwaite*, et al.*, "The role of social networks in students' learning experiences," *ACM SIGCSE Bulletin,* vol. 39, pp. 224-237, 2007.
[13] C. Vrasidas and M. S. McIsaac, "Factors influencing interaction in an online course," *American Journal of Distance Education,* vol. 13, pp. 22-36, 1999.
[14] N. Lambropoulos, X. Faulkner, and F. Culwin, "Supporting social awareness in collaborative e-learning," *British Journal of Educational Technology,* vol. 43, pp. 295-306, 2012.
[15] L. P. Macfadyen and S. Dawson, "Mining LMS data to develop an "early warning system" for educators: A proof of concept," *Computers & Education,* vol. 54, pp. 588-599, 2010.
[16] J. Bayer, H. Bydzovská, J. Géryk, T. Obšıvac, and L. Popelınský, "Predicting drop-out from social behaviour of students," in *Proceedings of the 5th International Conference on Educational Data Mining-EDM 2012*, 2012, pp. 103-109.
[17] C. Prell, *Social network analysis: History, theory and methodology*: Sage Publications Limited, 2011.

Tracking Students' Eye-Movements on Visual Dashboard Presenting Their Online Learning Behavior Patterns

Kunhee Ha[1], Il-Hyun Jo[2], Sohye Lim[3], and Yeonjeong Park[2*]

[1] College of Education, Ewha Womans University, Seoul
diohhkh@gmail.com
[2] College of Education, Ewha Womans University, Seoul
{ijo, ypark78}@ewha.ac.kr
[3] College of Social Sciences, Ewha Womans University, Seoul
s.lim@ewha.ac.kr

Abstract. This study aims to investigate students' reactions and perceptions to the Learning Analytics Dashboard (LAD). LAD was designed and developed by researchers to present students' online learning activity in a visualized display. An eye tracking system was incorporated to measure students' eye-movement, including eye fixation, saccade and their sub derivatives on LAD. The results are derived from the data-mining of what the eye-tracking system generates. This study is expected to support a smart learning environment, where students can effectively monitor their online behavior patterns in real-time using their mobile devices. Students can utilize such information to change their learning patterns, and improve performance.

Keywords: Eye-tracking, Learning Analytics, Dashboard, Smart Learning

1 Introduction

With the exponential growth of the digital industry and electronic devices, we are seeing hundreds of digital displays every day; even now, the readers might be reading this paper on a screen via PC or smart device. Effective message design within a display is becoming important because our eyes tend to stay focused on the object of interest and the space on the screen is limited to display only the important information. Hence, recent studies that examine the reactions to the stimulus in a display are beginning to incorporate eye-tracking methods for their research purposes. In this study, we have conducted such an eye-tracking experiment in order to investigate college students' reactions to the visual dashboard as a stimulus of our experiment.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_51

Learning Analytics Dashboard (LAD) is a display providing visualized information that present students' learning process and behavior patterns for the purpose of facilitating their learning and performance. The application of learning analytics explores the measurement, collection, analysis and reporting of data, which are associated with students' learning and their environment [1, 2]. Moreover, LAD is conceived as a visualized output from educational data mining, which is another emerging area that explores diverse data-mining techniques, such as prediction, classification, modeling and association to solve educational issues [3].

Our research team has designed and developed such an LAD application for the purpose of supporting students' smart learning; further, we have posed how students react to this dashboard. In addition, because the information in the dashboard consists of diverse visual elements with charts, graphs, indicators and alert mechanisms, we are concerned as to what extent students are able to perceive, understand, and interpret the information. The major goal of this study is to find the design implications for refinement of the developed LAD by observing and analyzing students' reactions throughout the eye-tracking system.

2 Previous Studies

Previous studies on eye-tracking are mostly related to how people's eye movements react to the stimulus, such as advertisement media, website interfaces, video clips and digital games. While the purposes of using the eye-tracking method are all various in different disciplines, the most important consideration is how to apply the measures that the eye-tracking systems provide into specific research contexts and purposes. That is, the eye-tracking system allows us to study visual data processing, disposability of system interfaces and cognitive process in relation to eye fixation, saccade and theirs sub derivatives [4].

As related works of this study, several previous researches were conducted. First, Cowen, et al. [5] experimented with seventeen participants on two tasks for each of the four website homepages, and investigated their eye movements and performance, specifically, the response scores and task completion times. The average fixation duration, number of fixations, spatial density of fixations and total fixation durations were measured to observe whether they were sensitive to the relative usability differences revealed by the two performance measures. Because the stimulus in our study is in a webpage format, this study provided implications on the experiment design, specifically, to investigate the usability of the dashboard by the eye-tracking system.

Second, Huang and Eades [6] conducted an eye-tracking research in order to investigate how people read graphs. Throughout the experiments with thirteen participants, given 12 network graphs portrayed with three drawings in one block as well as questions to measure their understanding, the research found that a particular graph layout affects the reading behavior in two ways: slow down and trigger extra eye movements. Although this study suggested several limitations of using eye-tracking, such as a great deal of noise data from fixations between tasks, as the first eye-tracking study on people's graph information process, it becomes an important reference related to our study that attempts to observe how people read multiple graph information in LAD.

Third, Laqua and Brna [7] aimed to evaluate a novel design interface, called focus-metaphor approach. For this, they conducted a usability test on the interface prototype and collected fifteen participant's opinions, feelings and satisfaction throughout the online survey-based evaluation. An eye-tracking experiment helped to investigate students' different visual attentions among a common interface (grid layout), the original version of the new interface and a refined version (focus-metaphor). Like this study, we are interested in participants' visual attentions and collect collecting eye-tracking data in a comparison with two versions of dashboard that we have developed originally and refined after students' satisfaction survey and first usability test.

3 Method

3.1 Research Design

The studies introduced above all suggested a common and important implication. That is, to achieve our research goals, not only data from the eye-tracking system, but also from other data collection methods such as measurement of performance during specific tasks or questions, and survey questionnaires need to be involved. Therefore, based on the previous works, we designed a research method to conduct experiments using the eye-tracking system. Additional interviews were also performed with structured questionnaires to measure participants' level of understanding regarding their graph information.

3.2 Stimulus of Experiment

In this study, the major stimulus of the eye-tracking experiment is the Learning Analytics Dashboard (LAD), designed and developed by researchers in collaboration with the institution of teaching and learning at a large university in Korea. The developed dashboard consists of 7 graphs, including an overview scatterplot and other 6 graphs on students' total log-in time, log-in frequency, log-in regularity, visits on board and visits on repository (See Fig. 1). The information in LAD was selected based on a series of previous studies conducted by Jo and his colleagues [8-12]. For example, the major information of LAD was deployed in this study because previous studies indicated such variables to be meaningful for predicting students' learning achievement. Especially, they indicated time management strategies of the learners to be one of the major psychological factors related to learners' log-in regularity behavior.

The original LAD has been revised through the formative evaluation. Researchers conducted the first usability test with 6 college students by taking a qualitative approach, including a stimulated recall protocol, in order to observe how students react to the LAD and how they perceive its usefulness and usability. Also, the LAD was opened to 37 students who were asked to utilize it during a course of one semester. Online surveys were conducted after the mid-term and final exams. Students' feedbacks were reflected in order to revise the original LAD.

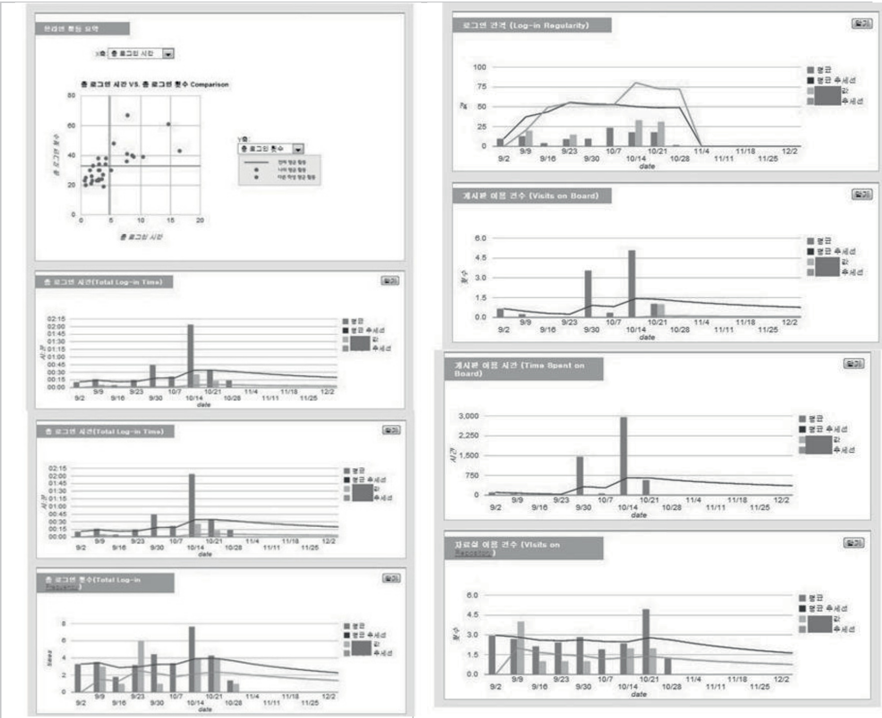


Fig. 1. Sample Screen Capture of Learning Analytics Dashboard (LAD)

3.3 Experiment Settings

For this study, twelve students at a university in Korea participated to investigate their reaction, specifically their visual attention and perceptions on LAD. The eye-tracking system used in the experiment was SMI (SensoMotoric Instruments) iVewX system, which enables to capture and record students' eye movements. By configuring out the AOI (Area of Interest), the following measurements can be derived and analyzed throughout the system: total fixation duration (the sum of all the fixation duration times whilst completing a task), number of fixations (the total number of individual fixations on a page whilst completing a task); and average fixation duration (the average duration of individual fixations on a page whilst completing a task). The experiment was conducted at a secured laboratory where two monitors were equipped and two versions of LAD were displayed to the participants. The experiment duration per one person was about ten to fifteen minutes.

4 Research Progress and Discussion

Currently, this study is analyzing the eye-tracking data; the results of this study will be presented and discussed at the conference. The eye-tracking system generates a large quantity of raw data that requires data-mining techniques; time-consuming pre-processing is required just like web log files left in learning management system. However, we expect that a scientific measurement based on the eye-tracking system will provide meaningful implications that will complement the survey method depending on the participants' subjective self-reported response. In this study, we will also discuss how the experiment involving the eye-tracking system can contribute to the body of knowledge of observing and measuring students' reaction and cognitive information process on a visual display.

References

[1] M. Brown, "Learning analytics: the coming third wave," *EDUCAUSE Learning Initiative Brief,* pp. 1-4, 2011.
[2] M. Chatti, M. Jarke, T. Indriasari, and M. Specht, "NetLearn: Social Network Analysis and Visualizations for Learning," in *Learning in the Synergy of Multiple Disciplines*. vol. 5794, U. Cress, V. Dimitrova, and M. Specht, Eds., ed: Springer Berlin Heidelberg, 2009, pp. 310-324.
[3] N. Bousbia and I. Belamri, "Which Contribution Does EDM Provide to Computer-Based Learning Environments?," in *Educational Data Mining*, ed: Springer, 2014, pp. 3-28.
[4] A. Bayazit, P. Askar, and E. Cosgun, "Predicting learner answers correctness through eye movements with random forest," in *Educational data mining: Applications and trends*, A. Pena-Ayala, Ed., ed Switzerland: Springer, 2014.
[5] L. Cowen, L. J. Ball, and J. Delin, "An eye movement analysis of web page usability," in *People and Computers XVI-Memorable Yet Invisible*, ed: Springer, 2002, pp. 317-335.
[6] W. Huang and P. Eades, "How people read graphs," in *proceedings of the 2005 Asia-Pacific symposium on Information visualisation-Volume 45*, 2005, pp. 51-58.
[7] S. Laqua and P. Brna, "The focus-metaphor approach: A novel concept for the design of adaptive and user-centric interfaces," in *Human-Computer Interaction-INTERACT 2005*, ed: Springer, 2005, pp. 295-308.
[8] I. Jo, "Beyond learning analytics: Educational technology approach toward learning analytics," presented at the Asian Conference in Education and Technology 2013, Seoul, Korea, 2013.
[9] I. Jo and J. Kim, "Investigation of Statistically Significant Period for Achievement Prediction Model in e-Learning," *Journal of Educational Technology,* vol. 29, pp. 285-306, 2013.
[10] I. Jo and Y. Kim, "Impact of learner's time management strategies on achievement in an e-learning environment: A learning analytics approach," *The Journal of Educational Information and Media,* vol. 19, pp. 83-107, 2013.

[11] I. Jo, M. Yoon, and K. Ha, "Analysis of relations between learner's time management strategy, regularity of learning interval, and learning performance: A learning analytics approach," presented at the E-learning Korea 2013, Seoul, COEX, 2013.
[12] I. Jo and T. Yu, "Relationship of Student Online Behavior and Learning Performance in Higher Education: A Learning Analytics Approach," presented at the E-learning Korea 2013, Seoul, COEX, 2013.

Unfolding Learning Analytics for Big Data

Jeremie Seanosky[1], David Boulanger[1], Vivekanandan Kumar[1], Kinshuk[1]

[1] School of Computing and Information Systems, Athabasca University, Canada
jeremie@rsdv.ca

Abstract. Educational applications, in general, treat disparate study threads as a singular entity, bundle pedagogical intervention and other student support services at a coarser level, and summatively assess final products of assessments. In this research, we propose an analytics framework where we closely monitor individual threads of study habits and assess study threads in an individual fashion to trace learning processes leading into assessment products. We developed customized intervention to target specific skills and nurture optimal study habits. The framework has been implemented in a system called SCALE (Smart Causal Analytics on LEarning). SCALE enables the tracking of students' individual study threads towards multiple final study products. The large volume, multiple variety, and incessant flow of data classifies our work in the realms of big data analytics. We conducted a preliminary study using SCALE. The results show the ability of the system to track the evolution of competencies. We propose that explicitly supporting the development of a targeted set of competencies is one of the key tenets of Smart Learning Environments.

Keywords: learning management systems · programming · coding competency · bigdata · learning traces · learning analytics · training

1 Introduction

The SCALE (Smart Causal Analytics on LEarning) system can be embedded into a LMS (Learning Management System) to enable finer-level tracking of students' study habits compared to coarser-level tracking currently possible in LMSs such as Moodle and Blackboard. The SCALE system consists of a number of custom-built sensors that track different types of student activities such as reading, writing, mathematical problem solving, coding, and collaborating. The main idea behind SCALE is to:

- continuously collect learning data from students from within their learning environment, and
- allow students and teachers to estimate, or infer, factors that are traditionally not available from the captured data

We have developed tools that track and record students' activities and skills in reading, writing, and coding [19, 20, 21, 22]. These tools allow us to perform advanced analytics based on trace data to evaluate students' competency growth in writing and coding.
Our goal is to capture every possible piece of data from any given learning environment and connect these datasets together to compile a big picture of the learning processes of

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_52

each student. In SCALE, we continuously monitor the student's competency growth as it evolves in addition to evaluating competency whenever students are tested as part of the curricular expectations.

Sensors are the key components of the tracing tools. They attach as plugins or modules to other main learning management tools such as the IDEs, LMSs, writing tools, and educational websites. The sensors capture user activity at finer levels of granularity, sending the captured data at real-time to a Hackystat database in a semi-structured format. Then we process the data from Hackystat and send the resulting more structured data to relational databases, such as MySQL. We also update the refined data in ontologies to be subjected to inferences. Queries of the databases and inferences from the ontologies are displayed in web-based dashboards. Figure 1 shows the general dataflow of the SCALE system.

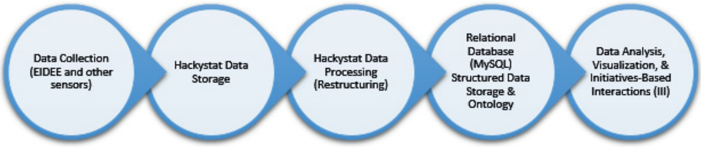


Figure 1 - SCALE System General Architecture

Data analysis also results in initiatives-based interactions of learners. That is, the dashboards enable learners to query the databases, run inferences of interest, as well as create study targets. The study targets can be associated with specific information (query results or inference results) to be reported back to the student. This notion of enabling students to be proactive about their own study habits is termed as initiatives-based intelligent interactions (III). Because of space restrictions, the IIIs will not be discussed further in this article.

2 Literature Review

Dawson et al. [3] describe a learning environment called SNAPP, or Social Networks Adapting Pedagogical Practice, that integrates Social Network Analysis (SNA)[1] with the LMS in order to capture students' interactions with each other on the LMS's discussion forums and/or blogs and relay that information in real-time to the teachers so as to help them better support student learning. According to del Blanco et al. [4], as a Learning Analytics tool, SNAPP uses the LMS discussion forum posts to categorize students in different categories and thus target those more in need of learning support. For example, SNAPP differentiates between engaged students, disengaged students who are at risk, and information brokers. This real-time information allows teachers to focus their attention on those "at risk" students to prevent dropouts or other negative consequences of being disengaged. Also, it is possible for the teachers to target knowledge areas where the disengaged students lack the most and even seek help from engaged students or information brokers. SNAPP integrates with Blackboard, Moodle,

[1] SNA (http://en.wikipedia.org/wiki/Social_network_analysis)

Sakai[2], and Desire2Learn[3], the most popular Learning Management Systems. SNAPP and SCALE are similar since both capture data from within a learning environment and provide analysis and visualization of the captured data. However, while SNAPP targets only the LMS, SCALE aims at going over the LMS barrier and into bringing data sensors and analysis to the learning tools used by the student. In addition, SNAPP focuses on a specific aspect of learning, that is social networking through discussion forums, but SCALE is designed to be a generic learning tool independent of the learning subject and/or area of study.

Our work is also related to the work of Mazza and his associates [Mazza & Milani, 2005; Mazza & Dimitrova, 2004], who apply Information Visualization (IV) techniques to help educators understand what is happening in their classes. Their approach is first implemented in CourseViz, a tool which works with the WebCT LCMS to produce various graphical representations of student tracking data [Mazza & Dimitrova, 2004], and subsequently in GISMO, which does a similar thing for Moodle [Mazza & Milani, 200]. While these systems exploit IV to present raw data, our approach goes a step further in terms that it analyzes the data and provides not only educators, but also learners with qualitative feedback and initiatives-based interaction. This feedback is not limited to one source of usage data, but it will be computed based on the aggregated data collected from different learning systems across domains targeting a variety of competencies.

3 Data Collection

The process of tracking students' learning activities starts with data collection. The SCALE system is designed for easy integration of any number of data sensors into the existing system and is highly scalable, thus allowing a constant flow of newly developed sensors.

Now, *Hackystat* [4] is the key technology used in SCALE. It is a Java open-source framework designed for data collection of various data in both development and learning environments using unobtrusive sensors. Hackystat runs as a service and constantly listens for incoming data packets sent in XML format. Then those data are stored in a database that can easily be queried using Hackystat's Java and REST APIs. SCALE also makes use of a whole range of tools to achieve our goal of tracking study activities to finer levels. For each of the following learning environments, we have designed a set of sensors that capture study activities:

1. *IDE (Integrated Development Environment)* – Examples of IDEs we target for data collection include Eclipse, NetBeans[5], VisualStudio[6], Code::Blocks[7], etc. We have built a plugin called EIDEE (Eclipse IDE Extension) to capture source code and students' activities within the Eclipse IDE. Other sensors will also be available for those different IDEs.

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[2] Sakai LMS (http://sakaiproject.org/)
[3] Desire2Learn (http://www.desire2learn.com/)
[4] Hackystat (https://code.google.com/p/hackystat/)
[5] NetBeans (https://netbeans.org/)
[6] Visual Studio (http://www.visualstudio.com/)
[7] Code::Blocks (http://www.codeblocks.org/)

2. *LMS* – Though current LMSs like Moodle and Blackboard already capture certain data from students' interactions with the LMS, SCALE will feature still more sensors attached to different LMSs to allow for more customizable data collection. One such sensor is an enhanced VPL (Virtual Programming Lab)[8] that provides a "web IDE" for Moodle where students can perform programming assignments from within the LMS and have their data captured using Hackystat.
3. *Word Processors* – examples of word processors include Microsoft Word, Google Docs, etc. The SCALE system will provide sensors, or add-ins, to the most popular word processors in order to track students' writing skills.
4. *Web Browsers* – The LMS only tracks students' activities within the LMS. With SCALE, we track what students learn outside the LMS. For example, a student is most likely to use the google search engine after encountering a particular term in the course contents. SCALE will offer browser add-ins, or plugins, to capture the URLs the student is visiting, Google search terms used by the students, the active time spent on a website, a tree of the parent-child relationship of the links visited, and so on. In addition to providing additional relations with other study datasets, the browser add-ins can also propose course-adapted resources to the student.

Sensors are, by nature, intrusive. It is of utmost importance to discuss aspects of user privacy and ethics in the context of sensors. Students' data are extremely sensitive and private, and the SCALE system ensures that no data item is collected unless the student consciously and voluntarily approves its collection, storage, and use.

Overall, SCALE's sensors capture every possible bit of data from the student, with the student's explicit permission, and push these datasets to a centralized data store where advanced analysis and processing is performed in order to infer important learning trends and evaluate the competency growth over time. The analysis results are displayed in a variety of visual formats in the SCALE dashboards that are available to both students and teachers. Figure 2 shows the SCALE data model.

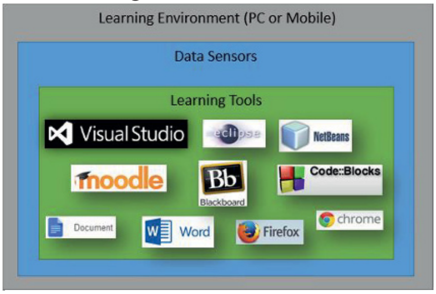

Figure 2 - SCALE data model

4 Data Analysis and Visualization

Huge amounts of data collected by the various SCALE sensors are meaningless until they are processed, analyzed, and the results are visualized and interacted upon. The SCALE central data store contains well-identified data entries from the different sensors. Sensed data are grouped according to the sensor that generated them and the user those data belong to. Depending on the type of the sensors and their data, we trigger or automatically launch the processing of the collected data entries and then perform analyses and inferences on the processed data.

Processing means we take the raw XML sensor data from Hackystat, parse it, perform some minimal required calculations, and then store the processing results in a database.

[8] VPL (http://vpl.dis.ulpgc.es/)

In the processing phase, we prepare the data for advanced analysis, visualization, and interaction.

Analysis is the final phase of the SCALE system and involves querying the processed data to find trends, group data, compute results, do aggregation, etc. Then the results are presented in the dashboards.

SCALE uses different computational models to perform analyses. For example, we use rule-based engines such as BaseVISor[9] to infer facts about the students' learning trends based on RDF[10] ontologies created from the processed data. Those ontologies can be processed to generate dependency graphs or trees showing relationships between different student activities. For example, an RDF ontology of a student's programming assignment source code could be analyzed into a graph showing the AST[11] structure of the code. Trends could also be inferred based on the time-series analyses of study activities. Converting into ontologies the processed data stored in the central SCALE data store allows us to use custom-made production rules. Custom production rules can be generated not only by the instructors, but also by students themselves. The resultant facts of such rule-based inferences are then stored in other tables and visualized in dashboards.

5 Experiments and Datasets

A successful experiment with an implementation of the SCALE system was conducted from January to March 2014 at a large corporation in the energy industry in Alberta, Canada. We developed a computer software called PET (Procedure Evaluation Tool) based on the SCALE system to train operators of the corporation in emergency operating procedures (EOP). PET's task was to track, at the finest level, each activity of an operator as he/she progressed through EOP tests and then aggregate the results of those individual activities into the final overall grade of the test.

The goal of this experiment was to test the use and the effectiveness of the SCALE technology in a training scenario. This experiment targeted seven operators within the company as test subjects. All seven operators were evaluated on their skill level, or competency, with two emergency procedures. The experiment was conducted in three phases. Phase 1 was conducted first followed by phase 2 four hours later. Then, 42 days later, phase 3 was started. Phase 1 and 3 were closed-book examinations of the two emergency procedures, whereas phase 2 was open-book. The results of the experiment are discussed below.

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[9] BaseVISor (http://www.vistology.com/basevisor/basevisor.html)
[10] RDF (http://www.w3.org/RDF/)
[11] AST (http://en.wikipedia.org/wiki/Abstract_syntax_tree)

Figure 3 - average grade & duration versus experience

Among the key observations made from the experiment's results are the relations between the experience, time spent in going through a knowledge verification session, and the performance of an operator. Performance is reported as a percentage and is computed according to the correctness of the operator's answers to the test questions. Answers are classified among five correctness categories. Each category has a unique weight contributing to the overall performance of an operator in a procedure.

Figure 3 shows how experience (years), average session duration (minutes), and average performance are related together for each test subject. For example, we see that operator 4 is one of the most experienced operators (~20 years), has got the highest average grade (85.83%), and has spent more time per session than any other operator. On the other hand, operator 3 with only half a year of experience got the lowest average grade (66.16%) and has spent significantly less time per session than operator 4. Figure 3 suggests that more experienced operators will spend more time in thinking over the questions since they are more knowledgeable about them. Hence, their experience may result in a higher performance.

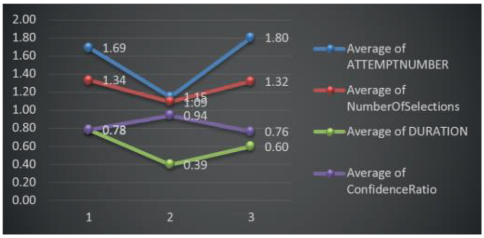

Figure 4 - average statistics for each testing phase

Figure 4 shows the average duration, the average number of visits, the average number of selections, and the average confidence for a specific operator and emergency procedure in each testing phase (or for all operators and all procedures). The graph suggests that the average confidence is "inversely proportional" to the average number of times a question has been visited and the average number of selections for that question.

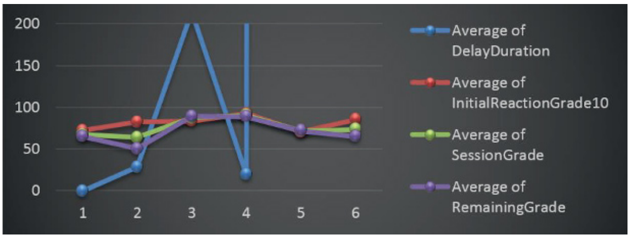

Figure 5 – average statistics for each testing session

Figure 5 shows how the average delay between each testing session impacts the average overall session grade, the average initial reaction grade, and the average grade for the steps outside the initial reaction. It is important to note that the labels in the horizontal axis represent the order in which all trainees have gone through the testing sessions. Moreover, note that at the third and fourth sessions, the testing sessions were open-book. The graph may suggest that the major delay between the second and third testing stages in the experiment impacted considerably the performance of the operators in both the whole procedures and their initial reactions. The delay seems to have produced some confusion (forgetting) for all steps in the procedure. However, we see at last (sixth session) that the average initial reaction grade re-increases more rapidly than the average overall session grade due to the higher exposure rate of the operators to a set of steps common to both procedures.

6 Conclusion and Future Work

The experiment demonstrates the benefits of "unfolding" the different study processes of the test participants across multiple EOPs. Instead of just assessing the final answers to each question and grading those according to a score key, we tracked every step of the test, taking many factors into account, to give a composite grade that reflects more on the skill development and confidence of the operator rather than just the score in the tests.

Several areas of challenge remain in order to improve our system and make it highly scalable. Among others is the data storage model that needs to be optimized for greater efficiency, reliability, and consistency. We plan to standardize the SCALE system to comply with the IMS Global learning management framework called Caliper and make all our learning tools use the same data model. We are working on integrating Hadoop [12] into the SCALE system to allow for distributed processing of the huge amounts of data our system collects.

References

[1] G. Siemens, D. Gasevic, C. Haythornthwaite, S. Dawson, S. B. Shum, R. Ferguson, E. Duval, K. Verbert, and R. S. J. D. Baker (2011). Open Learning Analytics: an integrated & modularized platform, SOLAR (Society for Learning Analytics Research).

[2] IMS Global Learning Consortium (2013). Caliper Learning Analytics Framework and associated Sensor API. IMS Global Learning Consortium, Lake Mary, FL.

[3] Dawson, S., Bakharia, A., & Heathcote, E. (2010). SNAPP: Realising the affordances of real-time SNA within networked learning environments. Networked Learning – Seventh International Conference, Aalborg, Denmark.

[4] del Blanco, A., Serrano, A., Freire, M., Martinez-Ortiz, I. & Fernandez-Manjon, B. (2013). E-Learning standards and learning analytics. Can data collection be improved by using standard data models?. In *Global Engineering Education Conference (EDUCON), 2013 IEEE* (pp. 1255-1261).

[5] Bakharia, A. & Dawson, S. (2011). SNAPP: a bird's-eye view of temporal participant interaction. In *Proceedings of the 1st International Conference on Learning Analytics and Knowledge* (pp. 168--173). ACM. (ISBN: 978-1-4503-0944-8.)

[6] Vivekananthamoorthy, N., Sankar, S., Siva, R. & Sharmila, S. (2009). An effective E-learning framework model - a case study. In *ICT and Knowledge Engineering, 2009 7th International Conference on* (pp. 8-14).

[12] Hadoop (http://hadoop.apache.org/)

[7] Haythornthwaite, C., de Laat, M., Dawson, S. & Suthers, D. (2013). Introduction to Learning Analytics and Networked Learning Minitrack. In *System Sciences (HICSS), 2013 46th Hawaii International Conference on* (pp. 3077-3077).
[8] Cheng, H.-C. & Liao, W.-W. (2012). Establishing an lifelong learning environment using IOT and learning analytics. In *Advanced Communication Technology (ICACT), 2012 14th International Conference on* (pp. 1178-1183).
[9] Aljohani, N. & Davis, H. (2012). Significance of Learning Analytics in Enhancing the Mobile and Pervasive Learning Environments. In *Next Generation Mobile Applications, Services and Technologies (NGMAST), 2012 6th International Conference on* (pp. 70-74).
[10] Vozniuk, A., Govaerts, S. & Gillet, D. (2013). Towards Portable Learning Analytics Dashboards. In *Advanced Learning Technologies (ICALT), 2013 IEEE 13th International Conference on* (pp. 412-416).
[11] Ali, L., Hatala, M., Gasevic, D. & Jovanovic, J. (2012). A qualitative evaluation of evolution of a learning analytics tool. *Computers & Education* **58** (1), 470 - 489.
[12] Arnold, K. E. & Pistilli, M. D. (2012). Course Signals at Purdue: Using Learning Analytics to Increase Student Success. In *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge* (pp. 267--270). ACM. (ISBN: 978-1-4503-1111-3.)
[13] Elias, T. (2011). Learning Analytics: Definitions, Processes and Potential. Retrieved from http://learninganalytics.net/LearningAnalyticsDefinitionsProcessesPotential.pdf.
[14] Ferguson, R. (2012). Learning analytics: drivers, developments and challenges. *International Journal of Technology Enhanced Learning* **4** (5/6), 304-317.
[15] Rahman, N. & Dron, J. (2012). Challenges and Opportunities for Learning Analytics when Formal Teaching Meets Social Spaces. In *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge* (pp. 54--58). ACM. (ISBN: 978-1-4503-1111-3.)
[16] Ferguson, R. & Shum, S. B. (2012). Social Learning Analytics: Five Approaches. In *Proceedings of the 2Nd International Conference on Learning Analytics and Knowledge* (pp. 23--33). ACM. (ISBN: 978-1-4503-1111-3.)
[17] Verbert, K., Duval, E., Klerkx, J., Govaerts, S. & Santos, J. L. (2013). Learning Analytics Dashboard Applications. *American Behavioral Scientist* **57** (10), 1500-1509. (Doi: 0.1177/0002764213479363.)
[18] Verbert, K., Govaerts, S., Duval, E., Santos, J., Assche, F., Parra, G. & Klerkx, J. (2013). Learning dashboards: an overview and future research opportunities. *Personal and Ubiquitous Computing*, 1-16. (Doi: 10.1007/s00779-013-0751-2.)
[19] Winne P., Nesbit J., Kumar V., Hadwin A., Lajoie S., Azevedo R., Perry N., (2006), Supporting Self-Regulated Learning with gStudy Software: The LearningKit Project, International Journal of Technology, Instruction, Cognition, and Learning, Vol. 3, PP. 105-113.
[20] Kumar V., Chang, M., Leacock T. (2011), Ubiquitous Writing: Writing Technologies for Situated Mediation and Proactive Assessment, Ubiquitous Learning: An International Journal, Volume 3, Issue 3, pp.173-188.
[21] Kumar V., Winne P.H., Hadwin A.F., Nesbit J.C., Jamieson-Noel D., Calvert T., Samin B., Effects of self-regulated learning in programming, IEEE International Conference on Advanced Learning Technologies (ICALT 2005), Kaohsiung, Taiwan, 5-8 July, 383 - 387, 2005.
[22] Boulanger, D., Seanosky, J., Kumar, V., Kinshuk, Panneerselvam, K. & Somasundaram, T. S. (2014). Smart Learning Analytics.

[June 10, 2014]

Usefulness of peer comments for English language writing through web-based peer assessment

Zhi Ying Ng[1,*], Wan Ying Tay[1], and Young Hoan Cho[2]

[1] Office of Education Research, National Institute of Education, Nanyang Technological University, Singapore
zhiying.ng@nie.edu.sg
[2] Department of Education, Seoul National University, Korea

Abstract. Peer assessment is an educational activity where students evaluate peers' performance quantitatively with ratings and/or qualitatively with comments. Quantitative and qualitative feedback given and received by students is the core of the peer assessment process, and acts as references offered for the author's consideration for amendments to his/her work which leads to knowledge construction. However, the effects of peer comments on students' writing revisions have rarely been studied with research on peer feedback commonly emphasizing the reliability and validity of peer ratings. Through this paper, we share the qualitative findings of students' peer comments on their English language writing. The case study was conducted in a secondary school in Singapore where a web-based peer assessment tool, was used to support part of the secondary three English language curriculums to help improve students' competence in writing argumentative essays.

Keywords: web-based peer assessment · peer comments · back evaluation feedback · English language writing · SWoRD · qualitative methodology

1 Introduction

As the educational landscape progresses, alternative assessments that cater to the pedagogical changes and needs of the 21st century have been introduced to encompass new assessment factors or items for different means. Formative assessment represents a new learning process engaging students in constant feedback for continued learning, rather than a sole emphasis on grades after an examination with the focus of learning being shifted from quantity to quality (Ng, 2008; Tan, 2011). As synthesized by Bennett (2011), most empirical studies on formative assessment have examined it as an assessment designed to provide feedback to both students and teachers on student progress, and investigated what could be further done to support such progress. Peer assessment has been considered by many researchers as a formative assessment effort (Cestone, Levine, & Lane, 2008; Topping, 2009). It has been increasingly used as an assessment strategy in classrooms today with the shift in instructional lens that learners are the catalyst and owners of their own learning (Ng, 2008).

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_53

Under the overarching view of peer assessment as mentioned above, our study aims to understand how learning takes place for students in this educational arrangement, through the feedback delivered by students in peer review and how they are seen as useful or not useful for writing revision.

2 Literature review

2.1 Conceptualization of peer assessment

Peer assessment has been defined by Topping (2009) as an "arrangement for learners to consider and specify the level, value, or quality of a product or performance of other equal-status learners" (p. 20). A formative approach to peer assessment would involve students helping each other plan their learning, highlight their strengths and weaknesses, work on areas for improvement, construct knowledge collaboratively and build interpersonal skills (Cestone et al., 2008; Topping, 2009). In contrast, peer assessment for summative purposes would focus mainly on getting students to pitch their peers' work against certain grading levels (Vickerman, 2009) or determine if a piece of work is a success or failure (Topping, Smith, Swanson, & Elliot, 2000). Topping et al. (2000) emphasized that peer assessment is more helpful to learners if elaborated qualitative feedback information about strengths and weaknesses are given, rather than solely quantitative feedback such as a grade or a score.

2.2 Related studies on peer assessment and peer feedback

Peer assessment has been widely adopted in the classrooms over the last three decades (Tsivitanidou, Zacharia, & Hovardas, 2011). Topping (2009) reviewed the literature on peer assessment and found it to be effective in varied educational settings and for learners across a broad range of ages and competence. He synthesized the benefits of peer assessment to be the availability of peer feedback for confirmation, suggestion, and correction; cognitive gains such as reflection and identification of knowledge gaps; and improvements in writing through peer editing and improvement in collaboration, including help seeking and help asking attitudes. Similarly, Sluijsmans, Dochy, and Moerkerke (1999) indicated that peer assessment was helpful in promoting responsibility and independence in students for their own learning, encouraging them to be active participants of learning and assessment, allowing for robust exchange of ideas among students, developing their personal skills, and allowing students to be more analytical by giving advices to others and learning from others' mistakes.

Despite the many empirical studies on the effectiveness of peer assessment, certain issues with peer assessment have been widely discussed too. One issue that has been extensively studied is the reliability and validity of peer feedback in peer assessment. Cho and MacArthur (2010) analysed the feedback types from single expert, single peer, and multiple peers and their relation to revisions and findings from their study resonated with earlier studies that multiple peer reviews resulted in greater quality improvement. This was reasoned by Topping (1998) that although peer feedback might not be of the quality of a subject-matter expert, its "greater immediacy, frequency, and volume compensate for this" (p. 255). Additionally, many researchers have also justified that students understood peer comments better than expert comments as they could observe peers' difficulties in person, hence are able to better spot problems more effectively from their own perspectives, analyze problems from their issues, and produce solutions to problems (Cho & MacArthur, 2010; Yu & Wu, 2013). These studies have shown that having multiple peer reviewers to assess a piece of work can improve the reliability and validity of peer comments.

Liu and Carless (2006) sought to understand tertiary students' resistance towards peer assessment and their survey results suggested that students were doubtful of the seriousness and objectivity of their peers, perceived peers to lack expertise in topic area, were hesitant to disrupt the power relations among peers whereby they had power over peers and vice versa, and reflected that the process was time consuming (see also Hanrahan & Isaacs, 2001; Lin, Liu, & Yuan, 2001). In addition to the studies on multiple peer reviewers improving the quality of peer comments, other studies have also highlighted supplementary variables that reduce the issues with peer assessment. Anonymity has been shown to be an important factor in creating an objective environment for peer reviewing (Cho & Schunn, 2007) and to foster collaboration and support online, as opposed to receiving feedback face-to-face which can result in confrontations if not managed carefully (Mutch, 2003). Sluijsmans et al. (1999) have shown in their study that training of peer assessment skills such as understanding the rubric, identifying of discrepancies in work, affirming others' knowledge and giving suggestions for improvement were essential for effective peer assessment among students. Our study thus adopts a web-based, anonymous and multiple peer reviewers reviewing arrangement, with training sessions on peer assessment skills for students before and during the peer assessment implementation.

3 Method

3.1 Overview

While great strides have been made with regards to the design of peer assessment, research gaps still exist, as current studies are mostly based on quantitative research designs, when qualitative methodologies and their analytic techniques are equally valuable for research on peer assessment to progress (Strijbos, 2010). According to Papinczak, Young, and Groves (2007), qualitative studies of peer assessment have the competence to contribute "insights into the nature and extent of benefits to learning" (p. 171). Moreover, the rich description of qualitative studies of specific peer assessment settings offers affluent evidence for hypothesis generation which can help inform quantitative research designs in which it can be verified (Strijbos, 2010). Also to note, most studies on peer feedback and comments in peer assessment have focused on undergraduates in comparison to it being studied at the secondary school level (Peterson & Irving, 2008; Tsivitanidou et al., 2011). Hence, this paper aims to adopt a qualitative lens to shed light on the discourse of secondary school students' peer feedback.

3.2 Research questions

The main objective of this paper is to explore the characteristics of peer comments written by secondary three students and to investigate their usefulness for writing revision. The research questions to be addressed in this paper are: (1) What are the typologies of the functions of peer review comments produced by secondary three students? (2) How did students respond to peer review comments of different characteristics: what kinds of comments are useful to them?

4 Web-based collaborative learning tool

A web-based peer assessment tool (Scaffolded Writing or Rewriting in the Discipline, SWoRD) that supports writing across curriculum was used to facilitate process writing for argumentative essays. "SWoRD supports the whole cycle of writing, reviews, back-reviews, and rewriting by scaffolding the journal publication process as its authentic practice model" (Cho & Schunn, 2007, p. 409). In addition, the online system allows for confined peer review and back evaluation between writers and randomly assigns four to five reviewers, maintains anonymity of students and facilitates easy customizations of evaluation criteria and ratings for the specific assignments which can be challenging and time consuming with paper-and-pencil peer assessment (Tsai & Liang, 2009; Tsivitanidou et al., 2011). Furthermore, this web-based tool allows for asynchronous peer interaction and collaboration, which has been shown to be more effective for writing as it reduces problems such as students tending not to spot their own mistakes and misunderstandings in text or consider the viewpoint of their target audience when they work individually (Cho & Schunn, 2007). Teachers can also better monitor individual students' feedback and interactions that are tagged to their real identities (which are anonymized for students) and the class' progress overall for the assignments they have set up online.

5 Data analysis

For the focus of this paper, two variables were included: typologies of peer review comments and the resulting responses to peer review comments through peer back evaluation comments written by students. Thirty-eight students in the same secondary three class participated in the peer assessment activity during their English language lessons. Students' qualitative comments produced on the criteria of "Supporting arguments" and "Opposing arguments" in the argumentative essay task through the peer review and back evaluation stages of peer assessment were analyzed.

Consistent to the qualitative research methodology, typologies of comments are allowed to emerge through inductive analysis rather than coding them to pre-determined categories (Papinczak et al., 2007; Patton, 2002). Through the convergent and divergent characteristics of the students' peer review comments, analyst-constructed typologies of the functions of the peer review comments are elucidated. Analysis of the data pursued a constant comparative and iterative method, which persisted until no additional themes were uncovered. Relationships between the typologies of peer comments and the characteristics of the respective resulting back evaluation comments were then drawn.

6 Results

6.1 Typologies of peer comments

Through inductive data analysis, peer comments can be characterized into four fundamental categories. The four categories of peer comments are characterized by their function of: confirming the status of the essay based on the comment prompts given; highlighting of strengths and/or weaknesses in essay; stating areas for improvement; and providing explicit suggestions for revision.

Confirming the status of the essay based on the comment prompts given. These comments written by some students were general in nature or simply reinstated without much explanation the comment prompts[1] which were built into the web-based peer assessment tool by teachers and researchers. Examples of comments in this category that solely informs the statuses of the essays are: "Yes,

[1] Comment prompt provided for the supporting arguments criteria: "Is the writer's stance supported by well-elaborated arguments, evidence, and details? Explain and provide suggestions." Comment prompt provided for the opposing arguments criteria: "Does the writer present opposing arguments and refute them effectively with evidence and details? Explain and provide suggestions."

arguments are stated and evidence [is] also shown. Good job.", "Opposing argument is effectively used to refute back. But supporting with evidence and details are not good enough."

Highlighting of strengths and/or weaknesses in essay. Most students gave comments belonging to this category, whereby they pointed out the good points and/or the bad points in an essay with some explanation in their own words. For example: "There were no credible sources from which the evidence came from. Well-elaborated however it sounds like a documentary rather than a debating essay as the sources were not reliable." A student peer reviewer pointed out the strengths in an essay by saying: "Good, you actually gave real-life examples such as statistics and results from researches to make your points more convincing."

Stating areas for improvement. Quite a handful of students gave advices to their peers on which areas they could work on to improve on their essays and these mostly come together with the pinpointing of strengths or weaknesses in essays. These advices served as directions or inspirations for student writers to consider and would require some effort from them to make amendments. An example of a comment falling into this category is: "Instead of saying parents are caring and loving, not pampering, you can say that some teenagers are not pampered and the reasons. After that link it back to your stand to improve your essay." One student peer reviewer also mentioned the broad aspects that would help improve an essay: "Your third argument is quite brief you did not explain detailed enough. You can state some statistic or research showing that the demand of maids has increased."

Providing explicit suggestions for revision. There were a few students who corrected their peers' work in details by providing them with elaborated suggestions or direct solutions to rectify the mistakes in their essays. For example, a student peer reviewer explicitly recommended the student writer to include some details to further support his/her arguments: "…you can write that teenagers these days are always catching up with the latest trends, they want the latest hand phone model and their parents will get it for them." Another peer reviewer provided information on what he/she felt was missing from the essay and provided a solution: "…you can support your stand more by using statistic [such as] 70% of Singaporean teenagers have maids."

6.2 Resulting responses in peer back evaluation feedback

The characteristics of students' back evaluation feedback were studied and their relationships to the respective typologies of peer comments were drawn.

Firstly, peer comments under the category of *confirming the status of the essay based on the comment prompts given* brought about responses that mainly conveyed confusion and uncertainty. For example, a student wrote: "Reliable sources? Do you mean to say evidence from scientists and doctors?" Other students wrote: "I don't really get what you mean." and "Did not specifically tell me which part to give more evidence.” These back evaluation feedback suggest that peer review comments may be vague and lacked the necessary information to help them with making amendments in their essays.

Secondly, peer comments under the category of *highlighting of strengths and/or weaknesses in essay* resulted in responses that largely conveyed gratitude. For example, students wrote back evaluation feedback such as: “thank you”, “okay”, “…it is greatly appreciated”, “noted” and/or replied with smiling face emoticons which are neutral or friendly gestures to their peers for their comments, but do not signal if the comments are helpful or not, or if they will be revising their work based on the peer comments.

Thirdly, peer comments under the category of *stating areas for improvement* produced responses that expressed greater awareness of one’s own work. One example is: “This comment tells me that my arguments are good which shows me that I [have] a good understanding of how I should write my arguments.” A student wrote: “Tells me what I did well, but also what I missed out on.” These back evaluation feedback may suggest that peer review comments helped them gained insight to their work through the perspectives of their targeted audience.

Lastly, peer comments under the category of *providing explicit suggestions for revision* resulted in responses that indicated usefulness for writing revisions. One example of such a comment is: “Comment is really relevant as it gives suggestions on how to improve on my future essays.” Another example will be: “Comment is very helpful as it gives more ideas on how to make the argument more believable and credible.” These back evaluation feedback may signal that there are elicitations for writing revisions due to the peer comments.

7 Conclusion

This study examined secondary three students’ peer comments and back evaluation responses and gave descriptions of the characteristics of the peer comments and considered their applicability for writing revisions. Results in our study have shown that students are largely able to give constructive advices to their peers, even though, not all peer comments would eventually be useful for writing revisions. This shows that students at the secondary school level may be more responsive to peer comments which are more specific than generic. This may then prompt if students would also benefit more from specific comments as opposed to generic comments from teachers and if teachers tend to give specific or generic comments to students in daily classroom settings? Future work would involve mixed methods analysis, including quantitative analysis of students’ peer ratings to corroborate existing qualitative results.

References

Bennett, R. E. (2011). Formative assessment: A critical review. *Assessment in Education: Principles, Policy & Practice*, 18(1), 5-25.

Cestone, C. M., Levine, R. E., & Lane, D. R. (2008). Peer assessment and evaluation in team-based learning. *New Directions for Teaching and Learning*, 116, 69-78.

Cho, K., & MacArthur, C. (2010). Student revision with peer and expert reviewing. *Learning and Instruction*, 20, 328-338.

Cho, K., & Schunn, C. D. (2007). Scaffolded writing and rewriting in the discipline: A web-based reciprocal peer review system. *Computers & Education*, 48, 409–426.

Hanrahan, S. J., & Isaacs, G. (2001). Assessing self- and peer-assessment: The students' views. *Higher Education Research & Development*, 20(1), 53-70.

Lin, S. S. J., Liu, E. Z. F., & Yuan, S. M. (2001). Web-based peer assessment: Feedback for students with various thinking-styles. *Journal of Computer Assisted Learning*, 17, 420-432.

Liu, N.-F., & Carless, D. (2006). Peer feedback: The learning element of peer assessment. *Teaching in Higher Education*, 11(3), 279-290.

Mutch, A. (2003). Exploring the practice of feedback to students. *Active Learning in Higher Education*, 4(1), 24-38.

Ng, P. T. (2008). Educational reform in Singapore: From quantity to quality. *Educational Research for Policy and Practice*, 7, 5-15.

Papinczak, T., Young, L., & Groves, M. (2007). Peer assessment in problem-based learning: A qualitative study. *Advances in Health Sciences Education*, 12, 169–186.

Patton, M. Q. (2002). *Qualitative research and evaluation methods*. Thousand Oaks, CA: Sage Publications.

Peterson, E. R., & Irving, S. E. (2008). Secondary school students' conceptions of assessment and feedback. *Learning and Instruction*, 18, 238-250.

Sluijsmans, D., Dochy, F., & Moerkerke, G. (1999). Creating a learning environment by using self-, peer- and co-assessment. *Learning Environments Research*, 1, 293–319.

Strijbos, J.-W., & Sluijsmans, D. (2010). Unravelling peer assessment: Methodological, functional, and conceptual developments. *Learning and Instruction*, 20, 265-269.

Tan, K. (2011). Assessment for learning in Singapore: Unpacking its meanings and identifying some areas for improvement. *Educational Research for Policy and Practice*, 10, 91-103.

Topping, K. (1998). Peer assessment between students in colleges and universities. *Review of Educational Research*, 68(3), 249-276.

Topping, K. J. (2009). Peer assessment. *Theory Into Practice*, 48, 20-27.

Topping, K. J., Smith, E. F., Swanson, I., & Elliot, A. (2000). Formative peer assessment of academic writing between postgraduate students. *Assessment and Evaluation in Higher Education*, 25(2), 149-166.

Tsai, C.-C., & Liang, J.-C. (2009). The development of science activities via on-line peer assessment: The role of scientific epistemological views. *Instructional Science*, 37, 293–310.

Tsivitanidou, O. E., Zacharia, Z. C., & Hovardas, T. (2011). Investigating secondary school students' unmediated peer assessment skills. *Learning and Instruction*, 21, 506-519.

Vickerman, P. (2009). Student perspectives on formative peer assessment: An attempt to deepen learning? *Assessment & Evaluation in Higher Education*, 34(2), 221-230

Yu, F.-Y., & Wu, C.-P. (2013). Predictive effects of online peer feedback types on performance quality. *Educational Technology & Society*, 16(1), 332–341.

User-Centered Design of Interactive Gesture-Based Fitness Video Game for Elderly

Feng-Ru Sheu, Yun-Lin Lee, Shio-Jeng Yang, Nian-Shing Chen*

Department of Information Management, National Sun Yat-Sen University, Taiwan
{fsheu, m014020034, taivoan, nschen}@mis.nsysu.edu.tw

Abstract. A preliminary usability evaluation of the gesture-based fitness game for the elderly was carried out with fourteen people from both genders, four men and ten women aged between 60 to 77. The results of a design study of a gesture-based fitness game system for elderly are presented with the intention to address the questions of how to design a gesture-based system which allows elder people to play in a safe, convenient, and enjoyable manner.

Keywords: Kinect, Usability Evaluation, User-centered Design, Active Video Games, User Experience, Gesture-based Interface.

1 Introduction

User interfaces are moving from traditional graphic user interfaces (GUIs) to nature user interfaces (NUIs). Gesture-based technology devices (such as Nintendo Wii and Microsoft Kinect) include sensors able to detect voice, gestures, which provide a new evolution that allows full human body motion to interact with systems and opportunity for promoting physical activities for the elderly [1,2,3,4,5,6].

We used the user-centered design (UCD) approach to develop a gesture-based fitness game system intending to train balance in older adults. A comparative usability evaluation of two prototypes of gesture-based (Kinect-based) fitness games for elderly (EverGreen I and EverGreen II), was conducted as part of an iterative design process.The objectives of the study were to determine the following: 1) to test whether or not the design changes improve usability; 2); which game system had faster overall task completion time; 3) which version of EverGreen (EG) had a higher subjective score for usability; 4) whether or not the modification/design changes improve the learnability. In this paper, we summarize the results of the evaluation.

G. Chen et al. (eds.), *Emerging Issues in Smart Learning*,
Lecture Notes in Educational Technology, DOI 10.1007/978-3-662-44188-6_54

2 Method

2.1 The Systems

Two prototypes were invested here. EG II was improved version based on the feedback gathered from the first usability test on EG I. Previous study showed that people's attention can only note an object one time. Therefore, reducing unnecessary of game objects, users can understand what actions should be made (See Fig. 1.). Besides to make it more consistent and simplified layout, major redesign was the menu selection (See Fig. 2. and Fig. 3.). Gestures for selection for EGI were to swing right arm to the right for making "cursor" move one step to the right, as using left arm for moving curser to the left. However, we found this gesture causing usability issues, such as move two options instead of one due to slow motion that elderly made or prolong the selection process because making changes (See Fig. 4.). Also, it cause fatigue after using arms in that particular gestures.

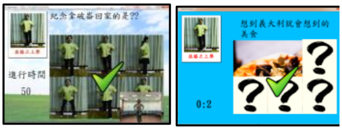

Fig. 1. Left one is game display of the EG I; right one is game display of the EG II.

Fig 2. The EG I's menus of Learning phase(left) and gaming phase(center & right).

Fig. 3. All of menus in the EG II. (From left to right are the menu of Game entrance, Game selection and two Playing selection.)

Fig. 4. The menu of game display for the EG II.

2.2 Participant & Test Procedures

Participant. Total of fourteen participants were recruited (10 women; 4 men) age from 60 to 77. Five participants for the first usability test, nine participants for the second prototype conducted 3 months later with the revision of the system. None of them used Kinect Xbox 360 before. One of them for second test has used Wii once.

Questionnaires. Questionnaires consisted of two parts: pre- test questionnaire and post- test questionnaire. The former includes: personal information form and the physical activity readiness questionnaire (PAR-Q), a self-screening tool and often used by fitness trainers to determine potential risks of physical activity. The latter includes System Usability Scale and Physical Activity Enjoyment Scale; to assess overall system usability and the enjoyment involving physical activity.

Sequence of Test Procedure. As shown in Fig. 5, when participants finished tasks, they were asked to fill out a post-test questionnaire, contains PAES and SUS. At the end of the session, a brief follow-up interview was conducted for overall experience and for clarification.

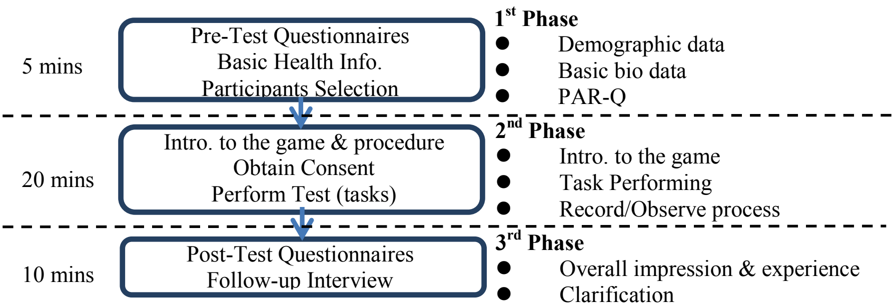

Fig. 5. Sequence of the test procedure

3 Results & Discussion

Overall task performance. Participants in both studies completed all tasks. Based on data collecting, the overall results suggest that the EG II interface is an improvement over the EG I interface. Participants in the second study using EG II had faster average task times than using EG I and had all statistically significant.

Subjective Results (SUS results). The composite subjective usability score (from the SUS) for EG II was higher than the score for EG I (see Table 1.). Based on all results together, especially on effectiveness and efficiency, it is suggested that the vertical way of selection works better than horizontal.

Table 1. SUS scores by prototype

	n	Mean score	Minimum score	Maximum score	Level of Significance
EG I	5	66.00	45	92.5	.001***
EG II	9	88.88	75	97.5	(Significant)

***p<0.001 **p<0.01 *p < 0.05.

4 Conclusion

The EG was evaluated in its target function--playing active video games -- by older adults. Results revealed effectiveness (all completion) and efficiency (shorter task time). It is very encouraging that participants only asked once how to play and the time to finish each sub-game unit was shorter each time, indicating good learnability. The user-centered design process was successfully applied to improve the EverGreen fitness game system resulting in a second prototype tested within this study. Data generated from this preliminary research will be used as feedback for the design and development team to incorporate enhancements to the application. Lessons learned in this study can also be shared with people who are also interested in the design of gesture-based systems for elderly. The gesture-based and game-based application has the great potential to be used by elder populations to improve or maintain the quality of life.

Acknowledgements. This research was supported by the National Science Council, Taiwan under project number NSC101-2511-S-110-003-MY3.

References

[1]Marin, J. G., & Navarro, K. F. Serious games to improve the physical health of the elderly: A categorization scheme. Proceedings of the 4th International Conference On Advances In Human-Oriented And Personalized Mechanisms, Technologies, And Services, Barcelona, Spain, pp. 64-71 (2011)

[2]Gerling, K. M., Schild, J., & Masuch, M. Exergame design for elderly users: The case study of silverbalance. Proceedings of the 7th International Conference On Advances In Computer Entertainment Technology, New York, NY, USA, pp. 66-69 (2010). Retrieved from http://doi.acm.org/10.1145/1971630.1971650

[3]Gerling, K., Livingston, I., & Nacke, L. For older adults: Effects of age-related changes on structural elements of digital games. R. M. D.: Full-body motion-based game interaction for older adults. Proceedings Of The 30th International Conference On Human Factors In Computing Systems, CHI'12, Austin, TX, USA, pp. 1873-1882 (2012)

[4]Gerling, K. M., Schulte, F. P., Smeddinck, J., & Masuch, M. Game design for older adults: Effects of age-related changes on structural elements of digital games. In M. Herrlich, R. Malaka, & M. Masuch (Eds.), Entertainment Computing - ICEC 2012. Lecture Notes in Computer Science vol. 7522, p. 235-242 (2012). Springer Berlin Heidelberg. Retrieved from http://dx.doi.org/10.1007/978-3-642-33542-6_20.

[5] Smeddinck, J. D., Herrlich, M. Krause, M., Gerling, K. M., & Malaka, R. (2012). Did they really like the game? - Challenges in evaluating exergames with older adults. In CHI Workshop on Game User Research: Exploring Methodologies, Austin, Texas, USA.
[6]Gerling, K., & Smeddinck, J. Involving users and experts in motion-based game design for older adults. Proceedings of the 31th International Conference On Human Factors In Computing Systems, 31th, CHI'13, Paris, France. (2013)