

Project-Based Learning for Academically-Able Students

**Hwa Chong Institution
in Singapore**

Joseph C.L. Tan and Anne Chapman



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CHAPTER 1

OVERVIEW OF THE ISSUES

INTRODUCTION

This book reports research aimed at developing understandings of the impact of a research-based project work learning curriculum on independent learning.

A case study examined the views and experiences of students at Singapore's Hwa Chong Institution, who were engaged in a rigorous secondary school curriculum developed to offer an independent, customized and experiential learning experience for academically-able students. The study primarily investigated how the students dealt with research-based project work learning used in a social constructivist approach designed to foster independent-learning attitudes. The study further examined, through the students' perspectives, the role of their teachers in facilitating independent learning, and also how the various resources in the school impacted and contributed to the process. It was deemed important to find out how these students coped with the research-based project work curricula in their school.

This chapter has six main sections. The first section provides an overview of the background and context of the study. It outlines the notion of project-based learning and describes recent trends in research-based project work internationally and in Singapore. It also sketches the context of the Hwa Chong Institution, the location of the study. The second section describes the key concepts of the study. The third section presents the aim and research questions of the study. The fourth section describes the research design and methods of data collection and analysis that were employed. The fifth section summarises the key findings of the study. The sixth section outlines the significance of the study. The chapter concludes with a structured overview of the chapters to follow.

BACKGROUND AND CONTEXT

Project-Based Learning

Simply put, project-based learning is a model that organizes learning around projects (Thomas, 2000). According to Jones, Rasmussen and Moffitt (1997), Thomas, Mergendoller and Michaelson (1999) and Ngeow and Kong (2001), projects are complex tasks, based on challenging questions or problems that involve students in design, problem-solving, decision-making, or investigative activities, and giving students the opportunity to work relatively autonomously over extended periods of time, and culminating in realistic products or presentations.

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Project-based learning, sometimes referred to as project work, can then be seen as an extensive problem-based learning activity in which students need to find ways to verify a phenomenon or solve a problem. As such, the skills set as well as the appropriate attitudes and abilities required of students include abilities like critical thinking, creative thinking, the ability to manage time and the ability to work cooperatively with others (Ngeow & Kong, 2001).

Sonmez and Lee (2003) also observe that experiential learning opportunities provide students the chance to learn independently and develop critical thinking skills. Scriven and Paul (1992 cited in Serfeith, 1997) define critical thinking as the intellectually disciplined process of actively and skilfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication as a guide to belief and action.

The approaches of problem- and project-based learning are not recent concepts. One of the earliest proponents of this approach in the early 20th century was the educational theorist Dewey who introduced the concept of a ‘problem situation’, and having students relating to real life issues and providing them with the resources to address the problems (Evenson & Hmelo, 2000). While revolutionary at that time, it was not till the late 1960s that the idea took a renewed interest that led to the incorporation of this approach into the formal education curricula. As a general model, problem-based learning was developed in medical education in the early 1970s and since that time it has been refined and implemented in over 60 medical schools. The McMaster Medical School in Ontario Canada introduced the complete problem-based medical curriculum with Maastricht University in the Netherlands in 1974 (Maudsley, 1999). The most widespread application of the problem-based learning approach has been in the first two years of medical science curricula where it replaces the traditional lecture-based approach to anatomy, pharmacology, physiology and so on. Since then the approach has been adopted in an increasing number of other areas including Business Schools (Milter & Stinson, 1994), Schools of Education (Bridges & Hallinger, 1992; Duffy, 1994); Schools of Architecture, Law, Engineering and Social Work (Boud & Feletti, 1991); and high school (Barrows & Myers, 1993). While there has been renewed enthusiasm for authentic learning, and approaches to pedagogies and instructions that focus on the connection of content and knowledge to the context of its application, the basic concept and tenets of ‘learning by doing’ have been practiced in the education realm since the earliest days of formal education.

Right from the start problem or project-based learning has been considered more of an approach rather than a specific method or process. As such there seems to be a lack of agreement regarding a common definition to describe it. Barrows and Tamblyn (1980, p. 1) define the approach as “the learning which results from the process of working towards the understanding of, or resolution of a problem”. Gibbons (2005) describes problem-based learning as a collection of information, pertinent to the problem, where students learn to analyse each information at hand and synthesizing

them to come out with possible solutions to solve the problem. On the other hand Boud and Feletti (2003, p. 1) argue that “the starting point for learning should be a problem, a query or a puzzle that the learner wishes to solve”. Nevertheless, they add that problem-based learning has been “one of the most powerful teaching methodologies designed to encourage students to take responsibility for their own learning” (Boud & Feletti, 2003, p. 1).

The International Context

In the United States (US), project work in schools has been favourably considered as an avenue for practical transference of skills from the school to the real world since the early part of the 20th century (Barron et al., 1998, p. 272). In fact the term ‘project’ has often been referred to as a broad classification of learning experiences. A few cases in point in the US saw the term ‘project’ referring to learning activities as varied as ‘making a dress’, ‘watching a spider spin a web’, ‘writing a letter’, or learning the ‘why and wherefore of the world series’ (Hotchkiss, 1924, p. 111; McMurray, 1920 cited in Barron et al., 1998). Kilpatrick (1918 cited in Barron et al., 1998, p. 333) concluded that the unifying thread was that students learn best when “wholeheartedness of purpose is present”. In recent times in the US, however, the adaptation of this project approach in schools has at best ‘waxed and waned’ with only a minority of teachers consistently adopting such ‘innovative practice’ (Cuban, 1984; Elmore, 1996). Quite a few reasons have been cited as to the limited adoption of project-based learning in US public school classrooms. These reasons include inadequate material resources, time limitation for creating and developing new curricula, large class sizes, and over-controlling administrative structures that prevent teachers the autonomy necessary to adopt such approaches (Tyack & Cuban, 1995). Perhaps the single most cited explanation has been the growing incompatibilities between such progressive approaches and the US college entrance requirements (Tyack & Cuban, 1995). To this end some authors have also criticized attempts to renew the interest of project-based approaches by arguing that project-based learning often leads to doing for the sake of doing. Given the lack of emphasis, support and resources as cited above, this is hardly surprising.

In Asia, where the emphasis in most mainstream schools and for that matter the Asian society at large has been that of scholarly and academic pursuits and academic excellence, project work has only caught on in the various school curricula over the last two decades.

In Hong Kong, there has been ample research in recent years on collaborative learning in its various permutations, from focused learning tasks to varying degrees of open-enquiry and problem-based approaches. Project-based approaches have been accepted since the 1990s as students are tasked to work in teams to work together for knowledge sharing, knowledge building and problem-solving. This process in essence provides the students with the opportunity to be acculturated as members of a knowledge community (Law, Ma, & Yuen, 2000).

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During the same period, it has been popular among schools in Hong Kong to assign group projects to students. Among the justifications for this approach is that project work promotes the information retrieval and self-directed learning abilities of students. It also subscribes to the concept that collaborative learning is good and that students should learn to collaborate with each other (Law, Ma, & Yuen, 2000).

The Singapore Context

In the Singapore context, among the significant changes in the national curriculum across schools is the infusion of project-based curriculum or project work in schools. Project work was introduced in all schools in the year 2000 (Ministry of Education, 2004). In the primary schools, this was done at Primary 3, 4 and/or Primary 5 (ages 9 to 11), while in the secondary schools, this was done at Secondary 1, 2 and/or Secondary 3 (ages 13 to 15). Beyond secondary schools, project work was implemented in junior colleges in the first year pre-university classes. In essence the introduction of project work in schools is to provide students with an authentic learning experience that gives them the opportunity to create knowledge from their learning and apply it to real life situations. As students engage in their projects they will gain important skills such as cooperation and collaboration, communication and independent learning, thus becoming prepared for the challenges ahead.

From 2003, the Singapore Ministry of Education (MOE) implemented project work as a key examinable component of the JC1 (Grade 11) pre-university curriculum where the grade attained is computed as one of the admission criteria for entry into the local universities from 2005 and beyond (MOE, 2004). The MOE views project work as an avenue that allows students to explore the inter-relationships and inter-connectedness of subject-specific knowledge (MOE, 2004).

Hwa Chong Institution: The Case Study School

The case study reported in this book was conducted at Hwa Chong Institution in Singapore, which offers a 6-year comprehensive secondary school programme. The programme caters to academically-able students aged 13 to 18 who are within the top 3% of the national cohort. Hwa Chong Institution, referred to in this book as the case study school, is uniquely positioned as an independent school as well as an integrated programme school. As an independent school in Singapore, the school receives similar funding to mainstream government schools. However, the school has full autonomy to craft and develop its own programmes and curriculum to cater to the profile of its cohort. While mainstream schools would require all students at Secondary 4 to sit for the General Certificate of Education (GCE) 'Ordinary' levels examinations, a select group of schools have been granted permission to 'exempt' their students from the national GCE 'O' levels examinations. These schools have established track records of students doing well in examinations to proceed on to

pre-university courses at the various junior colleges. This select group of schools thus offers what is termed an Integrated Programme.

The case study school is one such school where it is an Integrated Programme, Independent School. The school is thus tasked with the responsibility of setting educational innovations and initiatives (Kang, 2005, 2008). The case study school offers a unique curriculum that provides students with an independent, customised and experiential learning experience. In so doing, research-based project work is a key aspect of the curriculum.

The case study school introduced project work in 1984. It has subsequently developed customised curricula for students to incorporate and infuse project work (Yip et al., 1997). While project work was initially introduced as an enrichment activity to enhance learning opportunities, it has since become an integral part of the school's curriculum, as well as the students' assessment protocol. Project work aims to provide opportunities for the students to develop skills in the cognitive and affective domains and nurture them to be independent learners. Since the late nineties, the case study school has also fine-tuned project work to focus specifically on research-based project work.

Allocation to secondary school is based on the students' performance at the Primary School Leaving Examination, PSLE, a national exam at the end of the primary school system. Student categorization at the secondary school level is in several broad tracks to cater to the learning pace of students with differing academic abilities. The most academically-able among the annual cohort are allocated to schools of their choice based on vacancy and merit. This group would be those among the top 10% of the cohort. The case study school is a popular school which attracts students who are academically-able.

The student participants in this study were set against the backdrop of academically-able students and were not necessarily officially classified as students in the gifted stream. Those in the gifted stream constitute the top 1% of their cohort, having been selected through screening tests conducted by the MOE Gifted Education Branch at the end of Primary 3 (Grade 3). The student participants in this study were among the top 5% of the national cohort.

KEY CONCEPTS

In defining the parameters of this study, key concepts were addressed to provide focus and also to ensure manageability. The concepts elaborated in this section bear direct relevance to the focus of this study; independent learning within the context of research-based project work.

Constructivism and Social Constructivism

In discussions regarding the concept of social constructivism, the fundamental concepts of constructivism and its complementary concept of cognitivism are

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discussed in parallel. Cognitive theorists have described that cognitivism essentially recognizes that a significant degree of learning involves associations established through contiguity and repetition (Good & Brophy, 1990). These same theorists also subscribe to the importance of reinforcement. In essence, cognitive theorists view learning as the acquisition or reorganization of the cognitive structures through which learners process and store information (Mergel, 1998).

Constructivists pioneers such as Bartlett (1932, 1995) described that learners construct their own reality or at least interpret it based on their perceptions of experiences. Thus, an individual's knowledge is a function of his or her prior experiences, mental structures, and beliefs that he or she uses to interpret objects and events (Good & Brophy, 1990). Jonassen (1991) further described constructivism as grounded in perception of the physical and social experiences which are comprehended by the learner's mind. Other constructivists similarly imply that learners construct their own knowledge instead of just copying it from an authority, be it a book or a teacher. These knowledge constructs would then extend from the individual to others within the individual's learning community (Kanselaar, De Jong, Andriessen, & Goodyear, 2000). In short, the central idea of constructivism is that human knowledge is constructed, and that learners build new knowledge upon the foundation of previous learning (Kanselaar, 2002). Social constructivism then extends the above discourse to argue that a social group constructing things for one another collaboratively creates a small culture of shared artifacts with shared meaning (Kanselaar, 2002).

Learning and Independent Learning

The various dispositions and understandings of what constitute independent learning or, fundamentally, 'What is Learning?' are relatively vague because of the "failure to distinguish between learning theory and the conditions that enhance learning" (O'Donoghue & Clarke, 2009, p. 75). Barrow (1984) defines learning theory as the description of what happens when learning takes place, rather than why or how it takes place. Fontana (1981, p. 147) further defines learning as "a relatively persistent change in an individual's possible behaviour due to experience". Barrow (1984, p. 99) highlights the reference of 'experience' as "designed to contrast with changes in behaviour that come about automatically through maturation and physical development".

Kesten (1987 cited in O'Doherty, 2006, p. 3) states that independent learning is a kind of learning in which the learners, together with their peers, are able to make good decisions to meet their own learning needs. Consequently, Benson and Blackman (2003) have argued for undertaking a redevelopment and redesigning of curricula such that students' learning experiences improve with the infusion of activity-based research or project work to foster independent learning. They add that students engaged in this approach tend to be better prepared to undertake subsequent research and projects. Moreover, this approach allows students to understand the subject

matter better. As such, Kesten's premise focuses on the creation of opportunities and experiences necessary for students to become self-reliant, motivated and life-long learners.

This study thus presupposes that independent learning requires students to take responsibility for their own learning (Sivaraman, 2008). Individual responsibility results from the belief that learning can be affected by effort. This belief is a critical factor which leads to students' perseverance in the face of obstacles (Deci, Koestner, & Ryan, 2001).

Another important factor in encouraging independent learning is the student's own interests and desire to learn (Kesten, 1987). Deci, Koestner and Ryan (2001) have shown that students are motivated to learn if the learning activity is meaningful to them or if the knowledge is useful and provides a means of achieving a desired goal. Such learning activities provide a stimulus to reflective inquiry and continuing intellectual development.

Self-Directed Learning

The concept of independent learning ultimately recognizes that students will in some form engage in self-directed or self-regulated learning. As early as 1975, Knowles worked on the supposition that the motivational factors of self-directed learning include the learner's experiences as an increasingly rich resource for learning. He explains that self-directed learners' natural orientations are task or problem-centered. As such, he prescribes that learning experiences should cater to task accomplishments or problem-solving learning projects. Knowles further describes self-directed learning as "a process where the learners take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying resources, choosing and implementing appropriate learning strategies, and evaluating learning outcomes" (1975, p. 18). Teachers adopting this approach would then need to go beyond teaching students the 'will' but also the 'skill' in learning (Pintrich & de Groot, 1990). Armed with this toolbox of skills, students can then be made aware that they can be empowered to direct their own learning instead of reacting to directives from their teachers.

Martinez (2000) also introduced the argument that a learner's learning orientation lends itself well to self-directed learning. She describes learning orientations as addressing the learner from a whole-person perspective that recognizes the dominant influence of emotions and intentions on their learning. While acknowledging the important role of the traditional cognitive approaches, Martinez (2000) suggests that as individuals have different learning experiences and mature as learners, they gradually become more confident, sophisticated, and adept at understanding and managing an increasingly complex interplay of personally relevant affective, conative, social, and cognitive learning factors (p. 8). One's "learning orientations" are thus unique and exclusive to how the learner perceives and manages their learning to achieve or accomplish goals. Hence the significant question is 'how

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do individual learners approach their learning?’ Woodward (1998) argues for the use of goal orientation (intentions) for learning and development from an earlier age. As such, it might be appropriate to introduce into school curricula strategies and approaches that would progressively motivate students with the ‘skills’ of self-regulated or independent learning.

AIM AND RESEARCH QUESTIONS

The aim of the study reported in this book was to develop understandings of academically-able students’ perspectives on their independent learning from participating in a research-based project work curriculum at an independent secondary school in Singapore.

The main focus of this study was guided primarily by the central research question: How do students engaged with a research-based project work curriculum deal with independent learning?

Generating from the central research question, the study was guided by the following specific research questions:

What were the students’ *intentions* prior to the implementation and their participation in authentic and experiential learning, particularly that of the infusion and incorporation of a research-based project work approach to their curriculum? What reasons did they give for their intentions?

What *strategies* did the students develop to manage and ‘deal with’ the research-based project work approach in their curriculum? What reasons did they give for utilizing those strategies?

What was the *significance* that the students attached to their intentions, and their strategies, and what reasons did they give for this?

What *outcomes* did the students achieve as a result of their actions, and what reasons did they give for this?

These questions were not generated as specific questions for the students to address. Rather, they informed the development of interview questions to generate data for the development of theoretical propositions with regards to the perspectives and understandings of these students towards the research-based project work curriculum they experienced.

RESEARCH DESIGN AND RESEARCH METHODS

This study adopted a qualitative research methodology in the interpretivist paradigm to develop an understanding of academically-able students’ perspectives on their independent learning from participating in a research-based project work curriculum. With the definition of perspectives as the frameworks through which the participants made sense of the world (Woods, 1983), this research investigated the students’ perspectives on how they understood project-based curriculum vis-à-vis their classrooms and school situations.

To reiterate, a case study was made of students engaged in research-based project work in one school in Singapore. A purposeful sampling approach was employed to select a credible representative sample of participants in the case study school for in-depth study (Miles & Huberman, 1994; Patton, 2002; Punch, 2009).

Data-Gathering Methods

The data collection method reflected the qualities of interpretive symbolic interactionism (O'Donoghue, 2007), the theoretical framework that was adopted for this study.

The primary source of data for this study was semi-structured interviews with 30 students at Secondary 4 level in Singapore. The data was gathered in an iterative process to follow up themes as they arose. Individual interviews, as well as five focus-group interviews, were conducted, with each group representing a course of study involving research-based project work. The four guiding research questions were open-ended to gather information-rich responses in order to reveal the participants' perspectives of the research-based project work curriculum, and its significance in influencing and shaping their learning attitudes. Documentary evidence was gathered to complement the interview data, thereby providing the 'conceptual density' required for authentic research (Strauss, 1987). The documents included the school's policy proposal and reviews of the introduction and implementation of project work into the mainstream curriculum. In addition, the students' project reports also provided evidence of their reflections and learning as they engaged in project work.

Data Analysis

This study utilized the inductive analysis approach to manage and analyse data (Miles & Huberman, 1994, p. 428). The three-stage analysis of the data included data reduction, data display, and drawing and verifying conclusions (Miles & Huberman, 1994). The interview data were transcribed and analysed using open-coding (Strauss & Corbin, 1990) by which initial categories were developed and sorted into conceptual categories. The analysis of the data commenced upon completion of the first interview, highlighting emerging categories and concepts. This process continued across the rest of the interviews to ascertain possible patterns of similarities and distinct unique viewpoints from the responses of students across differing electives/subjects. The analyses of the students' responses included,

- Identifying conceptual categories in the data;
- Identifying relationships between and across the various categories; and
- Conceptualizing and accounting for these relationships at a higher level of abstraction (Punch, 2005).

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OVERVIEW OF THE FINDINGS

The empirical findings led to the development of seven theoretical propositions as follows:

Proposition 1

Understanding the rationale and processes of project work allows students to determine their own learning outcomes and motivates them to learn independently and ‘go beyond’ the contents of the syllabus. Engagement in research-based project work develops characteristics of independent learning, as learning becomes more informed and involved.

Proposition 2

Students leverage on the differing strengths of their group members and perform different roles to complete their projects. Beyond group dynamics, the students with complementary strengths and abilities work synergistically to ensure alignment in and enhance the quality of their projects.

Proposition 3

As students work on their projects in groups, they engage in collaborative learning which in turn leads to knowledge building. This contributes to collective wisdom which is evident in the products that are jointly produced by project groups.

Proposition 4

Having project groups comprised of members from different peer groups, classes, schools or countries provides students with an experience in collaboration beyond their immediate ‘comfort circles’, and facilitates interaction and understanding. Such interaction prepares students with the necessary skills to enable them to function well in the future in a more globalized environment.

Proposition 5

When students are not able to find time to meet in-person as a group, they rely heavily on virtual social media to ‘meet’. Adequate training to use the tools and facilities on social media is necessary before the commencement of project work in order to maximise their use once the project commences. This enhances learning efficiency.

Proposition 6

Students rely on their teacher mentors to varying degrees to ‘guide’ them in their project work, and not all teachers provide similar levels of ‘guidance’. Levels of reliance on mentors are influenced by factors including initial anxieties about project work and the practicalities of specific projects and research activities, expertise of the mentor, and the need to stay ‘on track’. Over time, teacher mentors effect a shift from the ‘hand-holding’ stage to independent learning.

Proposition 7

Beyond the guidance from their teachers, students engaged in project work benefit from physical, network and infrastructural supports, including: laboratories and equipment; sound library facilities and access to relevant online resources and social media; appropriate computing facilities; and training and workshops in project work learning.

SIGNIFICANCE OF THE STUDY

This study investigated the perspectives of the selected students on whether the ‘experiential’ learning approaches of research-based project work learning within their curricula promoted independent learning, and considered from their perspectives the impact these approaches have on their learning attitudes. The outcomes of the study provide opportunities to enhance and fine-tune the curriculum and suggest possible variations to its implementation of the experiential approaches within the curriculum at the case study school. The study also bears evidence for similar programmes to be initiated in other school settings with a similar profile of students.

CONCLUSION

This introductory chapter provided the overall framework of the research and the tenet of the study by discussing the aim of the study and describing the background and context and key concepts for the research. The chapter introduced the central research question as well as the guiding research questions for data collection. The chapter also outlined the research design and methods that were employed, the key findings and the significance of the study.

Chapter 2 discusses the background to the study which is located in the context of curriculum shifts in education systems across the world that focus on experiential and authentic learning with emphasis on problem-solving and project-based approaches to learning. The chapter provides a historical review of the changes in the Singapore education landscape with emphasis on the inclusion of project work in the school curricula across the various levels. The chapter concludes with

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discussion of the slant of the research-based project work curriculum in the case study school.

Chapter 3 reviews relevant empirical literature underpinning the research. The various studies that are relevant to this research are generally focused on experiential and authentic curricula. The literature review draws on research across both the international context as well as the local Singapore context. Most of the studies concern the perspectives of school administrators and educators; few have investigated the perspectives of students. Additionally, the project work that the participants in the sample school engaged in is also geared towards a research-based approach. As stated earlier in this chapter, this research-based project work approach differs significantly from the project-based approach adopted by many schools and educational systems. This chapter thus aims to contribute to this area.

Chapter 4 introduces the theoretical underpinnings of the study as it presents on the research design approach and the methods used. Chapter 5 presents the empirical findings, and Chapter 6 develops the theoretical propositions.

The concluding chapter summarizes the study and provides an overview of the research. The final chapter also discusses the findings of the study with presentations of the various themes and propositions as well as exploring the implications and recommendations for practice, policy and possible further inquiry.

CHAPTER 2

BACKGROUND AND CONTEXT

INTRODUCTION

This chapter locates the research project that is the focus of this book in the context of international, national and local education trends and reforms. The first section of the chapter outlines the challenges and impact of globalization on education and explores educational reforms in the United States of America (USA), the United Kingdom (UK) and Australia. The second section describes recent trends and issues in contemporary educational change in countries in Asia. The third section addresses the historical development of education reforms in Singapore. The final section describes key features of the Integrated Programme and Project Work delivered at Hwa Chong Institution, the case study school.

CONTEXT OF CURRENT EDUCATIONAL MOVEMENT IN THE INTERNATIONAL ARENA

Education in Today's Globalised and Connected World

The effects of globalisation have caused many countries around the world to experience significant changes across almost every aspect of society. The effects of globalisation in economic terms have largely been relatively positive in that they help to overcome the constraints of national boundaries, and to a certain extent optimize resources. However the impact on society at large challenges traditional perimeters of time and space, catalyzing and fuelling the rapid development of information and communication technologies (Burbules & Torres, 2000). While the transmission of information and the creation of knowledge across national boundaries have become almost instantaneous, this advancement however is not uniform across all nations. It favours societies that are better connected by allowing them access to new ideas via cross-border social and cultural exchanges between countries, which helps them to increase greater interaction and integration of national economic policies through international trade as well as investment and capital flows (Burbules & Torres, 2000). Hence there is an urgent imperative for societies to rely on education to groom their young and prepare them adequately to function and flourish amidst the challenges of globalization and advances in technologies.

As countries refocus and move from an industrial model to a knowledge-based economy, their education policies have evolved accordingly. Rapid changes in education policies in turn result in significant challenges for education systems

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across different countries. These challenges often articulate and manifest themselves in numerous initiatives and changes to the education system to enable and empower citizens operating in an increasingly complex society to be able to learn continuously, and work with diversity, locally and internationally (Hargreaves, 1994). Together with these changes and initiatives in the education system, there is also a need to review the focus and policies spearheading curriculum and assessments. Such changes in educational policies are cast largely in economic terms; that is, to prime the workforce so as to enable a country to compete in the global arena. In such situations, the focus of the country's education system then is dictated by the economic imperatives. At the same time global economic competition becomes largely dependent on the quality of education (Levin, 2001).

The Trail of Educational Reforms on the International Scene: The USA, UK and Australia

The crisis of World War II provided the impetus to focus on education to spearhead the process of social reconstruction. With the need to reconstruct industries, retrain and upskill the workforce and most importantly to revitalize confidence and regenerate optimism, many countries in the immediate post-war period turned towards a centrally reconstructed education system (Cibulka, 1995). In particular, the USA, the UK and Australia illustrate significant reforms, with influence internationally, including on the Singapore education system.

The post war period in the USA was a time when the country grappled with issues pertaining to threats of communism and inflation. The decades of the 1950s and 1960s were also plagued with domestic issues such as poverty and, in the latter stages, the Vietnam War. As such, there was limited headway with regard to education reforms during this period (O'Donoghue & Dimmock, 1998).

In the decade of the 1980s, especially during the economic recession, many of the developed countries including the USA began to seriously consider restructuring their education systems. In 1983 the publication, *A nation at risk: the imperative for education reform*, started the reform movement in the education system in the United States (Cibulka, 1995). The reform was based on the premise that there should be more attention and greater emphasis on the conditions of work in schools. Amongst the issues that the report highlighted was the decline in teacher professionalism, in part due to conditions such as poor remuneration, limited career development and opportunities, and other compelling factors. However, the thrust of the American education system then was focused on efficiency, improving productivity and enhancing human capital. The challenge then was to balance the demands for excellence and quality, for economic restraint and accountability, and for an adaptive and responsive (education) system able to meet the needs of a rapidly changing technological society (O'Donoghue & Dimmock, 1998, p. 166).

The goals of the education reform then focused on student outcomes and school accountability. This resulted in initiatives that included improving individual

schools, and enhancing student performance by adopting appropriate curriculum and instructional strategies and classroom-focused needs (Hord, 1995). Another of the proposed recommendations of the report was to raise the graduation requirements so as to improve the quality and standards of education (Murphy, 1991). Thus, schools then became fundamental in nation building. The overall direction in the education system in the United States then was to provide general education for all students, with emphasis on mathematics, science and technology (Kennedy, 1995). As the economic imperatives were important in education, schools then were expected to provide the necessary skills for domestic production and expanding capital.

A complementary thrust that was also cited in the reform included the shifting of administrative authority to professionalizing teaching (Darling-Hammond, 1993). In essence, the reform movement in the USA during the 1980s and 1990s focused on the devolution of authority and decision-making from being centrally-controlled down to the local level.

Across the Atlantic in Europe, the weakening economic climate of the mid-70s prompted changes in the education systems across many developed economies. The Thatcher government in England prescribed a more centralized control of education and its policies, resulting in the establishment and implementation of national curriculum and assessment in order to centrally control educational standards (O'Donoghue & Dimmock, 1998). Its main goal was to enhance quality and produce a better nation. In so doing, the UK government premised that "schools should emphasise the contributions of the economy to national life and prepare students to take their place in the economy" (Kennedy, 1995, p. 79).

This approach carried on in the 1980s reinforcing the assertion between education and the economic needs of the country. At the school level, there were significant efforts made towards innovations and reforms in the curriculum with the emphasis on modernizing, standardizing and improving the quality of curriculum and aligning curriculum with societal needs, which were sustained into the 1990s. Consequently the national curriculum in the UK was revised and made statutory in 2000, with a wider concern for work-related learning.

As in the UK and the USA, the Second World War brought about numerous social and economic changes in Australia. Despite the Federal Government then having the authority to provide benefits to schools in the post-war period, it was state jurisdiction that had the expensive domains of health, police and education policy (Louden & Browne, 1993).

Just as in the UK, the weakening economy of Australia in the 1970s prompted major changes to the education landscape. These changes in the Australian education system were similarly aligned to the relative skills of the workforce (Angus, 1995). Amongst the highlights reported in the 1973 *Karmel Report* were school level issues such as the lack of resources, poorly trained faculty, a constricted and narrow curriculum, school management that were authoritarian and the general inequities amongst schools. The report also recommended a number of bold changes in the policy directions for schools. The proposed changes included the devolution of

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responsibility to schools, providing equal opportunities for students, diversity in teaching and school-based curriculum generation. The Labour Government of the day responded by facilitating the necessary funding and resources like libraries and other general buildings as well as teacher development and educational innovations (Louden & Browne, 1993).

In 1985, the Federal Education Department imposed national testing with the emphasis on the outcomes of education (Louden & Browne, 1993). The singular goal of the Government was to align education as part of the reform agenda to produce a multi-skilled and flexible workforce. The release of the paper entitled *Strengthening Australian Schools: A Consideration of the Content and Focus of Schooling* in 1988 emphasized the need to communicate and highlight the primary purposes of schooling, and to advance teacher training. The report also called for an alignment of a general curriculum framework as well as a national approach to assessment (Louden & Browne, 1993; O'Donoghue & Dimmock, 1998). Subsequently, the Curriculum Development Centre developed a common curriculum and associated educational materials. As state education systems continued to be influenced by the Federal government, the alignment between education and employment continued to be reinforced (Beare & Boyd, 1993). This remains a key feature of Australia's education policy today.

In contemporary Australia the intent of alignment between the needs of the economy and education is clear. In fact the Australian government's approach to its education system as an avenue towards economic development is highlighted in its socio-economic reform policy (Cibulka, 1995). Often this policy dilutes the intrinsic value of education for its own sake (Cibulka, 1995).

The National Curriculum Board of Australia has put in place national testing in literacy and numeracy, with on-going discussions between the Federal Government and states and territories with reference to the changing agenda of power bases of education. As in the UK and some states of the USA, there has been increasing political demand to return the control of educational reform to central authorities. This has generated increasing tension in schools as teachers question their status as curriculum decision-makers. Further, their autonomy in curriculum matters may well diminish if the move towards centralization is manifested (Australia's National Report on the Development of Education, 2004).

EDUCATIONAL REFORMS IN ASIA

The trends outlined above in the USA, UK and Australia have influenced the development of education systems in Asia. In light of the need to up-skill their populations to meet the demands of the global economy, countries across Asia have embarked on significant reforms of their education systems. With rapid growth in the 1980s of newly industrialized economies such as Korea, Taiwan, Singapore and Hong Kong, as well as with the economic dominance of Japan, Asian countries have not only reassessed their respective economic policies but these reviews have tied

in closely with the changes in their education systems as well (Kennedy, 1995). With the singular goal to align educational effectiveness with economic strategies, countries across the region have embarked on varying degrees of educational reforms and school restructuring movements (Cheng, 1998).

Spurred on by their economic success stories in the 1990s, many Asian countries sought to strategize their education system towards providing their population with the necessary skills to ride the challenges of the new economies. Recent decades have seen Asian countries implement significant reforms in their education system to reframe and refocus strategies with the aim of ensuring effectiveness (Sharpe, 2002).

Japan emerged from the ruins of World War II with the urgent need to reform its education system, which was deemed as being undemocratic. Post-war Japan looked towards the USA as a model for a new education system based on the principle of equal opportunity for all (Sweeting & Morris, 1998). The initial period of education reform after the war was seen as the period of institutionalization and expansion of education. Subsequently, during the 1950s and 1960s, as Japan experienced unprecedented economic growth, the new education reform grew in tandem (Sweeting & Morris, 1998).

In the decade of the 1970s when the Japanese education system had groomed a generation that exploited the global economic growth, a critique of that same system accused it of being too exam-oriented and of cramming of the school curriculum (Sweeting & Morris, 1998). The educational reform carried out between 1984 and 1987 emphasized the issues facing the 21st Century with the twin foci of internationalization and the information age. The former was particularly pertinent as critics of the Japanese education system had cited the lack of an international outlook as one of the critical factors that hampered creativity (Sweeting & Morris, 1998).

There was also apprehension about the ability of the education system to competently educate the population with the competencies for Japan's next stage of economic advancement (Schoppa, 1991). As a result, the reforms that were carried out were targeted at shifting the function of the education system to nurturing lifelong learning competencies, hence shifting emphasis towards the role of the individual. Consequently, the key changes in the reform were the trend toward school-based curriculum development and the decentralization of educational administration (Ota & Kabayashi, 1988). In a sense, the education reforms were targeted at providing some level of autonomy and flexibility to the various stakeholders in order for schools to prepare the next generation of students to meet the demands and challenges of a more diverse environment and face the impact of globalization and the information industry (Shimahara, 1997).

Likewise in South Korea, education reform has been of increasing national importance. Modern Korea owes its advancement to the pivotal role that its education system has played in recent decades.

With the emphasis on excelling the process of nation-building, the South Korean government has implemented several reviews and reforms of the education system

since the first review in 1954 (Sung, 1998). The Presidential Commission for New Education Community (PCNEC), the advisory body to the President on education reforms, proposed a series of educational reforms between May 1995 and June 1997 that called for the setting up of a new education system to improve effectiveness and also to address the demands and challenges of the 21st century (Kim, 1999). With the implementation of the New Education System in 1998, schools across the country were charged with the task to develop the students more holistically. As a result the emphasis in school curricula has changed to provide a more student-focus, student-centred environment where students are actively encouraged to opt for subject areas that are attuned with their aptitudes and interests. In addition, greater emphasis has been placed on having students develop a more international outlook and appreciating other cultures in this age of globalization. As such, schools across all levels are encouraged to engage their students in activities and events that encourage such an international outlook (Kim, 1999). While the reforms provided schools with the autonomy to develop their respective curricula and manage administrative matters in order to develop and encourage unique characteristics and diversity in the education landscape, it also recommended students be given the space to learn at their own pace according to their respective cognitive development progress. The system provides for streaming of individual students' potential for development through lessons that take into account differences in the individual's ability, aptitude, needs and interests (Kim, 1999).

The Government of Taiwan has also had significant education reforms in recent times. This initiative took the form of the implementation of the 'Curriculum Guidelines for Nine-Year Compulsory Education' in 1998 (Chen, 1999). The thrust of this initiative was to provide for a more flexible curriculum that was less teacher-centred and did not revolve around textbooks and examinations. Various aspects of the reform have been implemented across all schools in Taiwan since 2001 (Chen & Chung, 2000). The emphasis of the reform is on curriculum integration and collaborative learning. It also provides scope and autonomy for schools to develop their own curricula. In so doing, the reform seeks to consolidate the human resource capital as the society embraces a more 'personal and social relevance' approach rather than the pursuit of 'academic rationalization' (Chen, 1999). Capitalizing on the enhanced and globalised arena, there is also a thrust towards the understanding of international cultures, helping the link to international society and cultivating whole-life learning (Chen, 1999).

As with most small economies with limited or no natural resources, Hong Kong depends on its population, or the resourcefulness of its population, for its survival and prosperity. In this light, it is of no surprise that in the last 40 years, several reforms and education policies have been put in place to enhance its education system. In its approach towards addressing the challenges of the globalised world that pushes the boundaries of economic structures, the Hong Kong Education Commission initiated various education reforms between 1984 and 2000. Following the transfer of sovereignty of Hong Kong from the UK to China in 1997, the new Hong Kong

government developed and implemented an important blueprint for education development that would take Hong Kong into the next century (Cheng, 1998). In the Proposal for Educational Reform in 2000, the Education Commission set about reconceptualising the Hong Kong Education System with the singular aim to craft and develop a diversified and sustainable education system that provided more choices and opportunities but at the same time maintaining quality. This reform also puts stress on encouraging life-long learning and all-round development (Li, 2006).

The key Asian economies of Japan, South Korea, Taiwan and Hong Kong have a common thread of implementing education initiatives and reforms to address the challenges of rapid economic growth. Hence, such initiatives and reforms are largely driven by the global economic environment. Towards the latter part of the last century, these economies and countries have veered many of their educational reforms and initiatives towards preparing their respective populations to face the challenges of the 21st century. While acknowledging the differing stages in economic development in the various countries in Asia, the respective governments have nonetheless implemented educational reforms and initiatives in the pursuit of educational and economic excellence.

As developed economies shift their focus towards knowledge-based industries, there appears to be an emphasis towards inculcating the culture of lifelong learning, and adopting a more inquiry-based approach in the curriculum vis-à-vis the respective education systems, albeit in varying degrees. No doubt that these countries are still addressing the issues in their respective education systems. Likewise Singapore has also walked similar paths in the country's short history since independence in 1965. Singapore has experienced similar challenges and aspirations to the countries cited in this chapter so far, though the circumstances around her development to date has been somewhat unique. As with the various small Asian economies mentioned, the Singapore government has spearheaded education as a key vector towards economic excellence and nation-building. The following section addresses the Singapore government's approaches through the various initiatives and reforms of its education system that mold Singapore to its current state.

THE SINGAPORE EDUCATION JOURNEY

This section traces the historical perspective of the Singapore education development and the contextual background within which this study is positioned. The section foregrounds the development of the Singapore education system and the concept of schooling. The focus is on some of the recent major educational initiatives that are set to redefine the Singapore education landscape. It can be said that the singular function of education in the early years in Singapore's short history has been fundamentally motivated by the early needs of society (Tan, Gopinathan, & Ho, 1997). It is also significant that the educational developments and reforms that were undertaken since then have largely been dictated by the changing economic, social and political scenarios in post-independent Singapore. As such, the education

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landscape in Singapore, and to a large extent the various educational initiatives and reforms in Singapore, parallel the country's national development and struggle for survival (Gopinathan, 1999).

The Early Years

Singapore, a small island city state of just over 700 square kilometres, is located in the southern tip of Peninsular Malaysia in Southeast Asia. With practically no natural resources, Singapore depends solely on its population of around five million, of which only 3.5 million are citizens, as its only resource. This population that is multi-ethnic, multi-cultural and multi-religious has a demographic diversity that consists of about 77% Chinese, 14% Malays, 7% Indians, and 2% other minority ethnic groups (Tan, Gopinathan, & Ho, 1997). It is thus not surprising that the government emphasizes quite disproportionately on building intellectual capital and human capacity to create wealth through the generation of knowledge and ideas. It is thus essential that the government focuses on developing and up-skilling the workforce in order to spur economic development.

The colonial policy since the early days of Singapore's history has been pluralistic. The differing education systems during those periods further accentuated such divisions. Consequently, when Singapore attained self-government from the British in 1959, the country not only inherited an education system that was modelled after the British grammar schools, there were also parallel vernacular schools systems in the various language medium streams. These schools were either Chinese, Malay or Tamil language medium streams of varying development and significance. The schools that were modelled after the British education system were basically intended to cater to the manpower needs of the civil service that used the English language across its functions and procedures. There was little focus, if at all any, to address the challenges of promoting economic growth and social cohesion (Gopinathan, 1999).

Upon independence and thereafter, the development of Singapore's education system developed in tandem with national development and the initial challenges and struggles for survival. The education system since the early years has since evolved to meet the changing situations and circumstances of Singapore's development (Gopinathan, 1999). In hindsight, the milestones of the various initiatives and innovations in the education system are distinctly categorized in the evolving phases of development. These milestones are discussed in the following sub-sections.

Education as Socio-Economic Leveller (from 1959 to Mid-1960s)

The education policies in Singapore from 1959 should be contextualised against the country's socio-political and economic situation and development (Gopinathan, 1999). The period in the 1950s saw Singapore engaged in deep ethnic and linguistic segmentation (Yeo & Lau, 1991). With its roots as a nation state made up of migrants from the Middle-east to South Asia through to East-Asia, the various

immigrant enclaves in the multi-racial society saw their loyalties still tied to their respective home countries (Yeo & Lau, 1991). There was also the problem of high unemployment which saw many thousands of school leavers unable to find jobs (Chan, 1971). It was therefore imperative that the government set up a comprehensive education system aimed to develop and nurture an appropriately educated and skilled workforce to face the challenges of an industrialized economy (Gopinathan, 1999). This was thus the critical issue of the then government under the new People's Action Party (PAP) as it found itself straddled with a diverse education system where differing schools were employing different languages (English, Chinese, Malay and Tamil) as the medium of instruction, and where each group of schools was abiding by very different curricula and content matters (Gopinathan, 1999). When the PAP came into power in 1959, foremost amongst its priorities was to develop and forge a cohesive and economically viable society. This was achieved by initiating an education system that focused on nation-building with the priority towards achieving the country's socio-economic goals. The then prime minister Lee Kuan Yew (1966a) and his government set about the mission to task education as a key approach towards developing a socially cohesive citizenry coupled with a workforce that was appropriately skilled.

The primary goal of the education system then was to integrate the various ethnic-based school systems into a comprehensive national education system. Together with the goal of nation-building, the Ministry of Education brought together schools under a national system aligned in a common curriculum. However the various schools were still allowed to retain their medium of instructions in their respective languages. There was also greater emphasis on literacy, numeracy, civic and moral education, mathematics and science and technical education. One significant initiative during that period was the introduction of common and standardized assessments at key stages of the school system; the Primary Schools Leaving Examination or PSLE at the end of Primary 6; the General Certificate (GCE) Examination at the end of Secondary 4; and the Higher School Certificate (HSE) Examination at Pre-University (Tan, Gopinathan, & Ho, 1997). It was also during this period that the government embarked on a massive programme to rapidly expand the educational facilities to provide a place for every child of school-going age. Consequently student enrolment in the schools increased (Tan, Gopinathan, & Ho, 1997).

Educational Upskilling of Society (1965–1978)

With independence in 1965, Singapore faced a different challenge. Issues related to heightened racial tensions, coupled with an under-developed economy as well as the political instability within the region, forced Singapore to consolidate and strengthened the country's capacity to survive economically, socially and politically (Lee, 1966b). Throughout this period, education remained a key strategy in its thrust to facilitate the country's economic push as well as build a cohesive society with a

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distinct Singapore identity. It is thus evident that both objectives, that of economic growth and social cohesion, were key features in curriculum policies. Prime Minister Lee made this clear as early as 1966 when he stated that for Singapore to compete with the more advanced nations of the world, the country needed to develop good leadership at the top and groom a well-disciplined, adequately skilled cohesive base and community of citizens. To the government, education was the key and only strategy to achieving this (Lee, 1966a). The period between the mid-1960s and early 1970s saw the qualitative consolidation and fine-tuning of the education system.

The period between 1960 through to 1980 was focused on making schooling economically relevant, mainly by diversifying the curriculum. Initiatives across the 1960s focused on the introduction and development of vocational schools with the rationale to provide students with usable skills. At the same time the Ministry of Education continued to develop and refine the curriculum as well as extend the programme to build more schools to match the growing population. Efforts were also made then to integrate the different language streams. This led to the introduction of the Bilingual Policy in 1966 where the learning of a second language was made compulsory at both the primary and secondary levels (John & Sim, 1994). This key policy was implemented on the notion that the country needed to ensure that students and future generations would be proficient in the English Language as well as in one's mother tongue, which was considered essential not only to widen one's employment prospects, but also to address racial segregation and barriers, and contribute to social cohesion (John & Sim, 1994). Subsequently, several initiatives were also introduced in the late 60s to use vernacular languages to teach History in the primary schools, and the English language for Science and Mathematics at all levels of schooling (John & Sim, 1994). Hence, such policies were the basis promoting economic development through the education system in the 1970s.

During this period also, the Ministry of Education introduced technical education within the school system. This swing in focus from academic to a more technical education was aimed to provide the necessary base to support the push towards industrialization. Consequently all boys and half of the girls and the lower secondary levels were required to take technical subjects and workshop practice. This provided the necessary numbers for having students exposed to technical studies in order to support the skills-based workforce for the country.

With the increase in student enrolment and easier access to education, the system that was structured towards the goals of the earlier stages of the development of Singapore was unable to adequately meet the emerging and differing needs of more diverse cohorts of students. There was thus a need for the education system to evolve.

Reforming and Fine-Tuning the Education System (1974 Report)

By the 1970s, it was evident that the education system that had served Singapore well in the preceding two decades was stagnating and lacking in defined goals and long-term objectives. As such, the Ministry of Education undertook a two-year study

with the 1974 report, entitled *The Goh Report* leading the first wave of restructuring of the education system (1979).

The 1974 report highlighted the inadequacy of the education system to cater beyond the needs of students who were ‘average’ or ‘mediocre’. There was an apparent lack within the system to customize to cohorts of students with differing levels of intelligence and learning abilities. It was evident that while academically-able students found their learning experience boring, students who were less academically inclined or those with learning disabilities were demoralized when being made to read a course that was ill-defined for their needs (MOE, 1974). The report further stated that the system took too long to train the required number of people for the economic development at that time.

The main issue observed was that the system required all students after their primary school education and having done their PSLE to proceed to the next major examination, the GCE Ordinary level examination after their secondary education. This was regardless of a student’s academic abilities. The report commented that this approach was unsuitable for students who did not have the academic aptitude or those who were below the average academic level (MOE, 1974). As such the report proposed the extension of the six-year primary education to seven years for those who were within this category so as to alleviate the pressure on these students who have difficulty managing their studies. In addition, the report proposed various strands of secondary education and training that included academic, technical and commerce streams to address the differing aptitudes of students. The report also recommended the introduction of a seamless merging of the ‘general education with vocational training or apprenticeship schemes’ for those with aptitude and attitude for careers in the industrial, commercial or service sectors (MOE, 1974). The various recommendations were implemented progressively from 1975 until the next critical milestone in 1979.

Education, the Practical Approach – The Goh Report (1979–1984)

In 1979, led by then Deputy Prime Minister and Minister for Defence, Dr Goh Keng Swee together with the Ministry of Education, a study team carried out a major review of the education system to understand its major issues and problems. The outcome of the review, the *Goh Report* (1979), highlighted several issues; among them the ineffectiveness of the bilingual policy. The report also identified the significant variation in academic performance of the various schools in Singapore (John & Sim, 1994, p. 15).

It reported that among each cohort of students, around 30% were not able to cope with the requirements of the bilingual policy. The Bilingual Policy, which was implemented in 1966, saw the introduction of the use of the English language to teach Mathematics and Science in the Chinese vernacular primary schools. Subsequently in 1969 and 1970, the policy extended across all English medium schools to introduce the teaching of Civics and History at Primary 3 level in the

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pupils' mother tongue language (Soon, 1988). A point to note also is that for the 75% majority of the Chinese-speaking population, the Chinese language that was spoken would likely be that of their respective Chinese dialects such as Teochew, Hokkien, or Cantonese rather than Mandarin. In fact the study team discovered that for many of them, Mandarin was as foreign as the English Language. However, as a result of the bilingual policy many students were taught in languages that they did not speak at home (Soon, 1988). In addition the bilingual education system did not have provisions to cater to the differing academic abilities of the pupils. Therefore, the attrition rates in both primary and secondary levels of pupils were high compared to countries such as Taiwan and Japan where they either had a "culturally homogeneous people", a "monolingual" education system or "no common school examinations" such as the PSLE or the 'O' levels (Goh, 1979, p. 3).

Then Prime Minister, Mr Lee Kuan Yew also stated explicitly that the "simple objective" of education in Singapore was "...to educate a child and bring out his greatest potential so that he will grow into a good man and a useful citizen" (John & Sim, 1994, p. 15). Consequently, streaming by ability was introduced in 1979 with the implementation of the New Education System (NES). Students in different streams at both primary and secondary levels were provided appropriately with differentiated curricula. The NES also saw to extending the duration of schooling for academically weaker students to accommodate a slower pace of learning (Goh, 1979).

The system also provided for students with varying aptitude in academic ability. For the academically-able students, the system provided a four-year 'Express' course leading to the General Certificate of Education (GCE) Ordinary Level at the end of the fourth year. Students in the top 10% of each cohort were additionally provided with the option to select Special Assistance Plan (SAP) Schools. These SAP schools were set up to offer students in selected established schools with a track for academic performance the opportunity to complete their secondary education in four years and to also take the English and Chinese languages at first language level while their counterparts in the Express course would take their mother tongue subject as a second language (Goh, 1979).

Those of average academic ability would complete their secondary education in five years. This 'Normal-Academic' course would prepare the students for the 'N' level examinations during the first four years, and when they attained the required grade, they would proceed to take the 'O' level examinations at the end of the fifth year (Goh, 1979).

Students who did not have the aptitude or the attitude for the academic track would complete their secondary education in the 'Normal-Technical' course when they would proceed to a vocational course at the end of the fourth year (Goh, 1979).

This level of customization and differentiation at the secondary level emphasized the belief that students ought to be schooled to the level that matched their ability and aptitude. The Goh Report (1979) purported that the streaming system optimizes

the development of the varying capabilities and capacities of students to provide every child with the opportunity to muster his/her potential.

The introduction and implementation of this ability-based education system made the overall system more efficient resulting in a significant drop in dropout rates and saw the overall improvement of student achievement (John & Sim, 1994). Critics of this approach, especially among parents, argued that students who were streamed to the less advanced course tended to lose out on opportunities for higher education (John & Sim, 1994). There were also arguments that the streaming process would lead to students becoming “demoralized and suffer from the social stigma associated with the lower course” (Soon, 1988, p. 19). Notwithstanding such critics, the Goh Report of 1979 and the subsequent New Education System of 1979 saw the introduction and implementation of some of the most significant reforms in the Singapore education system (Yip, Eng, & Yap, 1997).

Cultivating Peaks of Excellence in an Egalitarian Society (1985–1990)

During the period of the mid-1980s when the Singapore economy went through a recession, the education system underwent yet another milestone reform (Sharpe & Gopinathan, 1996). The Singapore government sought to confront the increasing challenges of the emergence of low-cost economies in the immediate region and beyond. Among the approaches that were taken, the Economic Committee set up in 1986 by the Ministry of Trade and Industry went about alerting the population of the problems and challenges of losing the country’s competitive edge if Singapore did not heed the signs to upgrade and up-skill the workforce. There were obvious gaps in the education, skills and capabilities between the Singapore workforce compared to those in the United States, Japan and Taiwan. There was thus an urgent need for Singapore to start developing workers and students to be more creative, adaptable and resourceful (Brown & Lauder, 1997).

Tasked with this mission the Minister of Education together with a team of 12 school principals visited the USA and the UK in 1986 to identify factors that highlighted good and effective schools. This mission resulted in a report – “Towards Excellence in Schools” (TES, 1987). This report thus became yet another significant milestone in the Singapore education system (MOE, 1987). The report fundamentally proposed and recommended the decentralization of the school management and curriculum from the then centralized model, and the devolution of responsibility and autonomy back to schools to ensure quality education (MOE, 1987). This was based on the notion that the autonomy and flexibility in the governance and management of the school would enable the school leaders to be nimble and respond more sensitively and promptly to the challenges in a rapidly advancing society and to craft and develop curricula that would prepare the students accordingly (MOE, 1987). This resulted in the implementation of the Independent Schools Scheme in 1987 with the initial three schools achieving independent status in 1988 and an additional five more schools in 1989 (Sharpe, 2002).

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These eight independent schools, including the case study school, were provided with autonomy and flexibility across all aspects of school management that included staff recruitment and deployment, appraisal and salaries, finance, management, and most importantly, the curriculum. While the government would continue to capitalize the main cost of schooling for students at these schools in the form of a capitation grant, these independent schools were financially independent albeit with the regular audit assessment and verification. The ultimate management of independent schools would be the responsibility of the respective schools' Boards of Governors whose members' composition would required approval by the Ministry of Education. The rationale of this scheme was based on the notion that with minimum bureaucracy and near-complete autonomy, these independent schools would be able to spearhead innovative education programmes for their students. These education initiatives and innovations could eventually be extended to the other schools in the system. The implementation of the scheme resulted in the improvement in professionalism in school leadership and overall improvement in school organization and management, instructional delivery and administrative efficiency (Tan, 1998).

The Singapore economy continued with rapid growth during this period. However the economy saw a shift towards higher economic value-added activities. As such, the government yet again saw the need to upgrade and up-skill the education and skills of the workforce to keep pace with economic growth (Sharpe & Gopinathan, 1996). The education system was thus poised to undergo another bout of alignment and (MOE, 1991). The focus during this time was school leadership, management and the curriculum.

Education in an Ability-Driven Economy in the 1990s

The decade of the 1990s saw the world veering toward the phenomenon of globalization. However, toward the later part of the decade many of the economies in Asia especially East Asia were experiencing a sharp recession. The Singapore government, recognizing the emerging challenges, refocused efforts to developing the country's human resources – Singapore's only real resource. This led to initiatives to develop and optimize the country's intellectual capital for the knowledge economy with the introduction of various initiatives and innovations in education (Green, 1999). The government saw the need to use education as a viable channel and a social investment in preparing the population to engage in a globalised and competitive world economy. The initiatives and innovations introduced in the education system were therefore aimed at ensuring that the education system remained nimble, relevant and responsive to global influences. This period of the Singapore education system has been termed the "ability-driven" phase in education (Sharpe, 2002). Among the initial steps that the Ministry of Education took was to commission an External Review Team (ERT) in 1996 to review curriculum in schools against Singapore's future economic, technological and social needs, and to

recommend proposals to prepare Singapore students for the 21st century. The release of the report entitled *Learning, Creating and Communicating: A Curriculum Review* in (MOE, 1997) saw the recommendation to broaden the focus of the education system beyond examinations and discipline studies.

Nurturing a Thinking Generation

The government realized that for Singapore to effectively compete in the new economy there was a need to increase the pace of change and to implement forward-looking policies (Goh, 1997). This in turn initiated a school-wide programme across all schools in line with the Thinking Schools Learning Nation (TSLN) policy. The policy addressed the total learning environment in schools to generate opportunities that would allow more flexibility and cater to diverse needs and learning styles of students. Key to this approach is the emphasis on development of creative thinking skills, lifelong learning passion and nationalistic commitment in the young.

Guided by the TSLN framework various initiatives were put in place to enable more time on interdisciplinary project work. Consequently, the Ministry of Education directed that the content of some subjects be reduced by 30%. This was achieved in parallel to the completion of the first phase of the Information Technology (IT) Master Plan where schools were generally well-equipped with computers and the necessary IT infrastructure. Many of the reforms in the education system toward the latter part of the decade focused on refining the education system to cater to a more learner-centred school environment in order to cultivate creative thinking among students (Goh, 1997). These reforms in the education system could be linked closely with the government's philosophy and drive to ensure the survival of the country against the odds to build a viable nation state. This is evident in the country's adherence to meritocratic principles and the almost obsessive focus on identifying and grooming talents. However, the changes and reforms in the education system have also resulted in a highly differentiated system that caters to providing students with differing aptitudes with opportunities to develop their potential (Sharpe, 2002).

The TSLN framework thus provided schools with the thrust to create a critical thinking environment and to empower students to develop such skills within the school system. This ability-driven phase in the education system in the 1990s occurred during the most dynamic period in the country's drive towards preparing Singapore for the 21st century. While the earlier decades focused largely on the Singapore's social and economic development, the shift in focus in the 1990s emphasized the development and nurturing of creativity and innovation (MOE, 1998).

Teach Less Learn More Initiative

Project work in Singapore. In 2004, then Singapore Minister for Education, Tharman Shanmugaratnam proposed the review of school syllabi in order to trim

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content delivery by teachers, and to promote independent thinking and learning in students. He argued that students ought to be allowed to pursue their interests and passion more deeply, rather than having to fit into a general curriculum. He anticipated allowing for such latitude for growth would align to the goals of an ability-driven education system. The Ministry of Education took on the initiative and recommended that schools place lesser emphasis on examinations, and empower students with appropriate and informed choices in their studies to make learning more enjoyable and challenging. This in turn would translate into more time for both teachers and students to reflect on their teaching and learning respectively (Shanmugaratnam, 2006).

In extending the momentum that aligns with the promotion of the Thinking Schools Learning Nation (TSLN) concept, the Ministry of Education launched the Teach Less Learn More (TLLM) vision. At his 2005 National Day Rally speech, Singapore's Prime Minister Lee Hsien Loong pronounced that the school curriculum should emphasize less on teaching so as to provide students with more opportunities to learn. He stressed that grades, while important, were not the sole determinant in life. He highlighted that schools ought to cultivate in students other aspects of life, such as co-curricular activities, community involvement projects, etc (Lee, 2004).

Developing peaks and nurturing talents – Towards a diverse education landscape. With increased consciousness of globalization and the new international economic scenario, the government envisaged a different set of challenges for the population. By the late 1990s, there was an apparent need to review the education system to align to the changing demands and challenges. This responsibility was tasked to the Upper Secondary Review Committee which in November 2002 tabled radical changes to the education system. Among their list of fundamental recommendations were the introduction of more diverse structures and a broader mix of schools in the education system. The report spelt out the need to spur innovation and nurture diverse talents. It was believed that a more diverse education system would be better suited to meet the different interests and needs of students, and this in turn would develop vibrancy and creativity that are critical for rejuvenation and innovation. The committee stressed that the country required such diverse talents with different educational experiences and perspectives to help generate ideas and innovations for further development. The committee asserted that Singapore needed to consider such necessary investment in the education system in order to secure the country's future.

The Integrated Programme (2004). With the recommendation of the Upper Secondary Review Committee, the Ministry of Education mulled over the proposal to create a more diverse school structure that allows higher ability and capable students with the option to select from a wider range of school curricula. One such initiative was the introduction of the Integrated Programme (IP) schools that offered a seamless six-year secondary and Pre-University education

(Shanmugaratnam, 2002). This programme allows academically able students who are capable of performing well in the GCE 'A' Level examinations to bypass the GCE 'O' Level examinations which many students in the 'Express' and 'Special' streams would be taking at the end of four years of secondary school, and proceed directly to the GCE 'A' Level examinations. Without the restrictive need to prepare for the O levels examinations, students in the Integrated Programme would have more time to pursue and develop their interest and passion, and be engaged in broader educational experiences.

The Integrated Programme was implemented in 2004 in four independent schools, including the case study school. Students in these schools are deemed academically able with strong intellectual calibre. The curricula and programmes in these schools thus aim to stretch these students to their fullest potential through enrichment and electives (Tan & Ng, 2005).

Differing approaches of Integrated Programme schools. In line with the essence of the Committee's recommendation to implement differing secondary school experiences, there are several types of integrated schools in the Singapore education system. Each of these schools was given the autonomy to select the approach they favour for their profile of students. The first model sees the link-up or merger of high performing secondary schools with the affiliated junior colleges (offering Pre-university levels) to offer a six-year integrated secondary school education. Students who enrolled in such schools at Secondary 1 or Grade 7 will flow through to Grade 12 six years later. This "Family of Schools" model follows the GCE 'A' level track and is the model adopted by the case study school (Tan & Ng, 2005).

The second approach follows the International Baccalaureate (IB) Model. The IP schools offering this six-year option cater to a select group of students see their education experience better suited to the Swiss International Baccalaureate programme (Trivina, 2005).

The third approach follows the "High School" model where a junior college extends their curricula to start at Secondary 3 or Grade 9. Students in such IP schools would thus spend four years in a junior college environment instead of the usual two years and would eventually take the GCE 'A' levels examinations (Tan & Ng, 2005). Ironically, in recent years, schools offering such a model tend to extend their programme further to accept students in Secondary 1 or Grade 7, thereby offering a full six-year programme.

Development of peaks of excellence in different areas – specialized schools. Beyond schools that offer comprehensive general curricula albeit catering to students with varying academic aptitudes and attitudes, the Ministry of Education has in recent years also established specialized schools to cater to students with specific talents. To date several specialized independent schools have been established that include the following:

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NUS High School of Mathematics and Science. Offering a programme of study that focuses on an accelerated Science and Mathematics curriculum, the NUS High School of Mathematics and Science also integrates these disciplines in a modular system with the teaching of the humanities, language, the arts as well as co-curricular activities and sports (NUSHS, 2011).

Singapore Sports School. This specialized independent school provides a balanced academic and training environment for young aspiring athletes. With their modular curriculum closely aligned to mainstream schools, student athletes are able to continue with their focused and rigorous training schedules that include participation in regional and international sporting events without compromising their studies (SSS, 2011).

School of the Arts. Established in 2008, this specialized independent school offers a dynamic curriculum that caters to students who are artistically talented. Its unique curriculum stimulates and develops their students' artistic and academic potential. The school aims to nurture a core group of talents who will be the next generation of creative professionals (SOTA, 2011).

School of Science and Technology, Singapore. Established in 2010, the School of Science and Technology offers a unique four-year secondary school curriculum that largely focuses on applied learning. While the school teaches regular academic subjects, it also gives students a range of choices in applied areas related to technology, media and design. With innovative teaching methods, the programme aims to get students to appreciate real-world relevance and application to the things they learn in class (SST, 2012).

While the other specialized schools cater to students with specific talents, two schools in particular offer unique curriculum that caters to students who are unable to cope with the mainstream academic curriculum.

Northlight School. Northlight School offers a unique curriculum that emphasises on vocational training aims to nurture the emotional strength of its students and provide essential life-skills. While the school offers a wide range of vocational options, the unique feature of the school is their 10 weeks of industrial attachment for their students in specific industries. This provides students with relevant on-job skills experience (NLS, 2011).

Assumption Pathway School. Like the above school, Assumption Pathway School offers a customised curriculum that allows students who are unable to access or complete mainstream academic education to choose from different pathways of learning. The vocational emphasis of the programme provides students with skills training in various areas of industry (APS, 2012).

BACKGROUND AND CONTEXT

Discussions in this section thus far have focused on the significant highlights and milestones that chart the Singapore education system. The following discusses the details of the case study school. The case study school has adopted the “Family of Schools” model which follows the GCE ‘A’ Level track of the Integrated Programme.

THE CASE STUDY SCHOOL

The Integrated Programme at Hwa Chong Institution

Hwa Chong Institution, the case study school, has been deemed as one of the established high performing secondary schools in Singapore based on the previous performance of its students in the GCE ‘O’ levels examinations, and presently in the GCE ‘A’ levels examination. The school was thus selected to be amongst the forerunners of change and innovation in the Singapore education system. This all-boys’ junior section and co-education senior section school has a historical background of being the earliest and most well regarded of the Chinese-medium secondary schools in Singapore and in the region.

The school was among the nine schools selected in 1979 to become a Special Assistance Plan (SAP) school where students read both the English and Chinese Language at the first language level with the aim to preserve Chinese culture. The medium of instruction for all other subjects from 1979 changed from the use of the Chinese language to the English language.

In 1988, the school was among the first three schools to be granted the status of Independent School. Management of the school since then passed from the Ministry of Education to the Board of Governors (BOG). Being an independent school, the school has full autonomy in all aspects of the management of the school from recruitment to student admission and most importantly the development of the curriculum that caters to the profile of the students. In addition, the school is also tasked and empowered to be at the forefront of education innovation.

The case study school implemented the Integrated Programme (IP) in 2004. Students in the school subscribe to a six-year programme and, unlike their counterparts in the mainstream schools, these students do not take the GCE ‘O’ levels examinations at the end of their fourth year. Instead, the students proceed directly to the senior years and take the GCE ‘A’ levels examinations at the end of their sixth year. The programme that the case study school offers to the students aims to provide a rigorous yet enriching learning experience that includes a range of enhanced learning activities and outcomes to stimulate the spirit of inquiry, discovery and intellectual adventure. In the school’s proposal to the Ministry of Education, the underlining principle of the IP at the case study school is to bring about a better sense of purpose and significance to learning.

As the school proceeded with the implementation of the IP, the curriculum across the levels, while fundamentally intact, had to be reviewed and reconceptualised to

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meet the expectations and demands of the IP which calls for an integrated approach across the various subject matters. In its basic premise, the curriculum falls into four distinct academic domains. These include: Mathematics and Sciences; the English language and Integrated Humanities; Chinese language and Chinese Studies; and Creative Arts and InfoComm Studies. The four domains generally correspond to the fundamentals for learning and form the integrated approach to the understanding and appreciation of knowledge. The integrated approach is also manifested beyond the core subject matters and domain in that parallel assessment modes have been put in place to assess students' understanding of the learning of the contents to application, integration of knowledge to stimulate inquiry and further learning in the students' areas of interest and passion. As such, a key feature in the school's IP is the incorporation of project work in the curriculum, particularly research based project work. The school believes that beyond the rigours of the usual instruction and assessment of content-based curriculum, having students understand concepts and applying them in practical project-based activities reinforces understanding of concepts and contents.

Project Work at Hwa Chong Institution

The case study school introduced project work in 1984. Today, the school has developed a customized curriculum for students to incorporate and infuse project work (Yip et al., 1997). While project work was initially introduced as an enrichment activity to enhance learning opportunities, it has since become an integral part of the school's curriculum, as well as the students' assessment protocol.

Project work aims to provide opportunities for the students to develop skills in the cognitive and affective domains, and to nurture them to be independent learners. This is achieved largely by enhancing the research culture among both the students as well as among teachers. Since the late nineties, the case study school has also fine-tuned project work to focus specifically on research-based project work. This facilitates learning beyond textbooks and provides an avenue for students to apply and synthesize the knowledge gained from their thinking, research and IT skills lessons to solve real-life problems.

As the project work curriculum evolves, the quality and number of projects undertaken by students have increased significantly. Many of these student projects have developed from subject and curriculum-based to authentic research projects supported by an active pool of research mentors beyond the school's faculty. The highlight of the project work curriculum sees students showcasing their respective projects in the annual school-wide Projects Competition that includes multiple rounds of oral presentations as well as web-based reports. As students engage in their research work, they are also provided with the opportunity to connect with mentors and researchers beyond the school. These exposures and engaged conversations with external mentors, tertiary academics, researchers and professionals extend the perspectives and outlook of students, and offer them

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in-depth research skills and knowledge. In so doing the experience furthers their interest and passion in their learning journey.

As the students progress through the various stages of presentations and defence of their projects to various audience groups and judging panels, they are provided with opportunities to hone soft skills such as communication and presentation, and being able to articulate and defend concepts and ideas with confidence. As students work in collaborative groups, they learn team dynamics and appropriate attitudes and social skills that are vital in their future pursuits. It is thus observed that due to the inter-disciplinary approach of the project work curriculum, students are introduced to the rigours of applying concepts and contents, to transfer knowledge and skills across disciplines. Hence, they are made to realize the relevance and inter-relatedness of what they have learnt.

This study thus investigated the perspectives of the selected students on whether the 'experiential' learning approaches of research-based project work learning within their curricula promoted independent learning, and considered from their perspectives the impact these approaches have on their learning attitudes.

CONCLUSION

This chapter has provided an overview on the education systems in different countries and related back to the evolution of the Singapore education system. Discussions on the various milestone policies and initiatives of the education system since its early years of independence highlighted the correlation between educational policies and initiatives in the Singapore education system and the historical, political, economic and social developments of Singapore.

Knowledge of the specific context of this country is key to understanding the study reported in this book. Research literature has shown that the students engaging in research-based project work enhances their independent learning attitude and aptitudes. The following chapter therefore, gives a review of the empirical literature that informs the study reported in this book, specifically focusing on the importance of engaging students in research-based project work to inculcate independent learning.

CHAPTER 3

LITERATURE REVIEW

INTRODUCTION

This chapter reviews conceptual and empirical literature relevant to the present study of academically-able students' perspectives on their independent learning from participating in a research-based project work curriculum at an independent secondary school in Singapore. The chapter is in four main parts. The first part reviews literature on the concept of project-based learning, including the roles of teachers and students in this approach and the key elements that influence project-based learning. The second part of the chapter presents the conceptual framework of the study, which is based on the theory of social constructivism. This part also relates the application of social constructivism to online and virtual learning communities, which provides a context for the present study. The third part of the chapter addresses information technology in project work. The final part of the chapter surveys empirical literature on project work and project-based learning internationally and nationally.

THE CONCEPT OF PROJECT-BASED LEARNING

Project-Based Learning

As an instructional strategy, project-based learning engages students in authentic learning through project work. This approach varies markedly from the traditional teacher-centred classroom and provides students with an “interdisciplinary, student-centred” activity that is “integrated with real world issues and practices”, and is usually stretched over an extended period of time (Wong et al., 2006, p. 2). According to Wong et al. (2006), this approach also relies significantly on student-initiated inquiry and interactions, resulting in the creation of knowledge.

As previously mentioned, in the Singapore context project-based learning is commonly referred to as project work. The Singapore Ministry of Education (MOE) defines it as a learning activity that allows students to build knowledge from different disciplines and thereafter to apply this knowledge to real world situations, in the process, allowing them to exercise creativity and critical thinking skills (MOE, 2012). Other skills that the students acquire from project work include collaboration, communication, presentation and independent learning skills.

Netto-Shek (2004) emphasizes that the project work approach to learning centres on generating questions or inquiry that directs students to look at concepts and

principles related to their study. She explains that project work, which entails an extended period of time, engages students to generate new knowledge to build upon the premise of their investigations and understanding. Netto-Shek proffers that project work, when implemented appropriately, allows students the autonomy to make decisions and work independently and collaboratively to generate solutions to situations that are not pre-planned. She argues that, while the learning may be student-driven, the monitoring imparted by teachers provides guidance and advice where required. As such, project work infuses real-world authentic challenges within the students' learning experiences (Thomas, 2000).

First defined in 1921 by William Heard Kilpatrick as the Project Method, project-based learning provides an approach that is more cognitively advantageous than traditional teacher-centred learning (Helle, Tynjala, & Olknuora, 2006). Helle et al. (2006) take the view that project-based learning enables students to hone and develop skills through the reconstruction of knowledge as they collaborate to develop their project and address the problem at hand, thereby compelling them to work out their thoughts and theories thoroughly and identify gaps in their content knowledge. This is a more authentic approach to the students' learning experience compared with so-called traditional approaches (Helle et al., 2006).

Helle et al. (2006) argue that such learning experiences involve students in higher order thinking. This is especially so when students have to link and integrate various systems of knowledge, theories and practices as they go about their project work, which eventually directs them to synthesize new knowledge. The collaborative environment also contributes to collective wisdom, and engages the students to learn and apply concepts in a meaningful way, thus enhancing experiential learning. Helle et al. conclude that students who are engaged and empowered in such learning experiences develop ownership for their learning, thus enhancing their motivational level.

The Roles of Teachers and Students in Project-Based Learning

With the emphasis on encouraging students to initiate their learning and carry-out their own projects, project-based learning shifts the learning process from a teacher-centred and teacher-directed approach to a more student-centred approach. The role of the teacher then shifts to that of being a mentor providing resources, support and advice to students (Howard, 2002; Thomas, 2000). In this approach, teachers also provide the necessary skill training to enable their students to embark on their projects. This could take the form of providing 'just-in-time' classroom activities when necessary (Wong et al., 2006). Teachers, instead of being directors and knowledge transmitters, coach students in their learning journeys as they proceed with their project work (Savery, 2006). In this way, teachers guide students with their research proposals and plans, assisting them with employing the resources that they need to carry out their project work, thus contributing to the learning process of the

students as they make sense of their learning (Hassard, 2000). In certain situations, a teacher could also assume the role of co-researcher with their students and be a peer member of the project group, thus enhancing the intellectual conversations within the group (Thomas & Mergendoller, 2000).

With the emphasis on students taking the initiative with their learning, the project-based learning approach shifts significant responsibility from the teacher to the student (Thomas & Mergendoller, 2000). Often students may also need to extend beyond the school to find external expertise for mentors or resource persons in order to improve on the quality, relevance and reliability of their project work. This is yet another area where teachers could help the students (Thomas & Mergendoller, 2000). Project-based learning thus empowers students to go beyond being knowledge recipients to being knowledge builders and generators of new knowledge (Scardamalia & Bereiter, 2006).

Male and Guzzomi (2012) expound that, along with the new curriculum design of project work, it is critical that an understanding of the role of teachers and the attributes of an effective teacher in the new curriculum is clearly defined. Male and Guzzomi (2012) explored the new teaching role, that of a 'facilitator', where the teacher is required to teach in interactive workshops rather than replace lectures and in which students learn through individual preparation and interactive activities with their peers. With this new and pronounced role, the teacher as facilitator must be skilled at encouraging and helping students to learn independently and interactively. However, a facilitator must also have an excellent understanding of concepts and skills across the traditional disciplines (Male & Guzzomi, 2012).

Elements That Influence Project-Based Learning

In order to sustain students in project work over a prolonged period of time, students need to be engaged cognitively in their areas of interest. They also need to see the relevance of their project work in order to be motivated to continue with their project (Blumenfeld et al., 1991). Blumenfeld et al. (1991) state that, for students to perform well, they also need to be provided with the necessary skills and competencies, both in content knowledge and research pedagogy. This is where the teachers need to provide the necessary guidance and deftly direct the students to carry out their projects. Therefore teachers themselves need to be equipped both in the relevant content knowledge as well as pedagogical proficiency.

However, teachers themselves must be convinced of the benefits of project-based learning and have the capacity and resources required for this approach. In the USA, quite a few reasons have been cited as to the limited adoption of project-based learning in public school classrooms. Amongst those reasons are inadequate material resources, time limitations to creating and developing new curricula, large class sizes, and over-controlling administrative structures that have prevented teachers the

autonomy necessary to adopt such approaches (Barron et al., 1998, p. 272). Perhaps the single most-cited explanation has been the “growing incompatibilities between such progressive approaches and the US college entrance requirements” (Tyack and Cuban, 1995, p. 18). Some have also criticized attempts to renew the interest of project-based approaches by arguing that project-based learning often leads to doing for the sake of doing (Blumenfeld et al., 1991).

As part of the guidance that teachers should provide in project-work, they should also regularly monitor the progress of the students’ work. According to Callison (2006), this could take the form of short but regular sessions between mentor and student project groups to check on progress and whether the group is on task. Callison takes the view that such sessions can help to chart directions and review the progress of the work done. Moreover, he suggests that teachers could also assess other aspects such as group dynamics and chemistry, and take appropriate action if necessary to address issues that may surface.

David (2008) notes the importance of strong school support to facilitate a project-based learning environment for students. This could mean creating an environment where collaborations between students and teachers are encouraged. He argues that, beyond providing just the physical infrastructure for such collaborations, the school administration should also be very willing and committed to adopt a flexible curriculum and school schedule to facilitate such interactions and collaborations. He further suggests that perhaps the most significant demonstration of such support would be to incorporate the output of a students’ project work as a significant component in the school’s assessment system, where it would help determine the student’s grade outcome and progression.

In the areas of physical infrastructure alluded to by David, Thomas (2000) includes other aspects of school-based and school-wide support, such as committing to an appropriate class size and classroom configurations and settings. In addition, he notes that the availability of technology as an avenue to collaborate, research, organize and communicate would also facilitate a project-based-friendly environment for the students.

With regard to factors that motivate students in the context of project-based learning, Barron et al. (1998, p. 273) recommend the following four design principles.

- Define clearly the learning objectives that will result in deep understanding;
- Scaffold learning to ensure that the learning curve for students is not too steep;
- Have appropriate regular assessments to monitor students’ progress and to provide feedback on how to improve; and
- Provide opportunities to allow students to collaborate with each other so that they can contribute to their learning by understanding how others work through the same problem, review each other’s work and eventually help one another to complete the task successfully.

A SOCIAL CONSTRUCTIVIST FRAMEWORK FOR PROJECT-BASED LEARNING

Social Constructivism

Project-based learning approaches foster students' interaction and collaboration in groups. They collectively learn, construct and develop their own knowledge, and often engage in new learning and creating knowledge that individually would be quite challenging for the students. Project-based learning is based on the theory of social constructivism, a form of constructivism that emphasizes the collaborative nature of learning.

Constructivism is a theory of knowledge that asserts that people construct knowledge about themselves and the world they live in through reflection on their experiences (Hirtle, 1996). It is a theory that challenges the traditional view that knowledge can be 'sent', in the form of words a message, from teacher to learner. Rather, from a constructivist perspective, knowledge is actively constructed through engaging cognitively and socially with the 'experiential' world. Bodner (1986, p. 874) summarizes the constructivist model of knowledge quite simply: "knowledge is constructed in the mind of the learner". However, Wheatley (1991) points out that there are in fact two main principles of constructivist theory. The first principle is that learners actively construct their own meanings and so their knowledge builds up over time. The second principle of constructivist theory concerns the function of cognition. This principle states that cognition is about making sense of the experiential world; about arranging and organizing experiences.

As noted in Chapter 1 of this book, social constructivism takes the principles and discourse of constructivism in a particular direction, emphasizing the role of social interaction in the construction of meanings. In particular, social constructivists argue that social groups help participants construct meanings for one another, thereby collectively and collaboratively creating a culture of shared meaning-making. According to Chapman (2003), this has important implications for understanding the centrality of communication in the learning process. She argues that learning is essentially a social practice, with meanings contingent on human interaction, as well as context. Moreover, whether meanings are made personally or socially, social interaction is a critical element of learning.

Established in the works of Russian psychologist Lev Vygotsky (Palinscar, 1998), social constructivism adopts the premise that learners construct knowledge through "social interaction, interpretation and understanding" (Vygotsky, 1962 cited in Adams, 2006, p. 245). According to Vygotsky, constructivists understand that learning is a knowledge construction process where learners gain understanding on this process. Knowledge construction occurs within a socio-cultural environment where students collaborate within their group as well as with their mentors or teachers, or any other resource person or persons within their community of learners related to the student (Barbour & Rich, 2007). Meanings are, at the same time, both

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individual and socially constructed. In this respect, the teacher then is an enabler in the knowledge construction and creates a conducive environment for this process. Consequently the teacher also assesses this process formatively albeit as a facilitator rather than an instructor who simply prepares students for summative examinations (Adams, 2006).

Vygotsky assumed that when confronted by challenges, a person is able to resolve issues that are beyond his or her ability as the person through interactions with others who have the capacity or who are more knowledgeable than him or her. The more capable others form the community of learners to which the individual belongs (Barbour & Rich, 2007). To measure the level of cognitive development of the individual learner, Vygotsky developed the concept of the zone of proximal development (ZPD), defined as follows:

...the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers. (Vygotsky, 1978 cited in Palinscar, 1998, p. 2)

Social constructivism shares the fundamental concepts of constructivism and its complementary concept of cognitivism. Whereas constructivism is based on the premise that individuals construct their own perspective of the world, through their own experiences and schema (Schuman, 1996), cognitivism is based on the thought processes behind an individual's behaviour. It focuses on observing changes in behaviour as clues to what is happening in peoples' minds. Cognitivism essentially recognizes that a significant degree of learning involves associations established through contiguity and repetition. Cognitive theorists also subscribe to the importance of reinforcement (Good & Brophy, 1990, p. 187). In essence, cognitive theorists view learning as the acquisition or reorganization of the cognitive structures through which the learner processes and stores information (Mergel, 1998).

From a social constructivist perspective, as students engage in project-based learning interact and collaborate with their team members, and also draw on the resource and advice of their teacher mentor, they are often able to resolve challenging issues and situations that may appear beyond their ability if they were to work in isolation. In this regard, the individual student constructs knowledge through interaction with his or her team mates, and in the process is involved in collaborative learning.

Collaborative Learning

As discussed, collaborative learning takes place when a group of students undertake a joint learning venture, often together with their teacher or mentor as a facilitator, where cognitive interactions within the group are focused on looking for solutions to problems or resolving identified challenges (Smith & MacGregor, 1992). Dillenbourg (1999) simply describes collaborative learning as a situation where

people learn in small groups of two or more. Zhang, Peng and Hung (2009) expand this description to explain that as students engage in collaborative learning, team members maintain communication with one another as they carry out their roles and responsibilities. This purposeful communication interaction brings to mind the idea of knowledge building. The prescribed roles and responsibilities undertaken by the respective group members are not unlike the division of labour that characterizes cooperative learning. However, the coordinated and focused communication within the group differentiates the interaction as that of collaborative learning. Kim et al. (2011) states that such instructional strategies exemplify the social constructivist school of thought and emphasize the necessity for collaboration among learners.

Earlier discussions in this book pointed out that as students work on their projects, they are often engaged in both cooperative and collaborative learning. Chai et al. (2011) expound that collaborative learning often starts as cooperative learning where students are presented with a structured approach to addressing the project, and that learning within the group is controlled largely by the mentor or teacher. They add, however, that cooperative learning then progresses to collaborative learning as the students gain more autonomy and become more spontaneous in communicating with one another as they proceed with their tasks (Chai et al., 2011). As students gain more independence and engage in collaborative learning, the role of the teachers in guiding them should taper gradually towards a less structured framework, and provide opportunities for students to gain more ownership of the project. Further autonomy for the more able groups could include allowing students to decide on their group members and topic of research to enable deep learning to occur (Chai et al., 2011).

In the case study school that is the focus of the present research, students are engaged in yet another approach to collaborative learning where they have full autonomy to determine how they wish to achieve the group's overarching goal in their project work in consultation with their teacher mentor. Zhang, Scardamalia, Reeve and Messina (2009) describe this approach as 'opportunistic collaboration'. They conducted a three-year design experiment aimed at evaluating the possibility and means by which Grade 4 students in the USA can assume collective responsibility for sustained knowledge advancement. In exploring the social structures and processes that evolved over time, it was found that group members communicated by utilizing available online platforms for focused communication and interaction, which in turn supported learning through intellectual exchanges. These online portals enabled the project group to share propositions, ideas and resources, and receive updates on the progress of each member of the group. The teacher set the general direction and goal of the project. Thereafter the students proceeded to plan and develop the framework and strategies required to achieving the goal.

Online learning communities. The social constructivist perspective of this book embraces the growth and development of online learning communities, a central feature of project-based learning in the case study school. As mentioned, when

students engage in project work and form focused learning communities to support and facilitate their learning experience, in addition to their teacher mentors they may call on experts who will be able to assist or value-add to their knowledge creation. This provides the basis for the formation of collaborative learning communities where such intellectual interaction would facilitate knowledge creation (Smith & MacGregor, 1992).

The notion of learning community is not new. However up to the late 1980s, such communities were still very much time and space bound, and group members had to meet face-to-face for discussions and interaction. Since the onset of the Internet age from the 1990s, many learning communities have been able to migrate to the online platform where they can form virtual communities to engage and interact, thereby overcoming the constraints of space and time. Among the leading scholars associated with the concept of virtual communities is Amitai Etzioni. Etzioni (2000) describes a community as a network of people who are affectively bonded and share a set of common values or culture. Etzioni and Etzioni (1999) argue that accessibility between and among group members are critical to establish and sustain communities. They expound that such accessibility is enhanced through the use of computer-mediated communications (CMC) to facilitate interactions and collaborations across geographical and time constraints, and to enable people to engage and stay in touch with one another regularly. Additionally, CMC enables online communities to extend to a larger audience (Etzioni & Etzioni, 1999). Palloff and Pratt (2007, p. 27) state that with the introduction of CMC, community extends beyond a “place-based concept”.

With enhanced access to the Internet and lower costs of computing facilities since the late 1990s, many people have become attracted to online communities or cyberspace. This online outreach extends to communities such as schools, clubs and organisations by facilitating virtual meeting opportunities and platforms for people to engage and interact with one another from virtually anywhere (Preece, Maloney-Krichmar, & Abras, 2003). In recent years, a great many virtual learning communities (VLCs) have emerged (Lewis & Allan, 2005). These VLCs are largely facilitated by CMC (Luppicini, 2003), and typically include people who are geographically-dispersed but linked in cyberspace (I. Y. L. Chen, N. Chen, & Kinshuk, 2009). The members of these learning groups are focussed, fulfilling their educational goals (Bassani, 2010). As such, VLCs empower people to overcome challenges imposed by geographical constraints and differences in time zones, to meet on virtual platforms to collaborate and form partnerships (Lewis & Allan, 2005). Such collaborations provide opportunities to pool resources and work in partnership, to learn from others, to venture into new areas and to obtain support from like-minded individuals (Lewis & Allan, 2005).

In the context of project-based learning, VLCs provide the platforms to harness the talents of their members to create synergy to develop novel knowledge, thus boosting the performance and cognitive level of members. This contributes to the development of collective wisdom (Gan & Zhu, 2007), as discussed in the following

sub-section. During these processes, members learn from one another, building trust and team spirit, and experience acceptance. The overall function of the VLC should be greater than the total of all the individual components. In other words, although members work independently performing their own roles, there is great interdependence among all. Research has found that interactions among group members engaged in project-based assignments via online portals can take the form of negotiation, research, sharing of readings, conceptualisation, and eventually lead to the creation of the end-product (Oliveira, Tinoca, & Pereira, 2011). In the present study, students across the different project groups collaborated actively on online platforms such as Wikispaces to communicate with one another and share resources and to facilitate their research collaboration.

Knowledge Building and Collective Wisdom

Until the late 1990s, knowledge building was generally deferred to the role of scientists, scholars and those involved in innovative work (Scardamalia & Bereiter, 1996). At that time, Hewitt and Scardamalia (1998, p. 82) stated that as students and teachers interact with each other to build knowledge, they form a knowledge building community which is defined as a “group of individuals dedicated to sharing and advancing the knowledge of the collective”. According to these authors, the aim of a knowledge building model of learning is to give everyone due credit for their ideas, and make ideas of team members accessible to all. They postulated that this learning model would lead students to take ownership of their own learning, and is likely to enable them to achieve greater educational success.

More recently, Scardamalia and Bereiter (2006) advocate that for learners to participate in knowledge building, instructional strategies should facilitate the creation of new knowledge. They argue that mimicking academic works does not constitute knowledge building, and that true knowledge building takes place only when students’ creations contribute to the progression of knowledge in the discipline concerned. They define knowledge building as:

the production and continual improvement of ideas of value to a community through means that increase the likelihood that the community’s accomplishment will be greater than the sum of individual contributions and part of broader cultural efforts. (Scardamalia & Bereiter, 2006 cited in Gan & Zhu, 2007, p. 219)

Knowledge building communities can take the form of VLCs, where students, teachers and possibly external experts communicate with one another via online communication tools such as email, asynchronous discussion forums, electronic message boards, chat rooms and synchronous video conferencing (Chang, 2003). Such online technologies enable student-mentor intellectual exchanges that can lead to the construction of novel knowledge (Dominguez-Flores & Wang, 2011; Wang, Poole, Harris, & Wangermann, 2001). In addition to telecommunication technologies,

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Web 2.0 technologies also provide platforms for building VLCs to enable innovative learning and the development of 21st Century skills that encompass the abilities to innovate, communicate, collaborate and solve problems (Ge, 2011).

Koh, Herring and Hew (2010) list four steps in knowledge building: sharing of materials; generation of ideas; integration of ideas (composing and justification of preliminary solutions); and resolution of ideas (applying ideas to novel situations). These steps were explored in the present study as a few of the student groups worked in teams to complete their projects through a VLC to build knowledge.

Gan and Zhu (2007) link knowledge building and collective wisdom. They define collective wisdom as follows:

The ability to gain a profound insight into deep understanding the essence of the world, which is derived from the processes of divergence, convergence, integration and creation of individual member's multiple intelligences in a group/team, organisation or the whole society. (Gan & Zhu, 2007, p. 208)

Gan and Zhu propose a four-level framework for the development of knowledge building and collective wisdom advancement in a VLC. The framework is based on the combination of Vygotsky's theory of ZPD and the trajectories of knowledge building. Level one involves the provision of the infrastructure for the extension of collective wisdom throughout the learning community, which is essential for the formation of VLCs. Level two is making e-learning possible via online or distance education. Level three is knowledge management which involves the organisation and storage of knowledge, using technological tools and making it accessible through electronic networks. Level four is the provision of a versatile and open learning environment for knowledge building, collaborative learning and converging collective wisdom. It is a platform for learners to exchange information, hold discussions, present ideas, and to obtain, share and categorise information. The authors argued that, in doing so, learners will gain experience in learning how to learn, practice teamwork and contribute to collective wisdom. The framework comprising these four levels of developing collective wisdom informed the analytic approach of the present study.

INFORMATION TECHNOLOGY IN PROJECT WORK

Use of Information and Communication Technology (ICT) for Project Work

As students engage in project work, they rely on related facilities and resources to assist them. In the contemporary context, this often includes information and communication technology (ICT). In fact for the five project groups in the current study, ICT or online applications featured quite significantly in their project work. Blumenfeld et al. (1991) conveyed the potential of ICT in enhancing project-based learning and expounded that besides motivating students, ICT may be critical in enhancing students' interests and assisting in their learning. ICT can also provide

the means to build on the artifacts and resources for the project work. It also provides and facilitates access to information required for their research, regardless of geographical location, as well as enhances connection to peers and mentors or teachers. With the advancement of Web 2.0 technologies, there is an increased use of online applications such as the Wikispaces where students engage.

These shared experiences on virtual platforms are especially valuable in the case of project work as it facilitates researchers to be mindful of the work done by others and the challenges they faced so as to avoid overlap and committing similar mistakes (Gannon-Leary & Fontainha, 2007). Gannon-Leary and Fontainha (2007) further elaborate that such online portals incorporating virtual learning communities (VLCs) can serve as a gateway where students can seek out advice, ideas and opinions.

The research literature reveals that the use of VLCs for project work is more prevalent at tertiary levels than at other levels of study in an international context, especially in distance learning or online courses. The use of VLCs in project work at the pre-tertiary level appears to be less common outside of Singapore and perhaps the USA. However, the bulk of literature on the use of VLCs for project work involves primary to tertiary level students from schools in the USA. Studies by Bell (2010), So, Seah and Toh-Heng (2009), J. Zhang et al. (2009), Scardamalia and Bereiter (2006), and Turvey (2006) have observed and described that VLCs and online platforms have provided students in primary schools with the resources to communicate in an online environment to solve problems, learn collaboratively and create knowledge

Types of Interactions in Virtual Learning Communities

As is the case in the present study, with recent developments in the Internet and access to online resources and the increased acceptance of social media, many student project collaborations across all levels have been utilizing online applications to connect, interact and engage in meaningful and focused discussions and creating new knowledge. These online engagements often gravitate towards focused and purposeful communities to form virtual learning communities (VLCs). Developments in online social media portals provide users with a range of features and applications to facilitate not only connecting and networking but also information sourcing and data sharing. Gannon-Leary and Fontainha (2007) observe that the applications and functions in today's VLCs empower learners to harness and synergize learning as well as elevating the capacity of learners as they collaborate and interact with each other. Such interactions within the shared communities enable learners to share knowledge and experience, gain new insights to topics of interest, increase their depth of knowledge, enable continual knowledge development and enhance connectedness among learners (Gannon-Leary & Fontainha, 2007).

Aviv, Erlich, Ravid and Aviva (2003) report that members within a VLC interrelate in diverse ways and play different roles. These roles could range between leading or initiating the discussions and assigning tasks, and contributing or supporting the

activities within the assignment task or project. There could also be a third role known as 'lurkers' who observe the proceedings and discussions within the community and, from time to time, contribute to the interactions (Aviv et al., 2003). This dynamic interaction within the VLC ultimately leads to the creation of knowledge (Aviv et al., 2003).

In a study by Thomas and MacGregor (2005) of the activities and interactions among undergraduates interacting across an online platform to complete their projects as part of their course requirements, the undergraduates would collaborate in groups to develop a website. Thomas and MacGregor (2005) found that the interactions on the virtual platform may be synchronous or asynchronous. These engagements fall within the three categories; task-related, socio-emotional and non-task specific types. Task-related interactions include problems that the group encounters. Group members post discussions of possible approaches that the group might consider for adoption, defining goals, identification of problems and reflection of completed work to evaluate whether goals were achieved. These postings are done asynchronously as they involve more thinking and required more time to complete or resolve (Thomas & MacGregor, 2005). The second category involves socio-emotional interactions and leans towards an affective inclination where group members consider the feelings of those involved. Message postings for this category demonstrate camaraderie, agreement or disagreement amongst group members and are usually synchronous in nature (Thomas & MacGregor, 2005). Thirdly, the non-task specific interactions include organisational or technical aspects, which relates to the facilitation of online communications and issues that pertain to the use of information and communication technology (Thomas & MacGregor, 2005).

Thomas and MacGregor (2005) also found that the nature of the interaction in a VLC evolved as the students advanced from one stage of their project to another. At the planning stage of the project in their study, it was observed that the students were involved in interactions and would focus primarily on the identification of the problem. Concurrently, the students would also attempt to define their objectives and scan for possible ways and means to adopt for their project Thomas and MacGregor (2005). As the students proceeded to the design phase of their project, interactions would focus on exploring and executing strategies. Some definition of goals could still occur at this stage. Subsequently, as the students continued to the development phase, their interactions entailed the implementation and execution of strategies. Some evaluation of strategies might still occur. Thomas and MacGregor (2005) explain that the types of interactions during the design and development phases required the students to interact on the virtual platform in ways that facilitated the implementation of strategies that were agreed upon by the team, to work towards the completion of the project. Thomas and MacGregor's work has been described at length here as their categories of interactions were applied to the student engagement in project-based learning activities in the present study.

Beyond the stated benefits of online interaction and VLCs, Palloff and Pratt (2007) highlight several issues that online interactions could post. For example,

these interactions could involve members taking advantage of the less threatening atmosphere or even the lack of face-to-face interaction of the virtual environment to post hostile, angry or judgmental comments. Such mischievous acts could lead to undesirable feelings and a negative atmosphere among the group members thereby discouraging healthy participation (Palloff & Pratt, 2007). As such, Palloff and Pratt (2007) advise that for a VLC to succeed, a code of conduct and communication guidelines should be implemented and enforced.

PROJECT WORK IN THE INTERNATIONAL CONTEXT

Project Work in the European Context

Turvey (2006) conducted a study of how pupils in UK primary schools used online tools to communicate and participate in online communities. It was found that, despite having some autonomy in virtual spaces, most children did not experiment with the potential of the tools but rather followed predictable patterns of behaviour. They worked in groups and used resources provided by teachers to create websites on topics that they had researched. It was observed that, as the pupils worked in groups, they learnt from each other through commenting on each other's work albeit on the prescribed online platform. Turvey concludes that while group work through projects provides many prospects for pupils to acquire valuable communication and exploration skills, and experience student-led independent learning, the role of the teachers is critical to regulate the quality of learning and guide the pupils to remain on task.

Ligorio and Van der Meijden (2007) investigated successful project partnerships among middle school pupils of age nine to 14 years across seven schools in Italy and the Netherlands. The pupils collaborated with each other and engaged in discussion on two online platforms; the first facilitated discussions, while the other provided the students with tools to construct three dimensional, virtual, cultural houses with chat tools and a discussion forum. The latter allowed teachers, researchers and pupils to share and store their notes and documents which included texts, photographs, videos and images. The pupils optimized their interaction across the online platform to reach across the two countries as they engaged in their project work.

Ligorio and Van der Meijden (2007) emphasise that the success of the project partnerships should not only be attributed to important factors such as support from the schools, the availability of computing facilities, having competent teachers as facilitators and the technical and instructional support rendered by researchers. They also underscore the importance of thoroughly designed projects for the success of such learning collaborations, and caution that this activity may require major changes in the curriculum to accommodate it and may add to the challenges faced by teachers and school administrators.

Studies on project work in secondary schools outside the USA especially on collaborative project-based learning are uncommon. In the UK, Underwood, Smith, Luckin and Fitzpatrick (2007) conducted a study of secondary students involved

in scientific investigative collaborations together with their teachers as well as a team of external scientists. The research projects were developed by the scientists involved to engage the students in authentic scientific investigations. These tasks were intended to enable students and their teachers to work in partnership with each other, and with the team of scientists and learners from around the world. The various parties communicated via an online platform where interactions could be synchronous or asynchronous. The interactions included data sharing as well as critical review of the data. Upon completion, while both students and teachers were positive about the experience, the teachers raised their concerns regarding the scope of project as well as the degree of technical expertise required to implement such initiatives in schools.

Postholm, Pettersson, Gudmundsdottir and Flem (2004) investigated the role of the teacher in facilitating project-based learning in a Norwegian secondary school. Their findings emphasize the importance of suitable project designs that are appropriately scaffolded to the abilities of the students. Postholm et al. (2004) argue that though the school may provide the suitable resources and facilities for the students to engage and interact, such as a platform for intellectual and social exchanges, these resources and facilities do not and cannot take the place of the guidance provided by the teacher. They contend that one of the critical roles of the teacher is to optimise the learning capacity of the students.

For students in post-secondary institutions, such guidance and scaffolding in research-based learning is infused and incorporated in part through virtual learning environments or e-portals. These online facilities allow students to interact and engage not only among themselves and their group members, but also with their facilitating mentors and lecturers (Oliveira et al., 2011; Bassani, 2010; Cleary & Marcus-Quinn, 2008; Rovai, 2000). These virtual platforms usually provide students with access to a chat facility or discussion forum that enables online intellectual exchanges, and a repository facility that allows file sharing (Guthrie, 2010; Cleaver, 2008; Campbell & Uys, 2007; Kurubacak, 2006; Murphy, Mahoney, Chen, Mendoza-Diaz, & Yang, 2005; Rovai, 2000; Glaser & Poole, 1999).

A case in point was investigated at an Irish university where undergraduates in a distance learning programme worked in groups, virtually, to develop e-learning courseware (Cleary & Marcus-Quinn, 2008). The university's online platform facilitated the group work and enabled the students to communicate and share resources as well as critique each other's submissions. Beyond the group, their mentors and tutors were also engaged in the discussions and provided feedback and comments when necessary. Cleary and Marcus-Quinn (2008) recounted that both the students and their tutors had positive experiences with the approach, and related that the online facilities provided adequate opportunities for the students to engage in collaborative learning.

Helic, Krottmaier, Maurer and Scerbakov (2005) relate a similar approach adopted by a software engineering course in Austria where university undergraduates were able to access lectures online and were required to collaborate in groups to develop

a software application. The school's online portal allowed the students to engage and interact among themselves as well as receive timely feedback and directions from their tutors with regard to their projects. Helic et al. (2005) report that both tutors and students found the portal an effective, time-saving and convenient channel for communication and collaboration where ideas and data could be shared without holding face-to-face meetings. Helic et al. (2005) also emphasize that for such online learning communities to engage in meaningful learning, it is important that the teacher is adequately competent to navigate in the virtual environment and engage the students meaningfully. With the teacher's appropriate competency, students would benefit from the interaction and a well-designed instructional material that would appropriately engage and challenge them. Consequently Helic et al. (2005) also suggest that students should be provided with their necessary training and skills to optimise their learning in the virtual learning environment.

Project Work in the North American Context

In the USA project-based learning is well established across the elementary levels through to the tertiary institutions. In this context, Bell (2010) reports that with project-based learning there is increased use of online facilities to engage, discuss and interact. These online facilities thus encourage the formation of virtual learning communities to facilitate the students' learning and knowledge creation. Bell (2010) also reports that beyond relying on institution-sanctioned portals, many of these VLCs use web 2.0-ready applications to engage and interact. Generic applications such as blogs, wikis, and social media such as Facebook are fair-game to both students and teachers who use them to connect and engage, and share and solve problems they encounter in the course of their project work.

In a study of a class of fourth-graders, Khan (2009) engaged her pupils in an invention project where they were to work in groups to modify existing gadgets. Khan (2009) related that upon receiving her initial instructions, her pupils set about forming learning groups online and started posting ideas and engaged in discussions and the sharing of resources. So independent, focussed and engaged were her pupils in the task at hand, that Khan (2009) felt quite redundant. From the reflections of her pupils, Khan (2009) found that they were able to seek answers and help from their peers or even their friends and siblings outside their project groups. Khan (2009) surmises that having her pupils able and ready to interact and engage in the virtual environment facilitated their learning process – independently.

Scardamalia and Bereiter (2006) followed the activities of pupils at a Canadian primary school as they embarked on a project to generate lesson notes. These resources were then posted online where the pupils received comments and feedback from the virtual community, which they then incorporated in their works. External experts were also co-opted to provide feedback and advice to the pupils. These inputs from the experts in turn contributed to the collaborative learning activity which led to collective knowledge construction. It was found that, by having the pupils generate

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conceptual frameworks and critique each other's work, their learning experience was elevated to higher cognitive levels. It was also noted that the online platform used provided the facility to document the thread of discussions. As such, the pupils were able to reflect on their thought processes and learning as they progressed in their project work. These threads of online discussions were useful especially when the group needed to retrieve ideas and concepts that were discussed and agreed upon for their projects. In addition, the online platform was appropriate to disseminate and circulate information among the group members and provide an appropriate avenue for "rapid question-answer and assertion-response exchanges" (Scardamalia & Bereiter, 2006, p. 116).

Similar to the research in Europe by Underwood et al. (2007), cited earlier, Case and Miller (1999) conducted a study among middle and high school students in grades nine and ten in the USA where the student researchers worked in partnership with scientists on science-based projects. It was found that the students and scientists formed learning groups and communities online to facilitate their research projects and engaged in communication, data and resource sharing, as well as ideas and challenge discussions. With the reach of the virtual communities, the students were also able to engage with students from other schools, thus allowing for comparisons and generation of new ideas and insights. The experiment data was also shared across the scientific community at large.

In another case, the Botanical Society of America (BSA) initiated an interactive internet-based programme where scientists engage middle and high school students in projects on plants (Musante, 2006). The interactions between the scientists and the students were mainly conducted online through a virtual forum where the scientists provided comments, feedback and suggestions to students regarding their projects. The guidance that the students received helped them to develop their research questions, hypotheses and experimental designs, and provided them a loose 'handrail' for their projects. The key element of this case pointed to the expert guidance that the students received in their projects, thereby allowing them to focus on research. On their part, the students were required to provide detailed logs of their works online where the 'expert' team provided the necessary comments and feedback. Musante (2006) reflected that the students gained much inspiration from their interaction with the scientists and were engaged in higher levels of cognition as they shared and explained their project initially with the scientists, and later with their peers in other participating schools as well as those outside of their research circles.

Like their European counterparts, universities in the USA are also offering their students on-site, online or distance learning courses that include project work or online group assignments as part of the course fulfillments (Koh et al., 2010; Brindley, Walti, & Blaschke, 2009; Thomas & MacGregor, 2005; Johnson, Suriya, & Yoon, 2002). According to Thomas and MacGregor (2005), students in these programmes form learning communities online where they communicate via synchronous and asynchronous systems with one another and their course instructor. They report that students tend to favour the use of the synchronous system for

social exchanges and brainstorming activities during the planning phase of the collaboration, and adopt the asynchronous system for task-oriented exchanges that require rigorous considerations associated with the designing and developmental phases of the collaboration.

Lou and MacGregor (2004) found that students consider asynchronous interactions more useful as they are engaged in constructive tasks that contribute to the development of their projects. Koh et al. (2010) also found that the asynchronous online conversations of the US graduate students presented evidence of highly cognitive knowledge construction that gave rise to solutions to problems as they worked collaboratively on projects to develop e-learning courseware. As such, appreciating the various types of online interactions could provide useful information to design appropriate online activities to engage learners.

Project Work in the Asian Context

In Asia, where the various educational systems continue to emphasize the traditional approach to teaching and learning, project-based learning is increasingly being introduced into schools. Chapter 2 of this book has provided an account on such progress. Nevertheless, while schools in Asia recognize the benefits of engaging students in project work, in many instances, the project work that students carry out often engages them in cooperative learning rather than collaborative learning. As such, while students are engaged to conduct project work, the task would require them to adhere to a set structure or format. However, beyond the pre-college level, collaborative learning in project work is increasingly observed at tertiary level learning.

In Hong Kong, Chu, Tse, Loh and Chow (2011) conducted a case study in a typical primary school setting where pupils were engaged in group projects. In their study, the pupils were conducting project work in three subjects, namely General Studies, Chinese Language and Information Technology. Chu et al. (2011) observed that while the pupils were provided with online facilities such as access to databases and were allowed to use search engines to obtain information for their projects, the pupils tended to stop short of utilizing virtual groupings to engage and enhance communication and knowledge creation among themselves, preferring instead to rely on traditional face-to-face sessions to hold discussions with their group mates and their teachers.

At the secondary level, in a study conducted by C. K. K. Chan and Y. Y. Chan (2010) where two groups of students, one in the junior high classes (grades 7-9) and the other in the senior high classes (grades 10-12) across eight schools in Hong Kong, started using virtual learning communities to engage and interact among themselves and their teachers, it was found that students were posting questions, ideas or theories on an online forum, developing and extending each other's contributions to advance their collective knowledge on the projects in which they were engaged. Chan and Chan (2010) observed that students who adopted a deep approach to learning were

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more participative in collaborative knowledge construction in a virtual learning community.

In another study conducted jointly by a university and 20 high schools in Hong Kong, the Secondary 5 students (Grade 11) in the 20 schools were required to collaborate in groups with team members from the different participating schools. The project groups were tasked to choose and decide on a social science research project. The students were supposed to not only source for the resources they required for their projects but also to refer to subject or content specialists from the university and professionals outside their schools. The objective was to study approaches to enhance the curriculum and pedagogy in schools in order to provide students with a more authentic and real-life learning experience in today's globalised knowledge-based environment (Law, Ma, & Yuen, 2000). Law et al. (2000) reported that the experience and learning by students were influenced by their approach and attitude with their collaboration and interactions with their group members across the duration of the project work. The researchers surmised that groups that performed effectively were those that had good rapport and dynamics among themselves, and also with their mentors. In turn, these project groups displayed highly intellectual exchanges among its members. It was also deemed important that the students together with their teachers and mentors from the university had engaged and interacted across prescribed online learning communities. These virtual learning communities provide a timely avenue for the students across the various schools to focus and 'congregate', albeit in cyberspace.

While the use of virtual learning communities for project work in Asian schools is not quite as prevalent as in other parts of the world, there is relatively related research. However, there is ample research at the university level where students engage in research or project work interact and engage one another across the online learning community using applications that are either provided by the institution or already available for use online; to the advantage of students, many such applications are free. (e.g. In Taiwan: Hou et al., 2007; Chang, 2008; Zhang et al., 2009; Chang et al., 2011; Wang & Hwang, 2011. In South Korea: Heo et al., 2010; Kim et al., 2011. In Malaysia: Neo, 2005). In all of the studies cited here, students engaging in either research or project work would form virtual learning communities among their group members and perhaps with their tutor and mentors as well. Beyond the interaction and communication facilities that are available to students and faculty, many students would also access the online lecture and course materials from an online portal. Other features such as file sharing facilities and discussion forums or chat facilities enable intellectual exchanges amongst tutors (or mentors) and students as they work on their projects.

In a study of undergraduates at a university in Taiwan, Chang (2008) found that the interaction and discussions among project group members, albeit across online learning communities, were important aspects of the students' learning experience as they engaged in their research or project work. Chang (2008) expounds that students who interacted and communicated frequently in focused and

meaningful discussions often produced better outcomes in the project work as their collaborations facilitated the meaningful sharing of ideas and concepts among group members. Heo, Lim and Kim (2010) also subscribe to this notion of the importance of frequent focused and meaningful interactions among project group members to facilitate project-based learning. In their study of Korean undergraduates who were engaged in project work, they found that the quality of interaction among the project group members and their mentors (tutors) were critical aspects that influenced and contributed to the success of project-based learning.

A similar experience was also noted in Malaysia where a study by Neo (2005) found that groups of undergraduates from a local university, while working on their projects, would continue their discussions using online communication applications during sessions when the groups were not able to schedule face-to-face discussion meetings. Neo (2005) commented that resorting to online facilities to continue the groups' discussions and interactions during periods when physical meetings could not be arranged enabled the project groups to maintain their progress timeline and enabled them to capitalize on their use of time.

Project Work in the Singapore Context

As reported in the previous chapters, project-based learning or project work is not a new learning approach to schools in Singapore. To reiterate, students from the primary school level to tertiary institutions have been engaged in project-based learning and project work as part of their assignments within the curriculum since 1997. However with the introduction of the "Thinking Schools, Learning Nation (TSLN)" initiative by then Prime Minister Goh Chok Tong in 1997, project-based learning became more prominent and took centre-stage in Singapore's Ministry of Education (MOE) strategy to develop and nurture the next generation of Singaporeans as thinkers and future problem-solvers. From the year 2000, project work became an integral part of the school's curriculum, and for pre-university students, the formalization of project work as a key component in the students' assessment was further elevated when in 2005, the score (grades) attained for project work for Pre-U 1 students would constitute up to 10% of the students' university admission grade. The following studies have investigated project work in Singapore since its formalization in assessment.

Jamaludin and Quek (2006) conducted a study with primary five pupils (Grade 5) from five different schools together with their teachers. The pupils were to collaborate in inter-school research projects. The pupils worked in groups of four and each group had two teachers from different schools to mentor them. To facilitate interaction among the pupils within the project group who hailed from different schools, an online discussion platform was introduced for the project group members to engage in discussions and for them to exchange thoughts and ideas. The online discussion application also facilitated interactions between the pupils and their teachers even when scheduling for face-to-face meetings were challenging. The pupils' reflection

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logs indicated that they valued the knowledge that they gained during the course of the collaboration. They also raised issues about the differing attention and inactivity of certain group members. Whereas several studies cited earlier credited the significant role of teachers or mentors in project-based learning, the researchers in this study were not able to conclude if the guidance that the teachers provided to the pupils did actually enhance the pupils' communication and interaction.

There have been several project-based studies in secondary schools in Singapore. A number of them have also focused on the impact of group communication and learning communities, including virtual learning communities (VLCs), as an important aspect of group learning and cognitive interaction for knowledge creation (Quek, 2010; Seet & Quek, 2010; Wong et al., 2006). For example, in their study of secondary two students (Grade 8) in seven schools, Wong et al. (2006) looked at how these students used physical meetings in school as well as online platforms to facilitate project collaborations. They found that this approach enabled the students more access time among their project group members for interaction and collaboration. This blend of interaction enabled students to hone their discipline to the task. Both their teachers and the students themselves were reported to be favourable to this approach of engagement to support their research work. However, the study also pointed out that in order for the students to optimize their engagement, especially on the online platform, not only should the students be taught how to use these online portals to augment their interactions in the virtual learning communities, teachers should also guide their students adequately so as to provide clear instructions when they go about their project work.

While such clear guidelines and directions for online engagement are important when students from different schools embark on joint projects, they are essential when project group members comprise students located in different countries (Seet & Quek, 2010). Optimizing the various functions and features of the virtual learning portal becomes even more critical in order to maximize engagement and interaction through online discussions and virtual meetings as well as the collection and sharing of data and information culminating in the drafting of the research report.

CONCLUSION

This chapter elaborated on the concept of project-based learning, and outlined the social constructivist perspective that informs this book. For the purpose of this study, the concept of project-based learning was defined and scoped. This chapter also reviewed research that informed the present study in terms of its focus and direction.

Key findings of the literature review include the changing role of teachers as facilitators in the learning process of their students especially when adopting the project-based learning approach when teachers take on the role of mentors, or even that of co-researcher. With schools incorporating project work in their curriculum design, the 'new' role of teachers as co-researchers and resource mentors sees the

emergence of a new teaching role for teacher mentors, that of ‘facilitator’. Here, the teacher as facilitator must be skilled at encouraging and helping students to learn independently and interactively. Additionally the facilitator must also have an excellent understanding of concepts and skills across the traditional disciplines.

There is also an increased tendency in recent years for students to be encouraged by their teachers or mentors to use the online virtual learning community to engage, collaborate and create knowledge. While traditional face-to-face interactions and physical meetings may be useful and beneficial, being able to organize and schedule such sessions often proves challenging especially among project groups whose members comprise students from various other classes, levels, schools or even countries.

The literature also indicates that teachers and mentors need to update and upgrade their adoption and application of these online facilities with the appropriate use of ‘new’ features to engage students, and more importantly to design online tasks that optimize collaboration, interaction and independent learning among their students. Moreover, the learning strategies and approaches should also gravitate away from cooperative learning towards more engaging and collaborative learning. Additionally, schools should also evolve their academic approaches to facilitate and incorporate these learning strategies and be less ‘traditional’ and prescriptive with regard to students’ learning styles so as to develop independent learning and encourage knowledge creation.

There are ample examples from international settings where project-based learning has stimulated students to learn beyond the text and encouraged them to create their own knowledge through collaboration and collective intelligence. Many schools in Asia however – while they may have adopted project-based learning and even incorporated virtual media – tend to continue with more traditional prescriptive approaches. The thrust of the current study then looks at one particular case where the school’s project-based learning approach coupled with the strategic engagement of students using virtual learning communities encourages and develops the students to learn independently, or what Zhang, Scardamalia, Reeve and Messina (2009) describe as ‘opportunistic collaboration’.

The following chapter describes the research methodology and approach for the study reported in this book.

CHAPTER 4

METHODOLOGY

INTRODUCTION

This chapter describes the research methodology for this study in four main sections. The first section describes the theoretical framework. The second section describes the research strategy and design including the case study approach and sampling details. The third section describes the methods of data collection and analysis. The fourth section explains how trustworthiness was ensured and the final section addresses ethical issues and considerations.

THEORETICAL FRAMEWORK

This study has been framed within the qualitative perspective as the central question aims to gather rich data to study the perspectives of academically-able students dealing with a research-based project work curriculum. The study is thus located within the interpretive, symbolic interactionist paradigm (Morse & Richards, 2002), with emphasis on the socially constructed nature of reality, that is, “the intimate relationship between the researcher and what is studied, and the situational constraints that shape inquiry” (Denzin & Lincoln, 2003, p. 13). The researcher also considered the qualities of the participants and the processes and meanings that are not experimentally measured (Denzin & Lincoln, 2003). While the researcher acknowledges that the research paradigm is diverse, multidimensional, dynamic and developing, he has also taken into account and reflected on the concepts, thinking and approaches of the social realities being studied (Punch, 2006).

Interpretivism

The term interpretive is, according to Cavalli (2001), used to refer to the paradigm for inquiry and not methods of inquiry. Guba and Lincoln (1994) and Erickson (1986) state that paradigms are metaphysical, and form the basic belief systems through which observations and reasoning about the world are organized and made sense of (Babbie, 2001). As such, researchers undertaking qualitative studies require different responses from different paradigms. These include the nature of questions and questioning methods as well as the kinds of interpretations that would and could be abstracted. Hence, the issues of human choice and meaning should then be the central questions of interpretive research (Erickson, 1986).

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Blackledge and Hunt (1985) describe five major assumptions that underpin the interpretive approach. These assumptions include everyday activity, freedom, meaning, interaction, and negotiation. Each of these assumptions influenced the research design and approach of this study. Firstly, Blackledge and Hunt (1985, p. 234) state that “everyday activity is the building block of society; that every aspect of society can be traced back to the way people act in everyday life”. Erickson (1986) similarly emphasizes the importance of investigating the everyday life that may seem trivial at first glance; however, such patterns in the everyday actions may be overlooked because of familiarity or contradictions. Hence, to better understand the perspectives of academically-able students on research-based project work curriculum, it was necessary to investigate how the participants engaged in research-based project work in their day-to-day curriculum activities, and have them reveal what was happening. These experiences cited by the participants during the interviews were documented systematically by having them reflect on their learning activities either as individuals or collectively in their respective groups or teams.

Secondly, Blackledge and Hunt (1985) suggest that there is also a certain degree of freedom that people can exercise in their everyday activity. They add that to some extent people are able to create their own day-to-day activity. This everyday activity can also result from people interacting together and producing their own roles and patterns of actions. As such, how the participants dealt with the research-based project work was best understood by investigating their day-to-day interaction roles and patterns, and by considering the distinctive local meanings that the activities had for them (Erickson, 1986).

Thirdly, it is also important to understand the meanings that people give to their behaviour so as to better understand the everyday activity (Blackledge & Hunt, 1985). From an interpretivist’s viewpoint, these meanings include the aims or intentions as well as the significance and reasons. It is assumed that these meanings are personal to the people involved. These meanings led to the development of the guiding questions in this study.

Fourthly, in their day-to-day activity, people rarely act in isolation. Instead people interact with each other and interpret each others’ behaviour before responding (Blackledge & Hunt, 1985). As such, interpretations may be coloured by biases or prejudices or even factors such as age, gender, race, intelligence, motivation, and so on. Thus, to fully understand how the participants perceived the research-based project work curriculum and how they dealt with it, it was essential to investigate how they interpreted their interactions with others.

Finally, Blackledge and Hunt (1985) also revealed that through a process of negotiation of meaning, a shared understanding and interpretations amongst people would occur. Ultimately, as an on-going process of subtle negotiation, people would eventually change or modify their views. Therefore the study looked at how the participants retrospectively perceived their experiences in relation to becoming

independent learners, and how much of this trait is attributed to research-based project work.

Symbolic Interactionism

This study has also adopted a micro-sociological, symbolic interactionist perspective which concerns the understanding of how individuals and groups interact, with the emphasis on the importance of meaning and interaction as essential human processes (Patton, 2002). From this perspective, through interaction with others, people create shared meanings that become a reality to them (Patton, 2002).

With reference to G. H. Mead's work in 1934, Blumer (1969) highlighted three major premises as fundamental to symbolic interactionism. The first premise is that human beings act towards others based on the meanings that others have formulated for them (Blumer, 1969; Schwandt, 1994). Thus this research inquired into the participants' perspectives on what working as a team in their project work meant in terms of their learning styles and attitudes. The second premise is that language gives people a means to negotiate meanings through symbols. Communication is symbolic. We communicate via language and other symbols such as gestures and signs. In this study, the focus was on the interactions between the participants as they engaged in research-based project work. The third premise is that meanings are managed, and modified through an interpretative process used by the person in dealing with the things they encounter (Mortimer, 2003; Patton, 2002). Hence, in this study, attention was focused on how the participants interpreted their respective learning experiences as they engaged in research-based project work in their respective everyday activity.

Blackledge and Hunt (1985) further argue that researchers, who bring into their research factors from outside the interaction, show that they are aware of how the interaction can be influenced by factors outside the control of the participants. Accordingly, this research also explored with the participants their views on factors outside their control such as school policy, assessment rubrics, demands and requirements from their respective co-curricular activities and so on.

RESEARCH STRATEGY AND DESIGN

The study was designed to gather descriptive data about the participants' experiences with the research-based project work curriculum. It also sought to gain insights into the concerns of the participants with regard to the experiences and challenges that they faced.

Understanding the participants' unique interpretations of phenomena such as the research-based project work curriculum required knowledge of the context within which those conceptions were constructed. The importance given to context in qualitative research also made the approach suitable, as the aim of the research was

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to understand the perspectives of the participants on their learning experiences. The case was bounded by its curriculum context and could be termed naturalistic (Punch, 2009; Lincoln & Guba, 1985).

A case study was therefore made of students engaged in research-based project work in one school in Singapore. The case study approach was suited to this study as it allowed for an examination of views within each of five focused-groups and then between the groups. This allowed for the development of a shared view of the perspectives of the students and the highlighting of differing views. It also allowed for an investigation of issues between the groups that can account for differences.

Case Study Method

Yin (1984) describes case study as an empirical inquiry that investigates a contemporary phenomenon within its real-life context. Stake (1988) refers to case study as a “study of a bounded system, emphasizing the unity and wholeness of that system, but confining the attention to those aspects that are relevant to the research problem at the time” (p. 258). Punch (1998b) describes case studies as aiming to develop as full an understanding of that case as possible (p. 150). It aims to understand the case, as a whole, in depth, in its natural setting, recognizing its complexity and context. In particular, Brewer and Hunter (1989) indicate that case studies are effective when exploring actions and interactions. Sarantakos (1998) adds that, in the case study, the participant is perceived as an expert and not just a source of data. The four key characteristics of a case study, as described by Punch (1998b), are that it has clearly described boundaries, it is a case of something, the wholeness of the case is preserved and multiple sources of data are likely to be used.

To achieve the aim of this study the case study method was used to develop a full understanding of the perspectives of the students. These perspectives were in relation to how the students dealt with a research-based project work curriculum that focussed on cultivating or enhancing independent learning, and the actions and interactions among themselves (the learners), and with their project mentors (teachers). This method acknowledges that the students, being ‘skilled’ in the approach of research-based project work that the school offers for four years, are ‘practicing experts’ in the approach. The case study method provides a framework for understanding a theoretical concept that presently has no clear framework. Punch (1998b) describes this as understanding a case in its complexity, entirety and context (p. 154) and so generalization is not intended. In addition, besides understanding the processes and outcome of the case, it also helps to “strengthen the precision, the validity, and the stability of the findings” (Miles & Huberman, 1994, p. 29).

To reiterate, the study sought the perspectives of academically-able students dealing with an experiential research-based project work curriculum aimed to cultivate

or enhance their independent learning attitudes. Woods defines perspectives as the “frameworks through which people make sense of the world” (1983, p. 7). He argues that perspectives are ways of viewing a phenomenon and interpreting it in an effort to obtain a ‘world view’, and are based on assumptions that are culturally specific and context-bound.

In the case of this research, the ‘students’ perspectives’ took into consideration how the student participants understood research-based project work vis-à-vis their classrooms and school situations. There was also the need to explore how these situations were interpreted according to the participants’ experiences, beliefs and assumptions as well as how these interpretations were exhibited in their behaviours.

The central research question was: *How do students engaged with research-based project work curriculum deal with independent learning?* Four guiding questions were developed with a view to gaining insight into the participants’ perspectives. These guiding questions were important to the research focus and were incorporated as productive guides to generate the rich data that was relevant and important to the central research question. Hence, the guiding questions for this particular study were as follows:

- What were the students’ *intentions* prior to the implementation and their participation in authentic and experiential learning, particularly that of the infusion and incorporation of research-based project work approach to their curriculum? What reasons did they give for their intentions?
- What *strategies* did the students develop to manage and ‘deal with’ the research-based project work approach in their curriculum? What reasons did they give for utilizing those strategies?
- What was the *significance* that the students attached to their intentions, and their strategies, and what reasons did they give for this?
- What *outcomes* did the students achieve as a result of their actions, and what reasons did they give for this?

This set of guiding questions in turn cascaded down to data collecting questions.

Sampling Procedure

Sampling for this study was guided by a desire to “provide the greatest opportunity to gather the most relevant data about the phenomenon under investigation” (Strauss & Corbin, 1990, p. 181). In order to provide robust explanations for analyses and interpretations, and also to generate conceptual frameworks, a purposeful sampling approach was used to select a wide representative of participants in the case study school for in-depth study (Miles & Huberman, 1994; Patton, 2002). Studying a small sample of information-rich cases can be very revealing and informative as it may provide valuable insights and perspectives rather than empirical generalisations

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(Patton, 2002). As such, the researcher selected a representatively wide sample to collect a variety of perspectives and situations.

Participants

All students in the case study school were engaged in project work from the time they enrolled in Secondary 1, when they were exposed to and taught the various approaches to research-based project work. The students were thus introduced to the basics of the various genres of research skills from Secondary 1. These skills in research-based project work culminate in students being assessed formally in a nationally graded project work assessment at Pre-U 1. The grades that the students attained in the nationally-assessed and graded project work subject would then be computed in the students' overall grades in their final year at Pre-U 2, and computed with their application for entry to the local universities. In order not to disrupt and distract the Pre-U 2 students who were intensely involved in their project work, this study selected students in Secondary 4. These students had already undergone four years of research-based project work experiences and were deemed able to provide rich qualitative data for the study.

The students in the case study school at the Secondary 4 level were banded according to their attitude and aptitude towards specific electives that they have passion and interest in. This banding option was done from the start of Secondary 3. These electives or special programmes included the Mathematics and Science Talent Programme (combined Mathematics Talent Programme and Science Talent Programme), Humanities Research Programme, the Language Elective, and the Bi-cultural Studies Programme. Groups of between five and six students, each group representing one of the programmes were invited to participate in the study. The proposed 30 students were selected purposefully to encompass the range and diversity present in the target population (Punch, 2005, 2009).

As participants were selected from students across the five programmes, the issue of whether subject disciplines might affect the participants' views and their perspectives of the research-based project work curriculum and its influence on their learning attitudes was negated or minimized. This represented a deliberate or purposive sample to help yield the most appropriate data for the investigation (Punch, 2005, 2009).

At the initial stages, these selected students were invited to participate in the research. Together with the research proposal and the list of tentative questions, the proposed interview schedule was also provided to the students who were informed that they could withdraw from the study at any time should they decide to do so. As the selected students were around 16 years old, letters requesting consent were sent to their parents as well, together with similar sets of information. The researcher also made provision such that should any of the initial group of selected students decide not to participate, the corresponding additional number would be invited to make the required number proposed for the study. However, all of the initially proposed participants agreed to take part.

The Role of the Researcher

It was essential in the study for the researcher to understand the students' perspectives by gaining the trust and acceptance of the participants so as "to establish the appropriate research relationships, rapport and trust" and encourage them to reflect critically on their experiences (Miller and Glassner, 2004, p. 128) with research-based project work.

Having been a staff in the case study school for 23 years, the researcher's role as an 'insider' provided a suitable in-depth understanding into the setting of the study. This 'insider' status of the researcher could be perceived as an advantage as access to participants and archived documents was available. Additionally, the researcher's experience and understanding provided enhanced awareness, knowledge, and sensitivity regarding the challenges, decisions and issues that the participants encountered. As a member of the faculty, the researcher was able to identify closely with the participants and valued their inputs and responses.

While this in-depth knowledge enriched the study, "the human instrument would be as fallible as any other research instrument" (Merriam, 1988, p. 37). This same familiarity could also bring in the problem of social interaction, dimensions of power and issues of confidentiality to influence the research. Familiarity with the setting could also lead to a loss of 'objectivity' especially that of inadvertently making erroneous assumptions based on the researcher's prior knowledge and experience (DeLyser, 2001). The issue of the researcher's subjectivity with the 'insider' status might also bring certain biases to the study. These might influence the researcher's views, understandings and interpretations of the data collected. With too much familiarity, there is also the issue that the researcher might make assumptions about the context of the study, and inadvertently ignore important information or overlook significant areas of inquiry. Similarly, the process of interview might also be complicated by the assumption among the participants that the researcher already knew the answer (DeLyser, 2001). In light of such limitations, as a member of the administrative team in the case study school, the researcher does not engage in active and regular teaching role. As such the researcher currently has no direct involvement in the implementation of the research-based project work. This limits the researcher's experiential knowledge in the curriculum and promotes the need for inquiry.

There is also the argument that the researcher was also an 'outsider' in the research. Assuming the role of the researcher also acts as a barrier that separates the 'insider' from those in the setting, the participants. One initial concern at the start of the study was that there may be tension in the balance between the development of rapport with the participants, and the maintenance of the distance required to make sense of the data (Gerrish, 1997). In this study, the researcher was thus both an insider and an outsider. However, there are strengths and limitations to both insider and outsider research. Recent literature on an insider/outsider status has highlighted the complexities of either status and has acknowledged that both statuses are not

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clearly delineated. There is also consideration about the role of the researcher along a continuum between ‘complete participant/member researcher’ and ‘complete observer’ (Ellis & Bochner, 2000). As such, in this study, the researcher bore in mind his different roles as data was collected, analysed and interpreted. This study then was a process of interpretation leading to the construction of meanings as the different understandings were negotiated.

DATA COLLECTION AND DATA ANALYSIS

Data Collection

As mentioned, in qualitative research, the researcher is the primary instrument for data collection and data analysis (Anderson, 1998; Miles & Huberman, 1994; Patton, 2002; Punch, 2000; 2006). As such, it was important for the researcher to be involved in all aspects of data collection, coding, and conceptualising as the study unfolded (Anderson, 1998). It was also essential that the researcher tracked the chain-of-evidence by maintaining a separate inventory of data with transcripts, tables, figures, and the like which eventually might not be reported but could be easily made available to other interested researchers (Anderson, 1998; Moon, 1991). Data was collected primarily through semi-structured interviews and, to a lesser extent, document collection.

Semi-Structured Focus Group Interviews

Semi-structured focus group interviews were used as the main mode of data collection to determine the understandings of the key actions by the participants. A strength of this approach was the opportunity to gather descriptive data in the subjects’ (participants’) own words so that the researcher could develop insights on how the subjects interpreted their social worlds (Bogdan & Biklen, 1992, p. 96). It also allowed the researcher to hear participants speak about themselves and their experiences, so as to develop an interpretation of how the research-based project work curriculum was seen from their perspectives and the significance of the meanings they attached to their experiences of moulding and enhancing their independent learning attitudes. Asking people to talk about their lives helps to generate empirical data about the phenomenon under study (Holstein & Gubrium, 2004, p. 140) and is effective in accessing people’s perceptions, meanings, and constructions of the reality of the research-based project work curriculum (O’Donohue, 2007).

The researcher decided on focus group interviews in this study to gather data from the students as the group interview process stimulates the students and aids them to recall relevant details (Fontana & Frey, 2005). This “synergistic potential in focus groups often produces data that are seldom produced through individual interviewing, and that results in especially powerful interpretive insights”

(Kamberelis & Dimitriadis, 2005, p. 901). Kamberelis and Dimitriadis (2005) further expound that “the synergy and dynamism generated especially within homogeneous groups often reveal unarticulated norms and normative assumptions, and would take the interpretive process beyond the bounds of individual memory and expression to mine the historical sedimented collective memories and desires” (p. 902).

The researcher also recognises that group interviews have certain challenges. Amongst these are that the data gathered cannot be generalized. There is also the problem of emerging group culture that may interfere with individual expression, such that the group may be dominated by one or two persons, and ‘groupthink’ is also a possible outcome (Fontana & Frey, 2005). To address these issues, the researcher was mindful of conducting the respective group interviews in a systematic approach so as to create a methodological continuity to assess the outcomes of the data gathered (Morgan, 2002). In addition, during the course of the focus group interviews and discussions, the researcher ensured that every member of the respective focus groups was engaged in providing their respective and unique opinions and perspectives, even as the members of each group engaged in active discussions based on the various questions posed by the researcher.

Through such focus group interviews, the researcher was able to relate “what was in and on someone else’s mind” (Merriam, 1988, p. 72). As such, this approach was suitable for gaining an authentic insight into the feelings, thoughts, intentions and experiences of the participants (Patton, 2002) concerning the manner in which they dealt with the research-based project work curriculum in their specific context.

Interview questions were developed from the guiding questions, as illustrated in the table below. The questions were open-ended so as to gather information-rich responses.

The interviews were conducted after the participants’ end-of-year examinations. Each group of participants was initially interviewed for about one-and-a-half hours. Though these interviews were the main mode of data collection, there was no plan to fix the number of interviews as subsequent data collection was guided by the directions that emerged from the analyses of the first few sets of data. Follow up individual and group interviews and informal discussions provided supplementary data as the need arose.

As mentioned earlier, prior to data collection, a cover letter explaining the nature and purpose of the study was distributed to all participants and their parents. The time commitment required of the student participants was also explained. A copy of the interview structure and the list of ‘focus’ questions were also given to both students and their parents. The interviews were all conducted on-site at the case study school in order to make it more convenient to the participants. Besides the convenience, the familiar environment of the school grounds helped to provide a congenial and uninterrupted environment for the participants. The interview sessions were recorded with prior consent of the participants and their parents. The recorded interviews were

Table 1. Guiding and interview questions

| <i>Guiding questions</i> | <i>Sample interview questions</i> |
|--|--|
| 1. What were the students' <i>intentions</i> prior to the implementation and their participation in authentic and experiential learning, particularly that of the infusion and incorporation of research-based project work approach to their curriculum? What reasons did they give for their intentions? | <ul style="list-style-type: none"> • What do you understand by the term research-based project work or project work? • What do you think were the reasons for the implementation of research-based project work or project work in this school? |
| 2. What <i>strategies</i> did the students develop to manage and 'deal with' the research-based project work approach in their curriculum? What reasons did they give for utilizing those strategies? | <ul style="list-style-type: none"> • How has research-based project work impacted your learning both within and outside of your class? • What were some of the challenges that you faced? • How did you prepare yourself/selves to engage in your project work? |
| 3. What was the <i>significance</i> that the students attached to their intentions, and their strategies, and what reasons did they give for this? | <ul style="list-style-type: none"> • What would you say were the more significant changes that have taken place in your learning styles because of research-based project work? • How has your learning changed because of your involvement in research-based project work? • Do you think that research-based project work is important? Should/shouldn't it be included as part of the school's curriculum? |
| 4. What <i>outcomes</i> did the students achieve as a result of their actions, and what reasons did they give for this? | <ul style="list-style-type: none"> • Do you have any suggestion as to how research-based project work could be improved? • How do you think you have benefited from being engaged in research-based project work? • Do you think being engaged in research-based project work value-added to your learning style or attitude? If so, how? If not, why do you think that was so? |

later transcribed to provide a rich database for analysis. Transcribing the interviews also helped transmit a very rich density of meaning (Ruddock, 1993) as it enabled the use of quotations in the descriptive and analytical sections of the study. Before

the analysis and reporting, a copy of the transcripts of each interview was shared with the participants to ensure accuracy of the records, and also to allow participants to confirm, add or delete from the transcript.

Document Study

Strauss (1987) encourages the exploration and study of documentary evidence as an enrichment tool to complement the interview data, thereby providing the 'conceptual density' required for authentic research. Various policy texts available at the ministry and school levels were studied together with the school's concept paper for the research-based project work curriculum. Relevant documents selected included curriculum outlines, instructional materials, students' project works and reflections, articles and newsletters featuring the school's experiences in the research-based project work curriculum. These documents which portrayed the implementation of the research-based project work curriculum in the case study school complemented the perspectives of the participants and made explicit the school's practices and decision-making. The information that was analysed from these documents helped the researcher to better appreciate what the participants were sharing during the interview sessions and served to triangulate the data obtained through interviews. Consequently, document analysis helped with the understanding of deep knowledge of the phenomenon under study.

Data Analysis

While qualitative research focuses on the study of social life in its natural settings, Punch reiterates that due to the richness and complexity of the data gathered, there exist "different ways to analysing social life, and therefore multiple perspectives and practices in the analysis of qualitative data" (2009, p. 252). There is a repertoire of qualitative research analysis approaches as there are "different questions to be answered and different versions of social reality that could be elaborated" (Coffrey & Atkinson, 1996, p. 14). While the differing techniques are often interconnected and complementary, there are those that are mutually exclusive (Miles & Huberman, 1994). Whichever the approach, data analysis is basically the process where the value/s of the evidence collected is studied and documented to address the central research question of the study. It involves the developing, testing and changing of propositions. In a qualitative study such as this, data analysis contributes significantly towards the actual direction of the on-going data collection and interviews. This study utilized the inductive analysis approach to manage and analyse data (Miles & Huberman, 1994, p. 428). This includes the three stages of data reduction, data display and conclusion drawing and verification. The following details the stages of the data analysis adopted for this study, which were applied to interview transcripts as well as documents.

Stage 1: Data Reduction

Data reduction involved the “selecting, focusing, simplifying, abstracting, and transforming the ‘raw’ data that emerged from the transcripts” (Miles & Huberman, 1994, p. 10). This occurred continuously throughout the analysis and took place throughout the process of coding and memoing. Coding is the concrete activity of labelling data, which gets the data analysis under way (Punch, 2005; 2009).

At the initial stage, “the data was edited, segmented and summarized” (Punch, 2009, p. 174). The next stage of data reduction included coding and memoing, and associated activities such as finding themes, clusters and patterns. This process entailed coding data gathered from the interview transcripts. These were reviewed and coded with data labels to assist with the process of extracting meaning from these data. These data labels were then organized according to categories. The coding process thus helped to develop conceptual categories that were examined throughout the data analysis. In addition, the codes, memos, notes and comments were also included and reflected on the transcripts. These reduced the data further to realize themes and patterns.

Reflective memos were also included together with data collection and coding as they provided suggestions at possible similarities in the data and helped the ‘discovery’ of higher order concept-categories and the eventual propositions. While memos started as operational notes, they progressed from personal annotations to becoming speculative and analytical (Strauss, 1987, p. 109).

Stage 2: Data Display

Miles and Huberman’s (1994) approach includes the use of graphs, charts, diagrams and casual models to reduce and condense information into comprehensible, compressed forms for drawing tentative conclusions from the data (Punch, 2005; 2009). These methods of data display helped to organize, summarize and assemble information so as to construct categories from the data. This helped the researcher to reflect on the meanings that emerged from the interviews.

This stage derived much of the information from the memoing and coding process, and was developed continuously as new data and information were reviewed. There was a close interaction between the data reduction and data display processes throughout the process of interview, transcription and data analysis.

Stage 3: Drawing and Verifying Conclusions

The third stage involved drawing out and verifying the meaning from the displayed data. Using the data displayed, the researcher developed concepts and generated groups of conceptual categories. Through this process, the researcher was able to reach a higher level of abstraction, effectively elevating the analysis “from an empirical level to a conceptual level” (Punch, 2009, p. 175). Memoing was a key

process toward achieving this aim. In this study, the researcher developed higher order concepts to integrate with the more concrete levels of data. Where appropriate, the researcher compared the analyses to examine and identify more abstract concepts. This process of abstracting and comparing facilitated the development of the analysis level to a more conceptual level.

ENSURING TRUSTWORTHINESS

Qualitative research employs different techniques to ensure trustworthiness. Lincoln and Guba (1985) argue that it is inappropriate to use the criteria of reliability and validity used by quantitative researchers. Janesick states that “qualitative researchers do not claim that there was only one way of interpreting events” (2000, p. 393). As such, Lincoln and Guba suggested alternative criteria of credibility, transferability, dependability and confirmability to establish trustworthiness of qualitative research. These criteria are more in keeping with the philosophy of naturalism (Lincoln & Guba, 1985, p. 240) and were applied in this study.

Credibility

The objective of establishing credibility in a qualitative inquiry where participants relate and construct their various realities was to show that “the inquiry was conducted in such a manner as to ensure that the subject (participant) was accurately identified and described” (Marshall & Rossman, 1995, p. 143), and that these findings were “credible to the constructors of the original multiple realities” (Lincoln & Guba, 1985, p. 296). In this study the researcher demonstrated the representation of the participants’ constructions of reality in relation to how the participants perceived their role and experiences with the research-based project work curriculum.

The researcher depended on the combination of the semi-structured focus group interviews and analysis of relevant documents to help to obtain the varied meanings and interpretations of events and interaction in order to provide a holistic understanding of the phenomenon (Strauss & Corbin, 1990). The researcher also triangulated the data collected from multiple methods of data collection and analysis to help to check on its validity. In so doing, the data that was gathered was without bias or corruption, hence ensuring the credibility of the findings. In addition, the data and interpretation were referred back to the participants to verify if the results were plausible (Merriam, 1988). In this way, the participants can help to review and validate their personal input (Strauss & Corbin, 1990).

Transferability

As the data for this study was unique to the context of the participants who were involved in the research-based project work curriculum in the case study school,

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the findings would correspondingly be exclusive to this particular group of participants who had experienced changes in the context under study. This would make the transferability of the findings quite difficult and challenging (Lincoln & Guba, 1985). Interpretivist investigations such as this study aim to find the concerns of certain groups of people and hence, the findings would be peculiar to their respective settings and would make it impossible to transfer findings from one situation to another. In fact, the naturalistic philosophy (Lincoln & Guba, 1985) suggested that propositions discovered were time and context-bound; hence, the traditional notion of external validity would no longer be meaningful in this interpretivist study.

This study did not seek to deliver generalisable statements but to provide “as complete a data base as humanly possible in order to facilitate transferability judgments on the part of readers who might wish to apply the study to their own situations” (Guba & Lincoln, 1989, p. 242). In this respect, the findings of this study were generative, and not generalisable.

Dependability

The researcher maintained an audit-trail for this study to ensure the dependability of the results (Lincoln & Guba, 1985). This audit trail sought to document the entire process of the research, and included the initial development of the problem situation that brought about the problem statement and central research questions, to the final recommendations of the study. Additionally, the interview recordings, as well as transcripts, documents, data reduction and analysis notes, and data reconstruction records were collected, collated and stored. The entire trail of the study including the crafted propositions remained intact, and was made available to allow the researcher to take the reader through the process of the study so that the process by which conclusions were drawn could be apparent. Through this audit trail, other researchers will be able to “ascertain the dependability or trustworthiness of the outcome” (Maykut & Morehouse, 1994, p. 146).

Confirmability

Another criterion to ensure trustworthiness is the degree to which the data and interpretations of the study are grounded firmly on evidence collected from the participants rather than the researcher’s own imagination (Lincoln & Guba, 1985). This infers that the researcher has not “overtly allowed personal values or theoretical inclinations to manifest and sway the conduct of the research and findings derived from it” (Bryman, 2001, p. 724). Therefore, all records for the study were maintained to help ‘track’ the research process and to attest that the findings were reviewed from within the participants’ experiences and their understandings of the phenomenon under study.

ETHICAL ISSUES AND CONSIDERATIONS

Participants' Consent

In order to address the various ethical issues during the various stages of data collection, analysis and dissemination, steps were taken to safeguard and protect the rights, needs and values of the participants (Creswell, 1994). Foremost amongst the issues was the need to seek informed consent from participants ahead of any data collection process. This was to ensure that participants “engaged in the research projects voluntarily, with full understanding of the nature of the study as well as the obligations and commitments” (Bogdan & Biklen, 1992, p. 53).

As this study was conducted in the context of the case study school, the researcher had initially approached the Principal of the school to seek his consent for his students to participate in the research. The research interests and objectives were listed in a formal letter of invitation to the Principal and the potential participants. As participants were selected at random through their form teachers from among the student population who were around 16 years old, parental consent was sought. Respective parents were provided with details of the study including the purpose and aims of the study, a description of the research project, as well as details, methods and schedule of the data collection.

The participants (and their parents) were provided with the list of tentative interview questions to allow them to have an idea of the types of questions that were to be asked in the interviews. Participants (and their parents) were also informed that they could withdraw from the research at any time without prejudice, and that a joint decision would be made with regard to the data collected on withdrawal from the study, even though this might threaten the continued existence of the research.

Researcher's Background

While Maurice Punch (1986, 1994) stressed the considerable importance of the institutional background of the researcher to gain access to appropriate resources to facilitate the study, he also cautioned that such association and alignment might work against the researcher. As a member of the administrative team, the researcher has ready access to the selection of participants, as well as access to appropriate resources for the document study. However, the researcher was also aware of the challenges of gaining acceptance by the participants. Participants might fear revealing their weaknesses or issues to the administration. Recognizing this issue, the researcher attempted to foster a more conducive researcher/participant rapport in an open and non-threatening setting (Denzin & Lincoln, 2000). Punch added that “if the researcher and participants were seen as ‘collaborators’ in the research rather than as ‘subjects (participants)’ then the researcher should treat the participants as friends and acquaintances in their own daily lives” (1986, p. 83). Hence, throughout the research process, the researcher assured the participants of their “right to scrutinize

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the interview transcripts and research findings for accuracy, relevance and fairness” (Creswell, 1998, p. 166).

Confidentiality and Anonymity

While Patton argues that “informed consent does not automatically mean confidentiality” (2002, p. 412), the researcher ensured that anonymity and confidentiality were observed throughout the study. In this respect, the participants’ identities were confidential (and anonymous), and were neither identified verbally nor revealed or published in the study. In this regard, participants were assured that their verbal or written accounts were used solely for this study, and treated with confidentiality. To this end, alpha-numerical codes or pseudonyms were used to identify participants in all interview transcripts. The researcher remained mindful of the ethical obligations throughout the entire process of the study, and thus implemented these measures to protect the anonymity of all participants (Bogdan & Biklen, 1992).

CONCLUSION

This chapter has restated the purpose of the study and provided an overview of the research design and the methodology that was used in this study. It also explained and justified the interpretivist qualitative design approach adopted in this study, and described the sample and methods of data collection and analysis.

Also explained were provisions to ensure the trustworthiness of the research and how ethical issues were addressed. The empirical and theoretical findings are presented in the following two chapters.

CHAPTER 5

CASE STUDIES

INTRODUCTION

This chapter presents the findings of the case study research aimed at developing understandings of the impact of a research-based project work learning curriculum on independent learning. To reiterate the study sought the perspectives of students taking into consideration how they understood research-based project work vis-à-vis their classrooms and school situations. The case study comprised a sample of 30 Secondary 4 students (Grade 10), each of whom was engaged in one of the five programmes or courses of studies that the sample school offered to Secondary 3 and 4 students. These five groups of students were selected because they were all from the same cohort and have studied in the same school for four years since Secondary 1 (or Grade 7). The sample groups each represented a course of study that required students to embark on a research-based project where the emphasis of their respective research projects was unique to their specific programmes. The 30 student participants were randomly sampled from students across the five programmes, namely: the (combined) Science and Mathematics Talent Programme; the Humanities Programme; the Bicultural Studies Programme; and the Language Elective Programme (High School Talent Development Programmes, HCI, n.d.). The programmes are coded in the above order, from 1 to 5, in this chapter.

This chapter outlines the background of the case study school student participants and their project work programmes. The chapter then presents the case study findings related to the central research question, which was: *How do students engaged with research-based project work curriculum deal with independent learning?* The findings are organised around the guiding questions, as outlined in Chapter 4, as well as the various interview questions. An additional ‘guiding question’ was asked as a result of the key emergent theme of support and resources. Excerpts from interview transcripts are coded by group and student. For example, the code 2S2 refers to the Mathematics Talent Programme Student 2, the code S4 refers to students in the focus group of the Bicultural Studies Programme.

BACKGROUND OF CASE STUDY SCHOOL, STUDENT GROUPS AND PROJECT WORK PROGRAMMES

As described in Chapter 2, the Singapore school system has a diversity of schools to cater to the learning abilities and dispositions of students (MOE, 2005). The variety of schools and their corresponding programmes cater to students from a range of

abilities, from the more vocationally-inclined to the academically talented. Among the range of schools in the system are the independent schools. These schools, which were established in 1988, were accorded with full autonomy and flexibility to develop curricula and programmes to cater to their profile of students, most of whom would be categorised as high ability learners (Yip, Eng, & Yap, 1997). The main intent of such schools was to generate innovations and best practices to introduce to other schools where applicable (Tan, 1998). The case study school where the current research was conducted is one such school. It offers a six-year Integrated Programme (IP) curriculum that focusses on academic excellence and rigour (MOE, 2005). This Integrated Programme offers a seamless programme where secondary students can proceed to pre-university without taking the GCE 'O' Level Examinations (MOE, 2004).

Students who enrol in the case study school after primary school are among the more academically-able and rank among the top 5% of their cohort. During their initial two years in Secondary 1 and 2, the students undergo a broad curriculum that includes subjects such as both the English and Chinese languages at first language levels, Mathematics, Lower Secondary Science, Social Studies and another Humanities subject. In addition, all students are also required to engage in project work in groups, albeit the projects may be more general in nature as compared to those conducted by their seniors, who would be engaged in more research-based projects. Nevertheless, with the help and guidance from their respective teacher mentors, students in the lower secondary levels would be guided and eased into the rigours of project work.

As the students progress to Secondary 3 and 4 (Grades 9 and 10), the focus of the curriculum in the case study school categorically according to the students' differing interests, aptitudes and attitudes. A range of talent-based and passion-driven programmes offers students, especially the more able, the opportunity to delve in-depth into areas in which they have a particular interest. The thrust of these programmes is to nurture and develop the interest and passion of these students, and extend opportunities for research, as well as attachments to external institutions of higher learning or research, or the industries. Additionally, students also have a range of opportunities to participate in overseas experiences such as exchanges, conferences and competitions. The expectations for students who are selected for these programmes are also pitched at a higher level than those in the mainstream Integrated Programme in the school. These expectations are:

- Students in these programmes will be responsible and accountable for their own learning.
- They should desire and are able to define their own learning goals and evaluate their progress and achievements.
- They will learn how to build knowledge collaboratively and solve real world problems creatively.
- They will develop a lifelong passion for learning.

To qualify to be selected for any of the special programmes, the students would have attained an A grade for all their subjects at their Secondary 2 overall examinations.

As mentioned, for the case study school, project work is essential for students in the first five years of study. At the secondary levels up to Secondary 4 (Grade 10), project work is compulsory for students as a key feature of the Integrated Programme. This provides the necessary foundation for the students when they conduct project work in Grade 11, as required by the MOE. The grades that they obtain in Grade 11 are computed into their entry requirement to the local universities. For those students who are in the special programmes in the case study school, the project work is research-based. The following provides further details regarding the educational backgrounds of students in the special programmes.

The Science and Math Talent Programme

Two groups of six student participants were in the Science and Math Talent Programme (SMTP). Beyond the common curriculum that all students go through in their first two years in the school, these students, like their peers, had also undertaken to do project work and were introduced to the basics of research and project work then. When they were in Secondary 3, these students opted for the SMTP. To qualify and be selected for the SMTP, academically, over and above the 'A' grade (70% for their overall assessments for the subject at Secondary 2) that these students achieved for all the subjects that they took in Secondary 2, they also attained an 'A1' grade for their Mathematics and Lower Secondary Science. In addition, they all attained an 'A1' grade for their English Language and Literature in English. The A1 grade denotes those who had achieved at least an 80% for their overall assessments for the subject. As these students are required to read and research publications and articles in their respective courses, and also to draft research papers, the school deemed it necessary that those on the programme should also possess a strong command of the English language, hence the criteria for A1 grades for the English Language and Literature in English subjects. The overall assessment comprises the termly continual assessments, the end-of-year summative examination as well as their project work (High School Assessment Criteria, HCI, n.d.). For their project work, these students either opted to do a Science-based (High School Science Programme, HCI, n.d.) or Math-based project (High School Math Programme, HCI, n.d.).

For the Science programme, the students were provided with an enriched Science curriculum that was enhanced in breadth and depth across the three general Science disciplines of Physics, Chemistry and Biology. These modules are thematic and integrate knowledge from the three Sciences as well as Mathematics (High School Science Programme, HCI, n.d.).

The academic module in the programme provides the foundation for the students while the research module nurtures and develops their passion in their areas of

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interest and allows for greater creativity and innovation. This research module thus allows the students to explore opportunities for authentic learning, and equips them with skills necessary to conduct a research project and write a research paper.

At the start of the programme at Secondary 3, students were introduced to a semester-long basic Science-based or Math-based research module. The structure of the research modules, whether the students were in the Math or Science strain, introduced research methodology in areas such as,

- Crafting research idea and questions;
- Researching on current trends and feasible areas of research;
- Planning experimental design;
- Analyzing and presenting data;
- Project presentation;
- Writing a Science-based or Math-based research paper (Har, 2013, p. 215).

In addition, students had the opportunity to engage and interact with researchers and practitioners who shared with them their research experience.

Beyond the enhanced Science and Math curricula at Secondary 3 and 4, the students in the SMTP are also required to take up a core Humanities subject and an Integrated Humanities elective. In addition, both the English and Chinese languages are taught at First Language levels. Students are also required to read a subject called China Studies in Chinese. This is a unique Social Science subject that focuses on the following:

- History of China (From ancient to Qing Dynasty and post revolution)
- Geography, population studies and education of China
- Chinese philosophy (Confucian, Taoism and Buddhism)
- Contemporary Chinese society and culture (including effects of globalization, internet and pop culture)
- Political structure of China (including discussions about Special Administrative Regions)
- Evolution of the Chinese economy and its effect (from communism to free market; Special Economic Zones)
- Chinese foreign policy (historic and current)

The students who participated in the study were all involved in either their Math or Science-based research projects during their Secondary 3 and 4 years though they did not work together but with the other course mates.

The Humanities Talent Programme

The Humanities Talent Programme (HTP) is designed to challenge and develop students who have a flair for the Arts: Philosophy, History, Geography, Literature, etc. As such, beyond attaining 'A' grades across all their subjects in their Secondary 2 overall assessment, these student participants who were in the HTP would have

attained A1 grades for both their English Language and Literature in English (High School Assessment Criteria, HCI, n.d.). The HTP prepared and exposed the student participants to a variety of real world human issues, and instilled in them the skills to understand, analyse and dissect social issues that are varied and always in flux. These student participants were taught to have clear logic and well-honed skills in communicating that logic. The research projects that students in this programme did addressed social concerns, challenges and issues. Like their peers in the Science and Math Talent Programme, these students would have attended workshop sessions to prepare them to conduct such research. Usually qualitative in nature, these workshops trained the student participants in areas such as,

- Crafting research idea and questions;
- Researching on current trends and feasible areas of research;
- Planning research design;
- Analysing and presenting data;
- Project presentation;
- Writing a humanities research paper (High School Humanities Programme, HCI, n.d.).

The student participants were also provided opportunities to engage and interact with leaders in the community especially those whose roles included formulating social policies. With such exposures the programme trained the students to analyse and derive insights into realities that have no physical form, and to express and articulate their thoughts in terms that reach out to everyone. While the programme veered quite heavily to the humanities, all students in the HTP would also have taken the two core Science subjects at Secondary 3 and 4 that included Physics and Chemistry. In addition, like their counterparts in the SMTP, students in the HTP would have also taken China Studies in Chinese.

The students who had participated in this study had completed their research papers in their Secondary 4 year although they had worked in different groups.

The Bicultural Studies Programme

The case study school is among the pioneering schools to offer the Bicultural Studies (China) Programme. Its Bicultural Studies Programme course seeks to allow students to appreciate Chinese cultural inheritance, learn about China, as well as understand contemporary Chinese development. The programme aptly aligns with the school's aim to nurture bilingual leaders to serve the nation. This bi-cultural competence is a hallmark of the students in the school, where every student reads English and Mandarin at first language level while the medium of instruction in the school is English. The Bicultural Studies Programme (BSP) thus builds on this tradition. With the emphasis on China and requiring ample reading and research done in the Chinese language, students in the BSP had to attain an A1 grade in the Chinese Language over and above excellent grades across all their subjects at Secondary 2. As with all

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non-SMTP students, those in the BSP also had to have taken Physics and Chemistry as their core Science subjects as well as two Humanities subjects, a core and an elective at Secondary 3 and 4. However, due to the nature of the BSP, the China Studies that they undertook were more demanding with regard to depth and scope as compared to their counterparts in the other special programmes (High School Assessment Criteria, HCI, n.d.).

As part of the BSP, the student participants attended lessons not only in Singapore at the case study school but also in the school's Beijing 'satellite campus' (BSC) in China for a sustained period of time. In addition, these students had also been engaged in sustained immersions in other parts of China, including Shanghai, Hainan, Yunnan and beyond. As part of the course, students read China Studies in Chinese (CSC), and spent another six weeks immersed in the Chinese culture at the BSC (Yeo, 2013, pp. 9–19). The curriculum for the programme included topics such as,

- Modern History of China;
- Introduction to eastern and western philosophies;
- Political, economic, social and educational issues of contemporary China;
- Case studies of eastern and western cultures (Bicultural Studies Programme, HCI, n.d.)

Each BSP student was required to write a research paper where the research topics were related to his experience in China immersion. The research papers were evaluated and presented at a conference.

While most of the students in this programme did a research project related to their course of study, two of them decided to embark on a service learning project instead as part of their community outreach initiative.

The Language Elective Programme

The Language Elective Programme (LEP) sought to nurture students with the aptitude and attitude for Chinese Language and Chinese Literature. The programme enhanced these student participants' understanding and appreciation for Chinese literature for character development and knowledge. The curriculum for the programme introduced the student participants to the following areas:

- Introduction to the history of Chinese language and literature;
- History of China;
- Pre-Qin Poetry and Poetry of the Tang and Song Dynasties;
- Schools of Thought;
- Ancient style prose;
- Modern Chinese literature;
- Film Studies;
- Creative Writing;

- China Studies;
- Study of classical and modern Chinese Literature and Chinese Language.

Additionally, the student participants were required to embark on research projects in Chinese literary works. (Language Elective Programme, HCI, n.d.)

Similar to the students in the Bicultural Studies Programme, with the emphasis on Chinese language and Chinese Literature, students in the LEP had to attain an A1 grade in the Chinese Language in addition to the A grades across all their subjects at Secondary 2. They had also taken Physics and Chemistry as their core Science subjects as well as two Humanities subjects, a core and an elective at Secondary 3 and 4. However, one of their Humanities options was Chinese Literature while China Studies in Chinese was included in their subject combination (High School Assessment Criteria, HCI, n.d.).

With their interest in Chinese literature, the students who were involved in this study did projects related to their course of study both at Secondary 3 and 4 albeit in their different groups. One student in did a project at Secondary 4 where he compared Japanese and Chinese literary works.

CASE STUDY FINDINGS

Guiding Question 1: What were the students' intentions prior to the implementation and their participation in authentic and experiential learning, particularly that of the infusion and incorporation of research-based project work approach to their curriculum? What reasons did they give for their intentions?

Q1.1: What do you understand by the term research-based project work, or project work?

Project Work as a Process and Practical Application of Studies

The case study students had the shared understanding that research-based project work (referred to here as project work) is primarily a process used to achieve results. The results were described both as the 'end-product', which is usually presented in the form of a hypobook, and as a method for collecting information from various sources and then analysing results. The students strongly agreed that it was significant that the results were obtained from their own experiments as well as from the methods they used. Emphasis was placed on investigating diverse sources and kinds of information, evaluating results, drawing conclusions and generating new knowledge. Most importantly for these students, project work "promotes a better understanding of procedures and results" (1S6). All students valued the importance of their own role in the research process, emphasising that project work required them to conduct research themselves, that results were gained from their own experiments, and that they consequently developed their own hypotheses. This made

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project work both meaningful and worthwhile. The stages, or components, of the process were described variously as follows:

The research is looking at different sources. I can collect information from various mediums. (1S2)

One has to conduct and analyse the results to prepare for the future where actual research needs to be done. (1S6)

You learn basic concepts and do research to integrate them to come up with new knowledge. (2S6)

I was using existing information to do investigation into something that is not very well studied and obtained information from it. (2S1)

It is based on past research. We have to find something that is new from what we have gathered. We need to draw conclusions from this information. (4S4)

Sources of information utilised in the research process were seen to relate closely to practical applications of the students' studies. For example, a media studies research project for some students in the Humanities Talent Programme used films and film scripts as data to explore the idea of film theory and also the practical skills of making a short film. Another group of students in the Humanities Talent Programme used an integrated online concordance application to analyse political/media discourse. In their analysis, these students discussed the three overarching frameworks of critical discourse analysis, corpus linguistics and conceptual metaphor theory.

Another example of practical application of studies is a Language Elective Programme project on Chinese language usage, which drew on literature about Japanese writing as the major source of data, and engaged students in analyzing writing style of Japanese literature and its similarity with classic Chinese literature.

Two groups of students in the Science Talent Programme similarly researched areas that they were interested to pursue in their project work. The first group based their project experiment on a project that they had conducted the previous year. In the earlier project, the students proved that activated carbon managed to adsorb up to 94% of heavy metals. The group decided to continue with the project to further improve and test the effectiveness of the activated carbon in the adsorption of heavy metals. These students were motivated to pursue this project based on their awareness of the challenges faced by government agencies and non-governmental organisations (NGOs) to provide clean drinking water in rural areas through inexpensive yet effective and efficient approaches that are considered to be sustainable.

The second group of students in the Science Talent Programme initiated their project based on their studies of increasing cases of dengue-related problems not only in Singapore but also in the region. They discovered that the current methods of applying insecticides by the authorised government agency were toxic to the environment and affected the local biodiversity. The students examined methods

adopted by the National Environmental Agency (NEA) that had an adverse effect on the development of non-target insects and decreased the diversity of the local insect genera. The group was keen to find more environmentally-friendly, affordable and effective alternatives to control the population of the *Aedes* mosquitoes, the vector for the dengue virus.

Q1.2: What do you think were the reasons for the implementation of research-based project work, or project work, in this school?

Independent Learning and Developing Own Point of View

The students proposed a number of reasons why project work was implemented in the school. The overarching reason was to encourage independent learning in order to prepare the students for the future, including further studies, the workforce and other ‘real-life’ situations. The students generally understood independent learning to be a learning process that is initiated, planned and executed by the student to reach his own goals. The skills developed in this process were generally described as lifelong skills. Doing an entire project on one’s own was seen to foster independent learning. In this regard, one student explained how both the information gathered and the research process depend on the student’s own initiative to “fend for himself instead of being spoon-fed by his teacher” (3S6).

The school’s perceived aim of encouraging independent learning involved a number of related aspects. Several students described project work as providing an opportunity or chance to learn to be more independent. They compared their research projects with learning approaches and activities in their other classes, where the teacher provided notes, textbooks and other materials. They explained how, in the project work activities, they searched for a variety of sources and information themselves, which required initiative and a different mindset. They also believed that project work was implemented in order to help them synthesize this information in order to develop their own ideas and hypothesis, and to develop arguments to support their theories. Gaining experience in effective presentations of the research and findings was a further reason for implementing project work in the school. Citing these aspects of project work, a student in the Humanities Talent Programme stated, “so that is why I feel that doing a project will make us more independent and more resourceful as well” (3S4).

Motivation and Freedom to Learn

The case study students generally agreed that project work was implemented so as to allow students to investigate their own areas of interest, which in turn motivated them to learn.

I believe it is self-stimulation. There is no teacher or parents to supervise. You are propelled to learn by yourself. (2S6)

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It promotes the desire to obtain new knowledge. (2S2)

A Language Elective Programme student explained the link between motivation and the joy of learning at length:

I think the key intent apart from preparing us for our future life and training our independence if you would have it, is in my opinion, to help us find the joy in learning because we get to do something or learn something that we like or enjoy doing. Something out of the syllabus, and that we are not necessarily constrained by what our teachers teach us, although our interest would naturally derive from what we learn in class and what our teachers taught us, and we want to research further into it, but this freedom to be able to select which specific subject or which slant we wish to take, these kind of things in my opinion will help us find the essential draw in learning and do what we actually want to do in the first place. (3S5)

Freedom in conducting their project work was a recurrent theme for the majority of students. They felt that they had freedom to choose topics, follow up lead avenues of investigation, follow through on their own ideas, develop hypotheses and draw conclusions. As one student explained:

I think one of the most basic reasons why research-based project work is introduced in this school is to allow us the opportunity to research further into the different subjects or topics that we may be interested in but are not covered in our syllabus. So we have more freedom in learning in that sense.

Interestingly, freedom was facilitated in large part by learning a particular method of research. The majority of students mentioned that a major aim of their teachers was to teach them a method by which to conduct their research projects. According to one student, “there is a certain method which we have to use to develop the skill to obtain the information” (2S2). Project work was considered to provide a “wider horizon and scope to what is going on in other areas ... finding areas of interests and mastery over the area” (5S2).

Because students could investigate their own areas of interest, they could explore information of personal appeal and relevance. Students highlighted the value of choosing their own topics in developing their own point of view. This is indicated in the following comment by a student in the Humanities Talent Programme, who described his experience of project work in History:

For me personally for my own research paper this year, my HRP (Humanities Research Paper) was on History which was on Sino-Soviet split in which I was trying to find the US role in the Sino-Soviet relationship. Because it was not very conventional, so I have to look at new materials and resources or declassified documents in which you have to infer for yourself and look at the various policies that the US had taken and you compare one with another.

You come out with your own book and your own views. You synthesize what you have read and come out with your own views.

Resourcefulness

The students believed that, in developing their own points of view, project work also encouraged resourcefulness and helped “shape our minds” to become more objective. There was a general agreement among the students that they generally tended to be rather ‘subjective’ and ‘chaotic’ in doing school projects, before embarking on research-based project work. They believed that in doing project work they learned to think logically and in a more objective way. This was considered beneficial because “we have to solve problems in the future and this will make us more efficient” (4S2).

The importance of being directly engaged in research and taking a hands-on approach emerged as key theme in all focus group discussions. The following comment from a student in the Science and Math Talent Programme is typical of the common perspective in this regard:

... while the theory is important as it provides a basis for doing something, in a real life situation you will require hands-on skills to apply what you have learned. (1S4)

The hands-on approach was considered to allow the students ‘more freedom’ in conducting research and in generating new knowledge. They learned how to gather and arrange data systematically, which was considered by all students to be a very important skill. For one student, “finding out the answer for yourself” was a satisfying aspect of project work, and helped him develop a “passion for the research” (2S2). This student also appreciated the importance of learning how to write a research paper: “For me this is interesting as I have never written a research paper before”.

Preparing for the Future

As mentioned, all students felt that the major aim of project work is to prepare them for their future, in terms of their work life, higher studies and life in general. They strongly believed that whatever career path they choose, they will require lifelong research skills such as being selective and discerning when obtaining information, processing that information, taking responsibility for following through on projects to achieve their goals. Interacting with other people and working efficiently were also skills developed in project work that will be beneficial in later life. The following comments encapsulate some of these aspects:

Whatever we learn in school is preparing us for the future. We are developing the skills which place us in a better position in the work force. (4S4)

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We will be better adapted to the life outside of the school environment if we are exposed to this in the early stages of our learning process. (4S5)

It is a learning method which we can continue after we graduate. (4S3)

I have become a lifelong learner. (5S1)

Students Intentions When Embarking on Project Work

As mentioned in Chapters 2 and 4, project work has been incorporated in the curriculum of the case study school from the first year onwards in Secondary 1. While this is an academic requirement, many of the students, especially those in the special programmes, would take this opportunity to embark on projects in areas that they are especially interested in or have affinity. They were also keen to follow through on projects to achieve a meaningful and worthwhile outcome. A good example of this was the project cited earlier in this section, where the case study students in the Science and Mathematics Talent Programme continued a project from the previous year which involved exploring the properties of activated carbon in removing heavy metal and improving and testing the effectiveness of the activated carbon in removing heavy metal. The students' intention was to explore and test inexpensive yet effective and efficient approaches that are sustainable in providing cleaning drinking water in rural areas. One student explained their rationale for the follow-up project.

We were thinking that if we to have a prototype, we could check it out when we visit some of the Chinese villages when we go for our China immersion at the end of the year. (2S3)

The intention of the other Science and Mathematics Talent programme case study group was also to follow up on previous work that they found interesting and meaningful. To reiterate, this group worked on finding more environmentally-friendly, affordable and effective alternatives to control the population of the *Aedes* mosquitoes, the source of the dengue virus. The group's decision to embark on the latest stage of the research stemmed from the numerous media reports on the increased trend of dengue fever victims. The students hope to contribute potential solutions to this situation. A group member explained this intention as follows:

We discovered that the insecticide that the NEA used were not very environmentally-friendly, as such we thought of exploring alternatives to the current insecticides used that are environmentally-friendly. (3S5)

With the freedom to explore possible projects, students typically embarked on their projects due to their "passion and interest in specific areas" (4S3). The following comments sum up some of the students' interests and intentions when they embarked on their specific projects:

My friends and I had intended to find out how the speeches and rhetoric by the incumbent and opposition parties in the recent elections were similar or were they conflicting. (3S3)

With ‘multitasking’ being the buzz word, we wanted to find out the impact of multitasking among today’s teenagers. (3S1)

We intend to investigate the relationship between three types of parents and what impact does it have on their child’s academic progress, with the three types of parents being equalitarian, autocratic and passive parents. (4S2)

Guiding Question 2: What strategies did the students develop to manage and ‘deal with’ the research-based project work approach in their curriculum? What reasons did they give for utilizing those strategies?

Q2.1: How has research-based project work impacted your learning both within and outside of your class?

Development of Concepts and Learning Frameworks

The case study students cited that the most significant impact of project work for them was twofold: making sense of the concepts taught in class; and learning how to apply the theories taught in class. One student commented: “This will make you understand *why* you learn the concepts” (1S2). In gaining better understandings of concepts and, in many instances, going beyond the examples in their textbooks or those provided by their teachers, the students were better able to relate to their lessons by providing their own examples and experiences. They were therefore able to play a greater part in classroom interactions. A student in the Humanities Talent programme stated, “it has helped me to understand better what is taught and make me engage in class discussions and I can participate more actively and contribute in class discussions” (3S3). Many of the students reflected similar sentiments and agreed that when they could see how their project topics related with their classroom lessons, they were better able to engage during class time. Another Humanities student reflected on this situation as follows:

We can look at different angles through research, or look at past researches done and see how we can analyse and find new approaches or new information, and perhaps share these insights to the rest of the class. (3S5)

However, not all class work was considered to have direct implications to the students’ projects. Some students had undertaken research in areas that were not in their syllabus. In such cases, these students were largely motivated out of their keen personal interest in the subject matter. According to a student in the Bicultural Studies programme, “my group’s service learning project had nothing to do with any of our subjects. We did it because we believed in the cause” (4S2). There were

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also other situations where the students picked up skills that were not part of their syllabus, such as statistical applications to analyse their days, and employing the various statistical instruments to verify or validate their findings. In such situations the students learned these skills and concepts as part of their projects, rather than from their other class work.

Some students found that when projects engaged them in dealing with subject matter that was related to their curricula, they often went beyond the basic concepts and applications cited during lessons. As they worked on the ‘real’ application of their projects, they found that they were able to grasp their classroom lessons better and this helped to reinforce their understanding.

The case study students also expressed the shared view that due to their familiarity with the process of project work, their ‘inquiry mindset’ also impacted the way they learn outside the classroom. “Outside of the classroom, I agree that it helps me to be more passionate on wherever I decide to embark on” (3S1). Some students also explained how the skills that they picked up over the years doing projects seemed to transfer to the activities that they were involved in beyond the classroom. “I find that I’m using the same skills and ideas that I use in my project groups when I’m involved in projects and activities outside the classroom” (2S3). The majority of the students across all talent programmes believed that, as a result of project work, they were no longer confined to learning from their textbooks or the notes provided by their teachers. The following comment from a student the Language Elective programme is typical in this regard:

I have been a textbook learner before coming to this school. I have now learned to find information away from the text book...It has helped me to get a full picture of the study and related subjects. (5S1)

Students also cited that in determining the areas and topics for their project work, they often challenged themselves to seek answers beyond what is taught during lessons. In the course of doing their projects, they also started to ask critical questions. This curiosity spurred them to investigate further the concepts and theories that confronted them in their readings and research in the respective areas of their project and delve deeper into the subject matter. For example, one student commented, “I am keen in finding the reasons why, and the theories behind what I learned during Physics lessons” (2S3). The responses from the many students indicated that project work also provided them with a degree of flexibility to allow them to consider different aspects and applications. This encouraged them to go beyond what they had learned in class.

As project work allowed the students to see more relevance in their school work and lessons taught in the classroom, quite a few students started to develop new contexts of learning, and this helped them nurture a more Socratic approach to questioning what they were taught in class, and also how to go about researching for information. One student shared his view that engaging in project and research work enabled him to “learn something and directly apply it” and was also satisfied that

he had “learned how to conduct my own research rather than relying on someone else’s research to learn” (1S6). In so doing he was able to “form new knowledge and understanding”.

With a more critical mindset, students developed a more questioning disposition as they confronted new concepts and theories or even corrected ‘flawed’ assumptions: “If there were misconceptions due to misunderstandings in the past, you are able to find the solution to the problem instead of relying on someone else’s research” (1S6). Regardless of which special programme they were in, the vast majority of the students believed that they had developed a more critical approach in their learning process: “If there were doubts regarding research. You have to think critically and question what is taught. I am building my foundation of knowledge even further” (2S2). Several students felt that they had adopted a new or differing mindset towards learning, or become more critical thinkers, as in the following remark

I think it (the process of project work) actually improves my critical thinking during class because for example when you’re doing research, when you answer the research questions; there is no sure-fire way to answer one question. You can look at it from several perspectives, so in that sense it helps to train our critical thinking in tackling this sort of questions. (3S1)

As the students engaged in their project work, especially in areas or topics of their choosing, many of them were spurred on to continue with the difficult tasks fuelled by their interest in the subject matter. Often the process required them to persevere beyond the short-term requirements of normal class assignments and have them engage in the various tasks of completing their projects over several months, and for some groups, the duration could be even longer depending on the complexity of their research topics. Nevertheless, throughout the process, the case study students expressed determination to remain in their projects to see through the findings and outcomes.

Q2.2: What were some of the challenges that you faced?

Adapting to New Demands and Meeting Expectations

While the students cited the benefits of the research and project work experience in inculcating in them the passion for learning, they were also quick to relate the challenges that they faced. Foremost amongst these challenges was adapting to the unfamiliar demands and expectations of project work. When the case study students embarked on project work during their first year in the school, they had to deal with a very different version of project work than what they had become accustomed to in primary school. One student explained, “when we were in primary school, our teachers would tell us what sort of projects to do and helped us along” (1S4). As the students grasped the scope of the projects that they were expected to undertake in the case study school, they realised that their first challenge was to decide what project

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that they and their project group members wanted to do. According to a Science and Math student, “the project categories questions are difficult and in some cases we have no idea or interest in any of them” (2S3). In addition, the ‘freedom’ to choose their projects posed yet another issue for the students in coming to a decision on the project option. A Language Elective student stated that this in itself can be quite overwhelming: “it is very difficult to decide on a topic as there are too many to choose from in my project” (5S1).

The first two years of project work in the case study school were quite generic both in subject matter and form. By contrast, the project work that students embarked on in their third and fourth years in their respective special programmes required them to delve beyond their classroom knowledge. However, those difficulties encountered in the lower levels regarding choice of project topic continued to haunt them. One student aptly described the general problem that many of them encountered:

I had difficulties looking for a research question. You need to find a project that is feasible. It was an issue when you had to establish a topic. There were certain topics which posed special problems in getting information and resources. (2S6)

The demands and expectations for project work for the upper secondary students in the special programmes classes are higher: “The requirement for project work is different from basic research. It can be confusing and it’s definitely more difficult” (4S3). The challenges included more intensive research-based projects that required them to learn specific skillsets related to their research. Students often found themselves unfamiliar with the ‘right approach’ to doing research: “Due to our lack of knowledge we have to make a lot of changes along the way. It was difficult not to be confused by the information presented to us” (4S4). Those in the Science and Math Talent programme were required to use laboratory equipment that they were unfamiliar with. This in itself posed a challenge to the students. One student related his experience:

I had to deal with completely new procedures. I have never seen the equipment and do not know how to use them. When experimental errors were encountered we have to find certain ways to resolve this. (1S6)

Students also realised that they had to change their mindset and understand the difference between completing a class project, which for them was usually an academic exercise or class assignment, and embarking on a research project:

...there is a huge shift in perspective and mindset between academic learning and research-based project because when you do a research-based project, there is no one set format, or an answer scheme, or where you give key words and our teachers give us marks, or anything of that sort. At first it was quite uncomfortable because we have to actually think about what we have to write or do in the project instead of following the answer key or follow the notes... there is no guided answer scheme or answer keys to refer to. (3S6)

As the students developed the skills and disposition to engage in such research-based projects, they found relevance and meaning in the task. Most students explained that they had to learn to work ‘differently’ when doing research. For example, they needed to compare the ‘right and wrong’ ways to go about doing research, and “not take everything I read as being correct. This changes our thinking and learning becomes real” (1S5).

Even when the students diligently carried out their research work for their project, they had to deal with uncertainties and ambiguities. One student related his experience when he initially embarked on his project in Secondary 3. In this particular instance, the student was known to his teachers and friends as being a very diligent student, however, faced with doubts about the research process, the student failed to meet deadlines to submit his project on time. Even when the students were able to cope with the demands of the project, for some the initial excitement of embarking on something new and ‘interesting’ soon wore off, as reflected by a member of a Science-based project group: “We had to spend three long hours counting bacteria. This is very tiring. You must be really resilient to finish the project” (2S2).

Among the key challenges that many of the case study students encountered was handling the literature that they needed to read and review in order to locate their research and develop their projects. Depending on the research areas and topics, some students found difficulty sourcing for right resources. “I find that I have insufficient resources to fully develop my research” (4S5). Several students pointed out differences in how they were expected to do their literature review in their secondary school talent programme, as compared to when they were doing their projects at the lower levels. For example, they were now constantly reading up on new developments and updating their reports. This was especially so if their project entailed current issues or technology-based outcomes, as a Science student explained: “The presence of new research and trying to include these updates in our review is always tiring. Nevertheless we understand literature review is important” (2S6). A Bicultural Studies student described a very real problem facing students trying to access and understand large volumes of information:

I think another challenge is how to sift for relevant information because when we do research I always find this huge chunk of information and materials. So finding the main points of each research article and see whether it is relevant is very critical as it helps me cut down on the amount of readings that I have to read... So one of my main challenges that I faced is the ability to read very quickly and access if the article is relevant to my project. (3S4)

A common problem that plagued many of the students was managing their own project expectations and underestimating the time they had to focus on their projects amidst the demands of their curricula and co-curricular commitments: “I have a tendency to come up with grand plans. However, I have to learn how to make it manageable” (4S3). Working in groups required the group members to coordinate among themselves to work around each other’s schedules. With demands from their

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various commitments, both to school as well as family and personal considerations, students experienced difficulties meeting deadlines not only for their project obligations but also across their own school work and assignments.

Notwithstanding the various reasons cited, the main issue that the students faced was their inability to meet deadlines and their poor attempt at time management. A recount from a case study student exemplifies this issue as experienced by many of his peers:

I think time management was a huge challenge, because most of us or rather all of us did not have prior experience in doing a research paper. So we didn't know how much time we needed to invest in our project and research paper and how to manage our time. Because apart from the HRP (*Humanities Research Paper*) we would still need to do our normal curriculum, homework, and other stuff. So I think time was a main challenge when we did our HRP. However I think judging from my own experiences, after going through one year you kind of learn how to manage your time, going through the experience of HRP and managing my time, I've learned to better manage my time. (3S2)

The case study students related that another challenge that they faced was that of working in groups. As the students had the freedom to form their own project groups and select their group members, in the earlier years especially when groups were formed out of friendships and familiarity, the students realised that having group members who have differing styles of working did pose problems, as indicated in the comments below from a Science and Math Talent programme student and a Humanities Talent programme student:

While it was more difficult doing it alone, having teammates who you do not see eye-to-eye did made it just as difficult. And since we were also friends or classmates, it was very difficult to tell people off without offending them. (2S4)

I think many of us found initially that working in groups pose quite a few problems because when we were in primary schools, not many of us have worked together in groups on large-scale projects that go on for extended period of time. So some of us found out that the people who we chose to form our team or group were wrong choices, and we could not work together well. So these people may be good friends but may not be good project mates. (3S2)

Students also cited the problem that not every group member would put in the required amount of work, resulting in other members taking on the additional load. To overcome this problem, the rest of the group had to collaborate with each other to complete the task. This uneven workload became an issue, especially when differing grades were awarded to the various members of the group.

Another common problem that many of the groups encountered was that when they had members from different classes or programmes, they found that it was very difficult to arrange for actual face-to-face group meetings. An example cited by one student saw his group relying on an alternative platform to ‘meet’:

Our coding project required us to work closely but due to clashes in schedules and timetables, we had to resort to going online. The technical difficulties in coding made it difficult to work online. (1S3)

Students also commented that as they proceeded with the various stages of their projects, they tended to rely on their mentors as a resource to sound off their ideas: “my mentor was present to assist in choosing a topic when I was in Secondary 1” (2S5). In their senior years, the students would usually check back with their mentors to review the work that they had done: “after the first two years of project work, we thought we could get help from our mentor” (5S1). However in certain cases where the scope of the project had exceeded what they had learned in their lessons, some students found their mentors inadequate.

The mentor is not always useful. While they help clarify things, where the project is beyond their level, there is really no concrete support from the teacher. As such we have to focus on our own personal research, and with the help from the school, they will link us with an expert from the university or the industry. (2S6)

The roles of the teacher mentor will be discussed in detail at the latter part of this chapter.

Q2.3: How did you prepare yourself/selves to engage in your project work?

Adapting, Managing and Setting Realistic Expectations

As all the student participants in this study were in the latter stages of their fourth year in the case study school, they had experienced four years of doing projects, with the latter two years focusing more on research-based projects related to their specific special programmes. As such, many of them were able to cite how they had prepared themselves before they embarked on their projects, especially during their last two years. In general, the vast majority of students prepared themselves to deal with the challenges and demands cited in the previous section. They related how they dealt with the ‘new’ learning experience when they were introduced to the demands for project work when they first enrolled in the case study school in Secondary One. As they progressed through to their fourth year, the experience gained taught them practical ways to deal with the various challenges they encountered.

With at least four significant projects in their portfolio, the students generally learned to work around their various obligations and commitments. This entailed

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managing their time judiciously and setting realistic goals and expectations even as they embarked on very ambitious and challenging projects. During their senior years, many of these projects were at levels beyond their grade level. One case study student shared that, as he moved on from lower secondary to upper secondary level, he had to learn to manage his time and his many priorities and commitments. He stated, “Ultimately, it is a balance between studies and research. We have to source for appropriate equipment” (1S4). In order not to be sidetracked by the many distractions on the Internet when the students access online to do research, they also learned to discipline themselves as they proceeded to source for literature and resources online:

I think we also learn how to use the Internet more efficiently. Like when I was in primary school, I find myself playing Internet games rather than searching for information, so when I have to do my research these last few years, I had to discipline myself to just looking for relevant stuff from the Internet and not be distracted. (3S1)

While students understood the importance of working in groups or teams, the initial years when they first formed their teams for their project saw quite a number of issues and challenges ranging from problems with group dynamics to difficulties in arranging for common times to meet. When students formed groups, especially in the initial years, they tended to naturally towards their friends or those who they keep company with. They often realized later that this approach would leave the group lacking in certain skills essential to facilitating project work. A case study student appropriately described this issue:

I think we started off in Sec 1 and even in Sec 2 by forming groups among our friends. Instead we ought to be looking for the right people to form the project group. People who we know we can work very well and having the same interest and passion at the same time having different skills set to complement each other. (3S5)

However, as the students learned from these experiences and adapted to working in groups, quite a number of them learned how to select complementary group members to ensure successful outcomes, or at least, to prevent possible friction developing among group members.

Those who have been comfortable working on their own have also learned the merits of working in groups where they could rely on their team mates to complement on areas that they had problems with and thereby leveraging on each other’s strength. “I can discuss with my team mates when I am not able to solve problems on my own” (5S2).

Students also prepared for project work through developing skills in public speaking and presentation. The school on its part had organized programmes and workshops to introduce to students general project management skills. Among these sessions were presentation skills and public speaking. Coupled with ample

opportunities to practise the presentations of their projects, these students believed that they gained in confidence to speak and present their projects in front of an audience, be it in small group setting or on stage in front of a large audience at the various auditoria in the school. The following comment reflects the typical view:

I have developed my presentation skills over the years. In Sec 1, I wasn't confident in presentation but now I am more confident and I am able to present my research. I think I'm more confident to speak in public though I'm still nervous. (1S1)

Guiding Question 3: What was the significance that the students attached to their intentions, and their strategies, and what reasons did they give for this?

Q3.1: What would you say were the more significant changes that have taken place in your learning styles because of research-based project work?

Inquiry-Based Learning

The most significant change in learning style for almost all of the students was in the way they approached research. A key change that the students cited was that their learning styles became more inquiry-based as they sought to answer questions and investigate issues in order to find answers and come up with solutions. As the students attended courses and workshops that the school had arranged for them, they learned the various skills for conducting project work. They also picked up new vocabulary and competencies to help them understand the concepts and rationale for the procedures that they were taught. Aside from being introduced to a range of research protocols, the students were also exposed to different styles of presenting and writing their reports. One student stated, "for example, I also learned a certain format for research paper and how to organize it" (1S1). Across the various genres that they could locate their projects within, the students discovered differing approaches to presenting their findings. Beyond content and project skills, the students also learned about the theory and application of the principles of integrity and ethics when doing research.

Collaborative Learning

Beyond procedures, protocols, presentations and writing styles, the students also realised the value of empathy and the impact of working in teams to accomplish outcomes. This in turn influenced learning style, particularly in collaborative learning in groups. For example, one student shared this reflection:

I've learned to adopt a more caring, critical and interactive attitude in the process of doing the project. I also develop a strong support among my team members and learned how to relate with them. (3S1)

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Students saw the merits of forming groups with members comprising those with complementary strengths, though a number of them did raise the issue that having team mates with different attributes also meant that they would approach the findings from differing points of view, which could potentially be a problem if their initial group dynamics were not addressed.

Critical Thinking

An issue related to learning style that the majority of the students brought up was that the ‘training’ that they had received from doing project work helped them to be more critical and independent in sourcing the information they require: “I do not blindly follow what is put forth by the teacher. I find that I have developed a way of analysing certain ideas” (3S5). With the need to track information beyond the traditional sources, students found it both useful and ‘liberating’ to be able to access online resources for their research. As the students became more discerning with the information that they sourced, they found that they started to form opinions and interpretations based on what they had read and reflected, with the result that “I tend to be more critical of what I read and form my own views on things” (5S2).

The students typically found that they were not satisfied just with information that they could simply attain from the usual sources. Quite a few of the case study students shared that they learned to think critically and did not accept the information that they received from their teachers or from the text books at face value. The students discovered that they learned to critically assess the information and also “how to ask why this is so” (2S1). When it came to finding solutions, many of them expressed that they were keen to look for solutions for themselves, and this characteristic they added, also extended outside of the project work into the curriculum. They found themselves questioning the information that they had picked up from their usual sources and developed ‘new’ reasons or rationale for situations or phenomena that they came across: “You learn to think critically and to ask more questions... you develop an interest to research and as such your learning style has evolved” (2S2). They would then express these thoughts with their teacher mentors and raise ‘new’ questions or issues to gain further perspectives and opinions to formulate or develop their book or argument. These discussion sessions with their mentors or peers helped them gather additional information to interpret and frame their arguments and develop perspectives beyond their initial viewpoints to form a more complete understanding of the topic at hand. A student shared his perspective on his research experience:

I can say that had it not been for the research project, I would just read the text book and that’s all! But if I’m interested in an area or topic today, I would start off by going on to Google and search for materials or articles on the specific topic. For example, for my HRP (*Humanities research paper*) I was looking at

a unique situation of Sino-Soviet relationship in the context of the Cold War where both were Communist allies. I was thinking that what if the USA had manipulated both sides. So yes, this has made me more independent to look for answers to these questions. In the past, I would have just said that this is an interesting topic; I'll dwell on it for a while and just move on. (3S3)

The students found themselves relying less on information that they had initially received and instead preferring well-reasoned arguments and developing new knowledge that they were confident to share and defend: "We are allowed to disagree during discussions and allowed to argue from our point of view" (3S6). As they shared their findings, the students also realised that they were also more opened to accepting alternative viewpoints that challenged their own.

As the case study students engaged in activities that spurred their interest and were allowed to form their own arguments and theses, they found themselves being motivated to pursue their opinions in order to verify their viewpoint. The students found this "keenness to prove a point or share an idea or a hypothesis" in itself very rousing and motivating. As one student put it, "it is more motivating if I research it on my own. When we have the drive, we gain more knowledge" (4S3). The intrinsic motivation of such experience coupled with the opportunity to engage in meaningful discussions in the areas that they were interested in provided a learning experience that was appealing and engaging. This fulfilling experience generally encouraged the students to continue learning beyond just satisfying the assessment rubrics and getting the grades, and cultivated a genuine curiosity for learning. The 'addictive' nature of the experience that they underwent was often evident in the passion that they displayed when they present their projects:

I can say that when I do the project with my friends I actually enjoy looking for answers and finding new things. This gives me more confidence when I share with my other friends and when I present our project during the judging stages. (3S2)

Independent Learning

Ultimately, the students related that much of their learning was out of sheer interest, and where there was a need for sustained effort, it was their passion and love for the subject matter that drove them to be independent learners. A case study student reflected this point:

Project work is fun and interesting. It is very much like learning while having fun. It also trained me to be more independent and not to depend too much on the notes from my teachers. (5S1)

Other students gave credit to how their engagement in project work had energised them to conduct and continue with research:

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Research-based project work is an outstanding programme. It is different in our school. It promotes independence. This enforces what we have learned and allowed us to practice our own ways. We develop a learning skill which is 'learning to learning'. We practise this in our school work. (5S2)

As mentioned in the earlier section, the case study students have mostly affirmed that engaging in project work taught them the merits of sourcing for the information that they needed for their projects beyond their text books. This fostered independent learning: "I am more open to getting my information from other sources when I retrieve my knowledge such as publications and journals" (3S4). The nature of the students' research areas also required them to source for information from specialised databases and journals. These generally informed their literature review and helped them to either hone their research questions or locate their research topics within the available corpus of knowledge in the specific areas. "I tend to read quite a bit about topics that I intend to do my research and based on what information I read, I will decide how I can conduct my project" (3S6).

Aside from the traditional published medium, the case study students also cited that they had explored other media to source for information: "We are learning from multiple sources, from online resources to books and articles. In this respect, different media provided different forms of knowledge" (3S2). Throughout their project work experience, the students related that they have read beyond what is being taught in class. This broadened their perspective on the subject matter of their project and enhanced their learning: "The students become independent and responsible for their own learning. There is freedom to explore outside the curriculum" (3S2). Another case study student similarly expressed that "I have become more independent and the skills of learning are important for my life time" (5S1).

Q3.2 How has your learning changed because of your involvement in research-based project work?

Self-Motivation

The case study students believed that the experience of engaging in research and project work had impacted their learning through fostering self-motivation to gain new knowledge and skills beyond what is necessary for exams. Quite a few compared the project-based curriculum that they had done during their last four years with their peers who were studying in other schools that do not place as much emphasis on project work, let alone research work. The following comments, from two different students, reflect the common views on this issue:

When I look back at what I have done the last four years and also what my other friends in other schools have gone through, I can say that had I attended the other schools, I think I will only care about my exams results. (1S3)

I see that my friends in the other schools would just do a normal project that their teachers wanted them to do and after that, they will focus on their exams. And because the focus for his schools was on the exam results, there isn't much effort put into doing the project. (3S4)

However, with the case study school placing just as much emphasis on project work and in particular research work in the latter years, the students related that while they were able to engage in project areas that interest them, they were also aware of the grading rubrics and were attuned with the assessment demands.

Experiential Learning and 'Going Beyond'

The students reflected that while they understood the demands placed on academic performance and results, they were also appreciative that the school had placed emphasis on experiential learning as well and allowed them to explore various subject areas that they had interest in rather than always dictating what students should learn. The students generally held the shared view that their learning has changed because of their experiences and the consequential increased competence to do research in areas that they are interested in. They have learned to independently go online outside of class time to research in-depth on topics that they are studying. In class, instead of just reading the text books or the notes that they write, or just listening to what teachers say in class, they now also go and research for more information a natural part of their learning process.

Several students agreed that it was quite difficult to come to a compromise among group members on the topic for the project that they were to embark on. However, they also expressed that, in hindsight, the process of in which areas to locate their projects, and thereafter proceed with their research, taught them valuable lessons and life skills. One student shared his personal account on the thought processes that led to his team deciding on the topic for their project:

Because of this research-based project, we can pursue things that we were interest, for example for my Humanities research last year which was about the political literature in Singapore, as my team mates and I were quite interested in the political scene in Singapore, one of the angle that we decided to approach was to read up on political literature in Singapore specifically on the opposition parties and what were their strategies during elections. So if it was not for my research paper, I would have just left this interest to a holiday project. (3S5)

Students also related that when they and their group members worked on their pet topics, often the materials that they gathered exceeded the expectations and scope of their initial plans for their projects. This gave them "a better understanding on the subject matter" (2S5).

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This ‘going beyond’ enabled the students to learn much more about the subject matter. Spurred on by their interest, the majority of the students mentioned that they were motivated not only to gather information for their respective projects, but they found that they were also keen to share their findings with their friends and peers instead of just learning for the sake of preparing for the exams. As they shared their experiences with their peers they often found that other students with similar interests would also gravitate together and share their findings and opinions as well:

I want to know more as I am not satisfied with the teacher’s presentation or answers or explanations. So as I shared what I found in my research, I also gather information from friends who are also interested in the same area. (1S3)

As a result, this symbiotic process of attracting and sharing among like-minded people tended to energise them to “contribute to your passion for the subject...and work harder to obtain answers in your quest for knowledge” (2S4).

Guiding Question 4: What outcomes did the students achieve as a result of their actions, and what reasons did they give for this?

Q4.1 How do you think you have benefited from being engaged in research-based project work?

Understanding Concepts and Relating to Real-Life Examples

The case study students reflected that among the initial benefits that they had gotten from engaging in project work was an understanding of how the various concepts and theories that they had learned in class could be applied in real-life. The students related that they did not have to rely on their teachers or any graphics representations in books, or computer simulation and animations to illustrate applications of abstract ideas. Instead, where possible, they were able to re-enact experiments to test concepts or theories, or they were able to conduct research interviews and surveys to test and affirm or dispel assumptions that they read in their text books and journals: “It’s very hands-on, and this provided more meaning to learning. You learn the steps and procedures to conduct research to test theories and assumptions” (1S4). As they worked on their projects, in many of the cases which were linked to lessons that they were taught in class, students made sense of these lessons and this helped them to internalise their learning. This in turn fostered lifelong learning: “I have to link what I have learned in class to my project. In that way I am able to retain knowledge for life” (1S2).

One student stated that in addition to helping him to make sense of the concepts taught by his teachers, project work helped him pick up problem-solving skills with his group mates. He felt that these skills were perhaps more significant to him than just understanding the concepts of the particular lesson:

When you engaged in project work with real world problems it gives you a wider scope for problem-solving. You need to understand to help people to solve problems. I think the experience is more authentic. (1S2)

Quite a number of the students mentioned that the applied approach of the project work reinforced theories and concepts that they read in their textbooks. One of the case study students shared his particular experience: “When we learned about enzymes in our biology lessons, and conduct experiments in our research, it helps me see the actual process described in my teacher’s notes” (2S4). Other students also felt that conducting the various Science experiments as part of their project also expanded the limited examples that they find in their textbooks: “The details that we have in our textbooks were quite limited. However, when I researched on the topic for my project, I find more information related to the historical background of the event. That provided a clearer understanding for me” (1S1). This is also true for students who did projects that required them to conduct Science-based experiments to validate their hypotheses. However this was not always the case with groups that did projects that were more Humanities-oriented in nature, or those who did service-learning projects. Students who were involved in Humanities-based projects often cited the project process as one the key take-aways for them or that having done a social studies project helped them to understand social concepts better. As for those who did a service-learning project, the majority of them found it fulfilling just knowing that their efforts had benefitted their intended beneficiaries: “seeing the primary school kids enjoying themselves and aiming for higher goals was very meaningful and gratifying to me” (4S2).

Thinking Independently and Forming Own Perspective

The vast majority of the students agreed that engaging in project work and conducting research trained them ‘to start’ thinking more independently and to form their own opinions and ideas about specific subject matters. As the students sourced for more information on their projects, they were confronted with numerous viewpoints and differing perspectives. This compelled them to form their impressions objectively based on the information and materials that they had gathered, and more importantly, taught them to defend the standpoints, as described by a case study student who related his experience when he did his humanities project:

In my project work we had to find the truth about Kuo Min Tang and about its role in the history of Taiwan. I had to analyse the myths and misconceptions. I have to develop my own views from the various sources. Some of these articles are quite bias. (3S3)

The perspectives and opinions that students formed during project work were open to challenges from their peers when they presented their projects at the various

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judging stages. Often the students found that they had to accommodate differing views and perspectives. Thus they learned to compromise and accept and synthesize their own ideas from the various articles that they found on the topic. This was considered a major benefit of the programmes.

Ownership of the project and the learning process was a further benefit. As the students determined the subject matter for the project that they wished to undertake, they learned to be more proactive in their learning and to take the initiative to plan and implement their research work with more interest and passion. Many of the case study students found that, as they proceeded with their research, they would usually go beyond what they learned during lessons, and also gather alternative viewpoints from various other sources. This was especially so as the students delved into their topic of interest and found them spending most of their time focussing on their projects, which fed their interest further: "It has helped me to find the passion in learning" (1S5). Another case study student also reflected on how he felt about taking charge of their own learning:

Project work teaches me to be more independent. I want to take the initiative to go the extra mile for learning. It provides a stronger foundation than learning from the syllabus alone. The pure memorizing of facts is not effective in the learning process. We know the facts are related to other topics. In this respect, we learn how it can be applied and how they are derived. (1S6)

Confidence

Apart from the initial year when students had to adapt to the demands of project work, as the students progressed through to their fourth year, they became quite confident with doing projects. There was strong agreement among participants that incremental training that the school provided within the curriculum had equipped them to handle project work as part of their curriculum.

I find in my exposure to project work and doing research, we started with learning simple procedures. We build from this foundation and learned more advanced research procedures in Sec. 3 and 4. This I think promotes independent learning because it brought us to go beyond the syllabus. I think that this is a clear indication of learning. (1S6)

Through the years, the students learned beyond the requirements of their curriculum as they proceeded to research more in their areas of interest. Not only did they add to their content knowledge, they were also quite ready to critique the information that they had acquired. As Socratic reasoning was an essential part of their training, the students formulated and strategized their questions to address their hypotheses, "As part of our training in conducting research, we learned not to accept information at face value. We are more inquisitive and we ask more questions to find

the solution” (3S4). This gave the students’ projects more depth and taught them to defend their perspective and viewpoint.

The students also related that they had to learn to work in groups. Though the students thought that this task sounded easy at first, they soon realised that while they learned in the early years to select and form teams based on the complementary strengths of each team member, these differing strengths, while an asset to providing divergent viewpoints during discussion sessions, also contributed to the tension and directly impacted the group dynamics. As such, the students related that in doing projects they learned to work as a team, to communicate and take account of various viewpoints: “we learned how to work in a group where each member is strong in his area. It trains us to communicate with our team mates and to accommodate differences” (3S6). Collaborative learning and working in groups was this considered to be significant benefit of project work.

One of the criteria in the assessment rubric for project work requires students to present their projects and defend it before a judging panel and their peers. This ‘dreaded’ presentation stage, while quite unnerving to many students, provided them with the essential platform to hone their presentation skills and build confidence not only to present, but also to persuade and convince others. Many of the case study students mentioned that training in this respect was provided at different stages for each year’s event over and beyond the initial workshop that they attended in their first year;

I was never good at speaking in front of an audience...every member of the group has to present a part of the project and to answer questions posed by teachers and students, I learned how to deal with the stress. Actually, I think I am quite confident now after presenting projects for four years. I guess this is an important skill to have. (4S2)

Beyond communicating the group expectations and commitment with regard to their project, students also cited that one of the key benefits that they had derived from their project work experience was how to manage their time in relation to their projects and their other commitments and obligations such as homework, assignments, co-curricular activities and personal responsibilities. Ultimately, all the students interviewed related that this learning experience puts them in good stead as they advanced in their education journey where the skills and disposition that they picked up prepare them for the demands in later years and beyond. The students were quick to realize that the skills required to conduct research for their project were just as relevant beyond their academic careers.

These four years has prepared me for college. It cultivates interest and this motivates us to be more involved in what we like to do. I am very sure that these same skills and knowledge will be similar to what I would need even after I graduate. (3S5)

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Q4.2: Do you think being engaged in research-based project work value-added to your learning style or attitude? If so, how? If not, why do you think that was so?

Learning Becomes More Informed and Involved

Project work value-added to learning in various ways, integrating many of the benefits described above. Having gone through four years of the project work, all the students interviewed expressed that the experience had exposed them to a learning experience that took them beyond their textbooks to areas that they had interest in or have developed curiosity in and helped them develop interest as well, “I am encouraged to do more research on various other topics that I’ve interest in. This changes the attitude of learning from a chore to a hobby. Something that I really enjoyed” (3S4).

Many students commented that, in preparing them to handle the demands of engaging in research work, the school also taught the students valuable skills such as Socratic reasoning and developed their confidence to undertake challenging projects that excite their imagination and sparked their minds to seek for answers. One student reflected as follows:

It trains our independence in learning. You know how to question what is told to you. You ask why things are the way they are. You develop the curiosity to have a deeper understanding of issues. This will definitely help me in future to develop a more in-depth approach to solving problems. (2S3)

As the students proceeded to look for answers, the experience also taught them to be critical of information, and learn to sieve for relevant and appropriate materials. And after analyzing the information, they would form opinions and confidently argue the hypotheses that they had generated, “I understand them I am able to present these information confidently” (3S5). These attributes they believed not only value-add to their learning disposition but also equipped them with the necessary skills and attitudes that would put them in good stead in the next stage of their academic journey and also into their professional career in later years. Several other case study students also provided their opinions of how the project work experience had value-added to their learning, for example: “You learn how to work smart...and learn to think out of the box” (2S2).

Guiding Question 5: What is the impact of support and resources provided?

Q5.1: What is the impact and influence of your teacher-mentors?

A Teacher, a Guide, a Mentor and a Resource

While the school emphasised the intention to groom students as independent and self-directed learners, nevertheless much of the support and guidance provided by

the teachers, especially during the first two years, helped to ease the students into carrying out project work. In the later stages these teachers acted as mentors to guide and even role-model for their students. On their part, the students looked upon their teacher mentors as a valuable resource when they conducted their project work. Many of the case study students related the varying guiding roles that their mentors play across their project experiences over the four years.

While the school has organised workshops and courses to introduce to the students the procedures and demands of project work, students often relied on their mentors to guide them along the course of their project experience, especially in the first year in the school. This fosters confidence and promotes interest: “Our teacher mentors give us advice and encourage us. This helps us to gain interest in the research” (4S3).

Even when the research element was quite general and not as demanding, students in Secondary 1 still found the experience very challenging and overwhelming, “we found it very difficult back then when we were in Sec 1, when we started to do project work for the first time” (4S1). In their earlier years, especially in secondary one, the mentors helped to scope the projects for their mentees and facilitated in setting realistic goals and milestones for their student. Based on the varying capabilities of the groups, some of the guidance that the teachers needed to do required them to ‘hand-hold’ their students through the various processes and stages of their project. A student shared his experience in this respect:

I remember when I was in Sec. 1, my teacher provided guidance from start to finish. He taught us the feasibility of the project and questions to ask. He helped us narrow down the approach to use and even taught us how to approach people for interview. (1S5)

Several students also related that when they were in Sec 1, many of them would consider their mentors (teachers) as content experts as well. Not only did they rely on their mentors to guide them with project procedures and protocols, they also depended on their teachers to verify the relevance of their project content.

Because we thought she was someone who has more experience, we would go to her to check on our information, and when you cannot think of a solution she would convince us to investigate a little more... (1S6)

The students also related that their mentors have also actively ‘trained’ them on specific skills such as presentation techniques and assisted them closely with their project reports. Even after the first year when most of the junior students were quite familiar with project work, their teachers continued to monitor them just as closely. However, when the students advanced to the senior classes, apart from the timely workshops on specific research procedures that their school conducted on the demands and requirements of the research work to be carried out, many of the students would still return to their mentors to seek advice on research protocols and procedures. A Science student explained “our teacher mentors give us guidance. They introduce us to the field of research and directed us to look for resource and conduct experiments”

(1S6). To a certain extent, the students stated that they had also consulted their mentors to advise them on the nature and scope of their projects. Quite a few of them also said that they sought their mentors' help to point them in the right direction before they proceeded to source for their research information and materials.

With the increased demands both in their school work and co-curricular commitments and obligations, the students recounted that often their mentors would act to monitor and check on them to keep them on task, "she helped me with time management and helped to keep me on task. This helped me to be focused and not to deviate from the main emphasis of the project" (1S3). While the contents and subject areas of their projects tended to be at a higher level, the students reported that they had continued to regularly seek the advice of their mentors to affirm and validate the research information that they had gathered. Some students also said that their mentors provided valuable coaching advice for their presentation of their project reports as well as their oral defence.

As the students proceeded to their fourth year, many started to consider their mentors more as a resource and guide, providing valuable advice and counsel on their projects. They related that these inputs from their mentors, while not explicitly dictating the direction of the projects, were a welcomed 'value-add' to the quality of the projects:

When we did our project in Sec. 4, our mentor gave us very useful tips and advice when we shared with her our findings. This helped us to fine-tune our report and provided clarity to some of our arguments. (4S2)

The students also considered their mentors' advice as a valued 'second-opinion', especially when they were faced with dilemmas or were undecided on aspects of their findings; "my mentor pointed us to resources for our project and gave us suggestions when we were stuck" (3S2). As such, the students would refer to the mentors more for counsel and advice.

Q5.2: What is the influence of support, resources and facilities that the school provided to facilitate your project work?

Facilities and Physical Infrastructure Support

Beyond the help and guidance that the students received from their teachers and mentors, the students also cited the support that they received from the school in terms of facilities and physical infrastructure. Most of these comments relate to the school's Science laboratories at the Science Research Centre (SRC) which was set up in 2007 to support students conducting Science-based research projects. One case student described his experience using these labs:

The labs at the SRC are very useful, the equipment is advanced. We need high tech equipment in some cases, and we do not need to go to the polytechnic or university to use their labs. It is so convenient. (5S1)

Admittedly the students also faced issues and constraints: “unfortunately, the labs are always fully utilized and the equipment is always heavily booked. As such, we have to complete the task within these limitations” (5S1). Nevertheless, the students recognized that having research facilities on campus did provide them with the convenience to do their project in school. Many students were glad to have specific equipment in the school’s research laboratories to analyse samples, “so that we do not need to waste time transporting our samples to other labs for analysis” (2S3).

The students were also appreciative of the technical support that they received from the laboratory staff. Like their mentors, they related that the laboratory staff provided valuable inputs especially with regard to experiment procedures and protocol. As many of the groups were unfamiliar with the use of the equipment in the various laboratories, having the technical staff at hand provided the students with someone to turn to when they faced problems with their experiments:

We are thankful that the labs technicians are always available whenever we needed help. In addition, the technicians also advised us when we faced problems with our experiments. (1S2)

The other facility that was singled out for mention by several of the case study students were the two libraries on campus at the case study school. Over the years the school librarians have worked closely with teachers and students to tailor the collection and resources available at both libraries. With the school’s emphasis on research and project work, many teachers and students have requested access not only to books and published resources but also to online databases for a variety of journals and publications. This made it easier for students (and teachers) to conduct their research in school instead of going to other sources and libraries – “the school’s library resources are really useful to me. It enhances our quality of work” (4S3). Others have also found the library resources useful, especially having ready access to online journals and resources as this, “makes it very convenient as we can work on our project anyway in school and have access to all these resources” (2S2). The majority of the case study students also compared the resources available at the school library with those at the national library. In this respect, they were aware that the resources at the school library were “handpicked by the teachers. It is more suitable for student’s needs. The books are not too fundamental nor too deep” (4S2).

Almost all the case study students also commented that the campus-wide high speed wireless IT facilities made it very convenient for them to access and conduct online research on campus. They especially relished the ease of using online communication applications to connect and ‘meet’. Due to their busy schedules and toggling between schoolwork, co-curricular activities and other commitments, personal or otherwise, the students in this group relied very much on the Internet and the various mobile applications and portals to facilitate communication, discussions and store the resources. The following comment exemplifies a typical Science and Math project group experience:

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As it was difficult to meet as a group all the time, we relied quite a bit on virtual meetings and online applications. Our group have been using Google doc to share information and data. (1S3)

Students from the other talent programmes concurred and employed similar social media applications to facilitate asynchronous communications. The following comments capture some of their online learning activities:

Actually my group used wikis to post our findings but the Google doc is useful to share and update information and details. (1S4)

My group used quite a bit of Facebook and created private groupings to share our project info. (3S3)

While we prefer to meet as a group, if we can't then we went online to look for a right apps for collaboration. (4S2)

My friends and I used Google doc to share information but our main communication channel was Facebook. I mean we created private groups to message and respond. (2S1)

We would use some of the online blogs and forum to express our ideas and post our findings and reports for the rest to read and comment. (2S3)

Actually we used the online discussion forum that our teachers set up on the school's IVLE (*e-learning portal*). (3S2)

CONCLUSION

This chapter presented the case study findings, analysing the perspectives of the student participants across the five courses of study, relating to the research questions. Emergent themes drawn from the analysis led to the generation of theoretical propositions, which are discussed in Chapter 6.

CHAPTER 6

FINDINGS AND DISCUSSION

INTRODUCTION

The previous chapter presented the empirical findings according to the guiding questions, from the perspectives of students who were engaged in research-based project work in one of five courses of study at one school. Drawing on the emergent themes, this chapter develops seven theoretical propositions about the ways in which students engaged with research-based project work curriculum deal with independent learning. The propositions are discussed below

PROPOSITION 1

The first proposition is that understanding the rationale and processes of project work allows students to determine their own learning outcomes and motivates them to learn independently and 'go beyond' the contents of the syllabus. Engagement in research-based project work develops characteristics of independent learning, as learning becomes more informed and involved.

Research shows that project-based work provides experiences that foster independent learning in a number of ways. Having students engage in project work, especially when the project extends over a significant period of time, allows them to inquire and generate questions that address the concepts and principles that they encounter in their course of study (Wong et al., 2006; Netto-Shek, 2004). In doing so, they get to form their understandings and perhaps generate new knowledge to build upon or reinforce their investigations. This gives students the autonomy to collaborate and generate solutions, and make decisions independently (Wong et al., 2006; Netto-Shek, 2004). However, while the research and project work approach enables students to determine their own learning, teachers as mentors provide the necessary guidance and advice to direct and coach students in the process (Savery, 2006; Netto-Shek, 2004; Howard, 2002). Proposition 6 in this chapter will address in detail the role of teachers as mentors for project groups.

As students engage in groups to undertake a project, this process provides them with real-world learning experience and gives them the opportunity to hone and develop their problem-solving skills (Thomas, 2000). Engaging students in this approach where they have to link and integrate their research to match the concept and principles that they learned in their classes requires them to perform at a higher

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order thinking (Helle et al., 2006). Helle et al. (2006) highlight that students who are enabled in such learning experiences develop ownership of their learning, thus enhancing their motivational levels.

The present study found that understanding the school's rationale and processes of project work was important to developing the characteristics of independent learning described above. This understanding was honed over time, along with the students growth as independent learners. Case study students believed that engaging in the various processes of research-based project work provided them with a better understanding of the relationship between the research activities and procedures, and the outcomes or the 'end-products'. The students also highlighted that they valued their own role in the research process, and also in generating and developing their own hypotheses in their respective research areas and projects. There was a strong agreement that this makes their learning meaningful and worthwhile. Many of the students shared that they understood that the school's rationale for adopting the research and project-based approach was to provide them with the opportunity to develop essential lifelong skills and foster independent learning. As reported in Chapter 5, one student summed up the main sentiments:

I think the key intent apart from preparing us for our future life and training our independence is, in my opinion, to help us find the joy in learning because we get to do something or learn something that we like or enjoy doing.

When asked what they thought the school intended when it adopted and infused project work within the curriculum, the students highlighted the following outcomes.

Resourcefulness

As students established their own perspectives, project work also encouraged resourcefulness and helped them to be more objective.

Preparing for the Future

A key intent of project work is to enable students to be future-ready, in terms of their work life, higher studies and life in general.

Development of Concepts and Learning Framework

In terms of short-term goals, the most significant impact of project work for them was twofold: making sense of the concepts taught in class; and learning how to apply the theories taught in class. Their 'inquiry mindset' also impacted the way they learn and how they transfer their learning beyond the classroom.

Inquiry-Based Learning

Among the significant changes in learning style for almost all of the students in the present study was in the way they approached research. Their learning styles became more inquiry-based as they sought to answer questions and investigate issues in order to find answers and come up with solutions.

Critical Thinking

The 'training' that students received from doing project work helped them to be more critical and independent in sourcing information. As they became more discerning, they realised that they were forming their own opinions and interpretations based on evidence that they had researched. As such, they tended to be more critical of their sources and to form their own views on issues. The students also favoured well-reasoned arguments and developing new knowledge that they were confident to share and support. They also appreciated alternative viewpoints that challenged their own.

Independent Learning

Encouraged by their passion and interest for the subject matter for their projects, the students became stimulated to be independent learners. Engaging in project work taught them the merits of sourcing for the information that they needed for their projects beyond their text books; this fostered independent learning.

The outcomes that the students highlighted all contribute to the kind of learning that is generally understood to be 'independent learning'. The research literature shows similar findings in other contexts. In a study of primary school pupils in the United Kingdom who were involved in guided group project work of creating websites on topics that they had researched, Turvey (2006) observed that as the pupils worked in their groups, they learned from each other, and that group work through projects provided pupils with opportunities to acquire valuable communication and exploration skills. This steered them towards learning independently, albeit guided by their teachers. Also in the UK, Underwood, Smith, Luckin and Fitzpatrick (2007) conducted a study that involved secondary students engaged in scientific investigative collaborations with a team of external scientists. Underwood et al. (2007) found that involving the students in research projects provided them with authentic scientific investigative experience. Upon completion of the projects, both the students and their teachers were positive about the entire project learning experience.

Scardamalia and Bereiter (2006) monitored the activities of a group of primary school pupils in Canada who were embarking on a project to produce lesson notes. The

pupils' works were then posted online where they received comments and feedback, which they incorporated in their works. The pupils also received feedback, input and advice from experts that contributed to the collaborative learning activity which led to collective knowledge construction. Scardamalia and Bereiter observed that having the pupils develop the conceptual framework of the lesson notes, and having the various groups critique each other's work, elevated the pupils' learning experience to a much higher cognitive level. The pupils were observed to be able to articulate their thought processes and learning as they progressed in their project work.

In the United States, in a study of a class of fourth-graders, Khan (2009) assigned her pupils an invention project where they worked in groups to modify existing gadgets. Khan observed that when her pupils received their initial instructions, they went about forming their own groups, and started posting ideas and engaged in online discussions and sharing of resources. With instructive scaffolding, the pupils were enabled to work independently on the task at hand. The pupils later reflected that they were able to source for answers and help from their peers, their friends and siblings outside of their groups or class. Khan thus inferred that having her pupils enabled and ready facilitated their learning process – independently.

At the middle and high school levels, Case and Miller (1999) conducted a study among grades 9 and 10 students in a school in the US where student researchers worked in partnership with scientists on science-based projects. Case and Miller observed that the students formed learning groups and communities, which included that partner scientists. The students engaged each other online to expedite their research projects and engaged in communication, data and resource sharing, as well as ideas and challenge discussions. The online facility also enabled the groups to involve students from other schools, thus allowing for comparisons and generation of new ideas and insights.

In the present study, in addition to understanding the intentions of the school in adopting and infusing research-based project work within the curriculum, the students also saw how their own learning changed as they went through the programme over the course of four years. The key changes were identified as follows:

Self-Motivation

The experience of engaging in research and project work had impacted their learning through fostering self-motivation to gain new knowledge and skills beyond what is required for exams. While engaging in project areas that interested and motivated them, they now acknowledged the importance of the grading rubrics and the assessment demands.

Experiential Learning and 'Going Beyond'

The students acknowledged that while they appreciated the demands placed on academic performance and results, they were also glad that the school had placed

emphasis on experiential learning as well and allowing them to explore various subject areas that they had interest in. This 'going beyond' enabled the students to learn much more about the subject matter, and motivated them to gather information for their respective projects, and share their findings with their friends and peers. These sharing sessions also provided opportunities for their peers with similar interests to come together and share their findings and opinions as well. This symbiotic process of attracting and sharing among like-minded people tended to energise the students.

Thinking Independently and Forming Own Perspective

Almost all the students in the present study agreed that engaging in project work and conducting research trained them 'to start' thinking more independently and to form their own opinions and ideas about specific subject matters. As the students sourced for more information on their projects, they were confronted with numerous viewpoints and differing perspectives. This compelled them to form their impressions objectively based on the information and materials that they had gathered, and more importantly, taught them to defend their standpoints. The perspectives and opinions that students formed during project work were open to challenges from their peers when they presented their projects at the various judging stages. Often the students found that they had to accommodate differing views and perspectives. Thus they learned to compromise and accept and synthesize their own ideas from the various articles that they found on the topic. This was considered a major benefit of the programmes.

Confidence

As the students progressed through to their fourth year, they became quite confident with project work. The incremental training that they went through equipped them to better handle project work. The various presentation stages and the requirement to work in groups provided students with experiences that fostered confidence to advance in their capacity for learning.

Learning Becomes More Informed and Involved

Project work value-added to learning in various ways, integrating many of the benefits described above. Having gone through four years of the project work, all the students interviewed expressed that the experience had exposed them to a learning experience that took them beyond their textbooks to areas that they had interest in or have developed curiosity in and helped them develop interest as well. A major change in learning attitude was a deeper level of engagement with the learning experience, and feeling more informed about and involved in the research/learning activities. This finding resonates with research by Jamaludin and Quek (2006), who

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studied Primary 5 pupils (Grade 5) and their teachers from five different schools in Singapore, where the pupils collaborated in inter-school research projects. The pupils' reflection logs indicated that they valued the knowledge that they gained during the course of the collaboration, and felt this made them more involved in the way they learned.

In the present study, active learner involvement enhanced independent learning throughout all phases of the research projects. For example, in learning to handle the demands of research work, students gained valuable skills such as Socratic reasoning, and developed confidence to undertake challenging projects that excite their imagination and sparked their minds to seek for answers. The experience also taught them to be critical of information, and learn to sieve for relevant and appropriate materials. After analysing the information, they would form opinions and confidently argue the hypotheses that they had generated. These attributes they believed not only value-add to their learning disposition but also equipped them with the necessary skills and attitudes that would put them in good stead in the next stage of their academic journey and also into their professional career in later years.

PROPOSITION 2

The second proposition is that students leverage on the differing strengths of their group members and perform different roles to complete their projects. Beyond group dynamics, the students with complementary strengths and abilities work synergistically to ensure alignment in and enhance the quality of their projects.

The case study school project-work curriculum stresses the importance of students taking the initiative with their learning in order to shift significant responsibility from the teacher to the student. Strategies to effect this shift included having the students decide not only on the composition of the project team members, but also on the extent to which the group conducted preliminary readings and research, and on the nature and scope of their research projects. Thereafter the project group would have to approach particular teachers to pitch their project proposal. That teacher would then decide if he or she wished to mentor the group.

The students are aware of the relevance and importance of project work in their respective overall assessment grade; the policy of the curriculum compels them to initiate the various processes of project work even before they begin working on their projects. As the case study students in the various project groups took increasing responsibility for their own learning, they leveraged more on their respective individual strengths, and distributed the different tasks required for their projects to those deemed most suited to those tasks. For example, while every member of the team was expected to source and research for relevant materials and articles for their project, they needed to meet the requirement for assessment for project work that for all project web reports, research papers and presentation slides had to be uploaded to a specific format onto an online portal. As such, students with particular strengths in web design or report writing or presentation skills were assigned to the various tasks

based on their competencies in those tasks. The outcome of working together and pooling different strengths was an increased effectiveness both in achieving the aims of their projects, and in learning in general. This 'synergistic learning' was especially evident when the students did their projects in the senior years. The students also related that the corresponding effect of their 'task-specific' collaborations and learning from each other's strengths and competencies did result in greater learning for every involved member of their team across the various skillset. Similar experiences were cited across various other studies that included two different cohorts of engineering university students in France (Herold & Ginestie, 2011) and Australia (Mills & Treagust, 2003), as well as another two cohorts of university students taking science courses in Taiwan (C. S. Chang, Wong, & C. Y. Chang, 2011) and Denmark (Mallow, 2001). In those studies the project-based learning curricula brought about synergistic features of cooperative and collaborative learning which generally resulted in more effective project groups that developed and carried out better projects. This has also been the case at the elementary and secondary school levels, where students who were working in groups that leveraged on the differing strengths and competencies of their respective group members to carry out complementary tasks for their group projects also demonstrated improvements in content mastery and interpersonal skills (Bell, 2010; Callison, 2006; David, 2008).

The case study findings are in line with those of Gan and Zhu (2007), who described the profiles of members of project groups engaged in virtual learning communities, where each of the students involved in the project had differing abilities, experiences and knowledge as well as different learning styles. Gan and Zhu (2007) reported that these differences that were manifested in the students led to a hierarchy among the group members. The students in the present study related similar experiences in their respective project groups. This was especially highlighted by groups that had members with varying levels of experiences and competencies. While the case study school provided training opportunities for their students in the various aspects of carrying out research or project work, the students reported that where they had group members from other schools, these group members were lacking in such skills and competencies. Notwithstanding their lack of research training, the students in the current study would assign their non-schoolmates group members complementary tasks and roles. A case in point was the student who had two American group members from the Academy of Science in his project group. While the Singaporean students in the group have had training to conduct a science research project, and would have also done similar science-based projects the year before when they were in Secondary 3 (Grade 9), for the American group members, being involved in the science project was their first experience and foray into science research. Not allowing their discrepancies in experimental competency to disadvantage the team, the student in the current study related that the Singapore members of the group led the project in areas related to experimental techniques, and provided solutions to issues related to experimental controls and data collection. Conversely, their American counterparts provided differing perspectives and novel approaches

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at the planning stages of their project. The American students, who were also more widely read, brought to the research discussions and added resources to augment the breadth and depth to the group's project. This synergy among group members to leverage on each other's strength provided a seamless alignment to their project which resulted in the quality of their research paper and evident in their presentation slides. Needless to say, the group was awarded a high distinction for their project.

With regard to the dynamics of the various projects groups, while the students in the current study reported that most, if not all, members participated and contributed to the project, a few cited that there were also cases where one or two members in their groups were more dominant and active, and these members would effectively lead the group over the duration of their project work. This was similarly reported by Thomas and MacGregor (2005), who observed in their study of undergraduates interacting across an online platform to complete their projects that among high performing groups, a particular member would surface to lead the group. This lead member of the group would organize the work flow and distribute the task that each member would undertake. Beyond the allocation of tasks by the group lead member, the interaction and discourse that occurred within the group played a critical part in their learning process (Thomas & MacGregor, 2005). The efficacious learning by the group as a whole due in part to the impact of the lead member of the group and/or the influence of the group's mentor possibly enhanced the group's zone of proximal development (Vygotsky, 1978 cited in Palinscar, 1998). This situation was evident in the case study school whose groups did projects across the different special programmes.

The majority of students in the present study related that their interactions and collaborations in their various roles within their project groups did impact on their attitude toward, and capacity in, learning independently. These interactions and collaborations, which can be understood as synergistic learning moments, included for example: the discourse and discussions in deciding on the nature and scope of their projects; presenting to and persuading their choice teacher to mentor their group; deciding on the distribution of tasks and negotiating the various milestones in the project timeline; and presenting and defending their projects at the various stages of assessment. It was found that all of these learning moments presented students with the opportunity to hone their learning attitudes, and through these symbiotic experiences of depending on every member of the team to align their tasks and roles towards enhancing the quality of their respective projects, promote independent learning.

PROPOSITION 3

The third proposition is that, as students work on their projects in groups, they engage in collaborative learning which in turn leads to knowledge building. This contributes to collective wisdom which is evident in the products that are jointly produced by project groups.

It was found that collaborative learning greatly enhanced learning style, learning experience and learning outcomes. The students in the present study formed groups of between three or four to undertake their respective projects. There was some variation in the formation of the groups. For most of the students, their group members comprised their schoolmates but not necessarily those within their close circle of friends. There were also a few project groups that had group members who were from other local schools or even from schools in other countries. One particular case study student whose group did a science research project related that his project group of four members included two American students from the Loudoun County Academy of Science in Virginia.

Regardless of the programme and subject area in which the students conducted their projects, all of the groups went through almost the same stages during the course of their projects; namely, exploration, project planning, collection of data, analysis of data and finally coming up with the results and conclusions. Notwithstanding the nature of their projects, being involved in developing their respective projects engaged the students in the advancement of collective wisdom to construct new knowledge. According to Levy collective wisdom can be defined as the capacity of communities to cooperate intellectually in creation, innovation and invention (Lévy, 2004). As mentioned in Chapter 3, collective wisdom derives from the “processes of divergence, convergence, integration and creation of individual member’s multiple intelligences in a group/team, organisation or the whole society” (Gan & Zhu, 2007, p. 208).

It was found that this collective wisdom stemmed in part from the discussions, discourse and development of students’ projects through the various stages, providing them with an enhanced learning experience. In their respective studies Oliveira, Tinoca and Pereira (2011) and Koh et al. (2010) reported similar experiences with their students engaged in collaborative project work. Oliveira et al. (2011) studied undergraduates who worked and collaborated in groups on project-based assignments through an online learning portal. They reported that their students engaged at the onset of their project through negotiation and research to conceptualize their projects, and through the sharing of their respective research and readings brought to their discussions valuable resources to develop their assignments (projects) and created new knowledge, demonstrating collective wisdom as they progressed through the various stages of their projects. Koh et al. (2010) had previously found that, for university students, going through similar stages of collaboration and sharing of their respective projects resulted in the creation of collective wisdom and new knowledge.

The students in the present case study were similarly engaged in project-based learning where they were required to work closely, collaborate and develop new knowledge. Like students cited in the above studies, the case study participants had to also rely on online or virtual learning portals, not only to conduct research, but also to engage in discussions and resource sharing. This was especially so for those who had group members who were not their schoolmates. The requirement to engage online was not only a choice decision made by the various groups to facilitate

collaborative interactions amongst themselves; in fact the assessment requirements for project work in the case study school require all groups to submit the ‘products’ of their works via a stipulated portal. These products included the research papers, the project reports and the group presentation slides. While the students in Oliveira et al.’s study had the liberty to choose their virtual portals to collaborate, not all students in the present study had such freedom. For example, the groups that were engaged with the American students from the Louden County Academy of Science were expected to use Wikispaces. Nevertheless, teachers across both the case study school and those in Oliveira et al.’s study reported that their respective students were able to create quality projects through their collaborative efforts.

The various stages that the case study participants went through to develop their projects are similar to those described by Gan and Zhu (2007) in their framework for developing collective wisdom, which are: multiple intelligences; collaborative intelligence; collective intelligence; and collective wisdom. The majority of students in the present study went through stages such as having access to ICT tools and virtual portals to enable them to collaborate; being able to share resources and information amongst themselves; and finally develop knowledge to add to their collective wisdom. Whereas Gan and Zhu’s (2007) framework was developed from a study of virtual learning communities, the students in the present study were not engaged in e-learning or distant learning. Notwithstanding this difference in context, there were similar findings in relation to the development of knowledge. This dynamic interaction within the virtual learning communities ultimately leads to the creation of knowledge (Aviv et al., 2003). The case study students believed that they had benefitted in their knowledge capacity as they engaged in their project work.

Many of the case study students also related that they had learned to progress from working cooperatively at the start of their projects to collaboratively among group members as each member developed and gained competency as they advanced in the various stages in their project work. Cooperation was teacher-directed and structured, with each student having a specific role or activity to conduct. Collaboration was not monitored by teachers; rather, students organized and negotiated their own roles and interactions. This finding resonates with the view of Kolk and Bias (n.d.), who explain that the terms ‘collaborative’ and ‘cooperative’ are often used interchangeably:

During both collaborative and cooperative learning, students work together as they tackle new concepts and form new understandings. The two approaches are subtly different, but are both highly effective ways to organize classroom learning and project work. In cooperative learning, students work together to achieve a goal or develop an end product which is usually content specific. Cooperative projects tend to be teacher-centered and teacher-directed. In collaborative learning, students may still work toward a goal or develop an end product, but the process is characterized by self-responsibility and awareness, respect for others, and contributions from different perspectives. Collaborative projects tend to be student-centered and student-directed. (Kolk & Bias, n.d.)

Chai et al. (2011) also expound that collaborative learning often starts as cooperative learning where students are presented with a structured approach to addressing the project, and that learning within the group is controlled largely by the mentor or teacher. They add, however, that cooperative learning then progresses to collaborative learning as the students gain more autonomy and become more spontaneous in communicating with one another as they continue with their tasks (Chai et al., 2011). Further autonomy for the more able groups could include allowing students to decide on their group members and topic of research to enable deep learning to occur (Chai et al., 2011).

The present study found that the shift from cooperative learning to collaborative learning was enhanced by the use of online platforms, stipulated or otherwise. The online platforms allowed them to discuss ideas and proposals and share resources quite easily amidst the groups' inability to meet in person due to their differing schedules and commitments, or lack of geographical proximity in those cases where group members were not from the same school or even the same country. Using these virtual channels thus provided an efficient and effectively means to collaborate, and to develop their learning skills and competencies in this regard. These stages of collaboration found among students in this study as they engaged in project-based assignments were also reported in other studies. For example, in their study involving groups of students in a Masters degree programme, Elgort, Smith and Toland (2008) reported that the students in their study collaborated on their projects and used virtual platforms as a channel for communication. Elgort et al. (2008) reported that the virtual platform, which in that case was a wiki platform, facilitated positive interdependence and group responsibility within the respective groups, thereby augmenting participation among the students. The wiki platform also facilitated in the sharing of resources and helped the groups to organize their resources.

Additionally, in the present study, students were engaged in yet another approach to collaborative learning where they have full autonomy to determine how they wish to achieve the group's overarching goal in their project work in consultation with their teacher mentor. Zhang, Scardamalia, Reeve and Messina (2009) describe this approach as 'opportunistic collaboration'.

The present study also found that the collaborative learning and collective wisdom fostered through project work led to high level end products, including research papers, project reports and presentation slides. According to teachers in the various talent programmes of the case study school, the cognitive benefits of collaborative project work were evident in the project outputs across the various groups largely as a result of their interaction and engagement in the projects. Collaborative project work has been found to lead to a wide range of quality outcomes, such as such as the collaborative design production of virtual scientific posters (Snelling & Karanicolas, 2009), collections of wiki pages (Chua & Chua, 2008), the conceptualization and development of three-dimensional cultural houses (Ligorio & Van der Meijden, 2007), and the development of topical information websites (Thomas & MacGregor, 2005).

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In all of these studies, including the present case study, the collaborative research undertaken by the students enhanced their cognitive development and contributed to the development of collective wisdom.

PROPOSITION 4

The fourth proposition is that having project groups comprised of members from different peer groups, classes, schools or countries provides students with an experience in collaboration beyond their immediate 'comfort circles', and facilitates interaction and understanding. Such interaction prepares students with the necessary skills to enable them to function well in the future in a more globalized environment.

It is evident that the students in the case study school had indeed benefitted from engaging in research-based project work. This is not only based on the students' perspectives and personal accounts, but also on the quality of the research projects that they produced, including research papers, project reports and presentation slides, as well as their assessment grades where many of them had attained distinction for their project work. Many of the students have also represented the case study school in national and international events and fairs through the merits of their respective projects. It was also observed that the students had benefitted from other aspects of learning as they embarked on their project journey with their group mates. These aspects include the forging of new friendships and responsibility towards group members.

As indicated in Chapter 5, students reflected that, in the initial years of project work in Secondary 1 and 2, they tended to form groups from their circle of close friends or their classmates. However upon reaching Secondary 3 and 4, many of them learned to look for group members with complementary strengths and abilities to ensure alignment in their tasks, and to enhance the quality of their projects. Consequently, the members who formed the respective project groups did not generally belong to their respective circle of friends. Nevertheless, as these students engaged in months of intellectual discourse and exchanges, cooperating and collaborating among themselves towards their common goal, the group members formed strong bonds of friendship and understanding among themselves. Many of the students felt a shared 'ownership' of each other's roles and responsibilities and would rather see to the success of their group projects than their own personal benefit in assessment outcomes. As such, many of these students have, over the course of four years of engaging in project work, learned to transcend beyond their close proximities of friends to source for appropriate team members to complement their project team. This was evident especially for groups that had members not only from the case study school, be they local or overseas students. They also benefitted from the interactions that they had with their non-school mates as a result of their collaboration in the project. At the end of the entire experience, the students related that they had formed meaningful friendships with one another and developed an appreciation of the working (learning) styles of the 'non-school mate' team members and friends.

Research shows similar experiences among the students engaged in project work at tertiary level. For example, Thomas and MacGregor (2005) found that university students who formed project groups with new members outside of the circle of friends developed new friendships in the course of their collaboration. Like the students in the case study school, the students in Thomas and MacGregor's (2005) study used an online platform to engage and interact among themselves to work on their projects, complementing face-to-face meetings which were difficult to meet due to conflicting schedules. Similarly, students in the present study found it quite challenging to arrange for face-to-face meetings due to the different schedules and commitments of their project group members. This was especially so for those groups that had members outside of the case study school. In those cases, the online platform was an instrumental channel not only for developing close relationships with team members, but also for communication and sharing of ideas, and for the sharing of resources.

Thomas and MacGregor (2005) found that the interactions on the virtual platform may be synchronous or asynchronous, and fall within three categories; task-related, socio-emotional and non-task specific. In a recent study by Ertmer et al. (2011), groups of pre-service teachers from Sweden, England, Russia, South Korea and the United States had to collaborate on a group project as part of their coursework. These trainee teachers had to rely solely on the virtual platform to collaborate as it was quite impossible for them to arrange for physical meetings due to their geographical limitations and constraints. In addition, other than their asynchronous communication and collaboration arrangements, the groups were, as part of their coursework, required to conduct at least a specific number of synchronous discussions and meetings. They thus arranged for such synchronous sessions via real-time online platforms such as Skype or chat sites such as Facebook Chat. Ertmer et al.'s (2011) study showed that such international or cross-border collaborations through online virtual media not only provided prospects for collaborations, it also provided the opportunity to enhance each group member's cultural competencies as they learned about each other's cultural and working styles. Because the group members in that study would not likely be meeting in person to address the challenges and issues of their respective projects, learning instead to work across a virtual platform to collaborate, the opportunity to transcend the barriers of culture and language, albeit the differing accents and cultural connotations of terms and meanings, brought an added dimension of appreciation and understanding of a variety of international experiences that the students would likely be exposed to in their future educational, work and social lives.

The students in the case study school who had group members who were from another country faced similar challenges in the course of their group's project journey. Even those students in groups that had members from other local schools related that the differences in the cultures and learning styles from the other schools also presented some challenges as the group proceeded with their research projects. In the course of the collaboration these students had to regularly maintain communication

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with each other as they carried out their roles and responsibilities. The challenges that these students faced and their ability to overcome such obstacles trained them to be resilient and focused.

The present study also found that, as students interacted with their teammates and mentors they learned to develop their own points of view, and also how to come to a consensus as a group. They believed that developing relationships and communicating with a variety of group members encouraged them to be resourceful and helped shape their perspectives. The students also reflected that such collaborations encouraged and taught them to think logically and objectively. Such opportunity and experience provided a slice of real-world experience for the students who will very likely function in similar situations and circumstances in the more globalized of the future, where project collaborations across geographical and national borders may well be commonplace.

The learning styles, attitudes and skills developed by the students throughout the various stages of their project work are in line with the Learning and Innovation Skills described in the American education system's Framework for 21st Century Learning (The Partnership for 21st Century Skills, 2008). The Skills are: communication; collaboration; critical thinking; and creativity. Referred to as the 4cs, the Skills are "a shorthand for all the skills needed for success in college, career, and life" ("Twenty-First Century Children", n.d., Para 4).

In 2010 the Singapore Ministry of Education (MOE) introduced the 21st Century Competencies Framework (MOE, 2010) as part of its desired outcomes of education. There are clear parallels with the US Framework for 21st Century Learning. The MOE Framework includes the 21st century skills deemed necessary for the globalised world we live in. These are: civic literacy, global awareness and cross-cultural skills; critical and inventive thinking; and information and communication skills. Specifically, the outcomes are focused on: thinking, teamwork and effective communication, including collaborating in groups across different cultures; thinking critically and innovatively, and being creative in addressing and solving problems; and being competent with the use of ICT. According to the MOE, preparing students with these skills will enable them to engage more effectively in the digital age and the global environment.

The present study found that project work interactions prepare students with skills deemed necessary to function effectively in their future lives.

PROPOSITION 5

The fifth proposition is that when students are not able to find time to meet in-person as a group, they rely heavily on virtual social media to 'meet'. Adequate training to use the tools and facilities on social media is necessary before the commencement of project work in order to maximise their use once the project commences. This enhances learning efficiency.

The students in the present study related that due to the differing schedules among the group members, it was quite difficult for their respective groups to

meet 'in-person'. This was especially so for those who had group members who were not their schoolmates. However, even schoolmates found it challenging to arrange for common time to meet. The students shared that when they were in the lower secondary levels, those among them who formed project groups among their classmates normally did not face such issues, though some groups did have problems due to their friends' commitments and obligations outside the school. However as the students advanced to the upper secondary levels they discovered the benefits of including group members from outside their closed circle of friends, as discussed in Propositions 2 to 4. As a result, almost all the students in the current study shared that they relied quite heavily on online social media, virtual portals or applications to conduct their meetings and discussions, and also to share resources. Many of them were quite comfortable with the asynchronous nature of such media as it allowed them to engage in discussions on their projects at various times and differing locations depending on their respective schedules.

Several of the virtual applications and portals used by the students had synchronous facilities to allow everyone within their groups to meet at the same time, although not at the same location. However, for those students who had group members from other countries, such synchronous meetings were quite impractical due to time-differences of up to 12 hours in some cases. Almost all the students in the present study were engaged in social media such as Facebook or Wikis and were quite familiar with these online media for their social interactions. However, many of them felt that they lacked the knowledge on how to use these online platforms for their project collaborations and interactions. Some students who were required to use specific online applications such as Wikispaces or Google Docs believed that their lack of familiarity with the features of the online applications impeded their abilities to optimize the use of the platform for effective collaboration among their group members.

While students had received some training to use some of these online applications when they were in Secondary 1 or 2, they considered it to be 'quite basic' in that it did not address the challenges that they faced when they did their projects at higher levels. Challenges included, for example, working collaboratively on common online documents, which requires the students to share and work on data across different applications, and to critically comment on and evaluate their group members' propositions and ideas. In their investigation of successful project partnerships among middle school pupils of age nine to 14 years across seven schools in Italy and the Netherlands, Ligorio and Van der Meijden (2007) observed that pupils collaborated with each other and engaged in discussions on two online platforms; the first facilitated discussions, while the other provided the students with tools to construct three dimensional, virtual, cultural houses with chat tools and a discussion forum. Ligorio and Van der Meijden (2007) concluded that the success of the project should not only be attributed to the support from the schools, the availability of computing facilities, or having competent teachers as facilitators but that there should also be adequate and appropriate technical and instructional training and support rendered to students as well.

Students in the present study also cited that some members of their group would use the seemingly unregulated medium to “talk or rant” about matters not related to their project, hence distracting the group from engaging in productive work. This distractive behaviour during online interactions among students in virtual learning communities has been reported by Palloff and Pratt (2007). They state that students are sufficiently emboldened by the less threatening atmosphere and lack of face-to-face interaction of the virtual environment to become distracted from learning activities, and may post hostile, angry or judgmental comments. They argue that, if left unchecked, this situation may discourage productive participation among group members. They thus recommended that guidelines or codes of conduct should be in place and enforced to ensure meaningful collaboration among group members (Palloff & Pratt, 2007).

Students in the present study proposed that, together with the research-based training that they received before they embarked on their research projects, similar training on how to use and optimize online media should be conducted to enable them to use these applications and platforms effectively and efficiently for their collaborations. The students also suggested that the training sessions should include how to utilize these virtual platforms as a value-added resource in their research.

In their study of Secondary 2 students in seven schools in Singapore involved in project work, specifically the setting up of a virtual learning community to enable project collaboration, Wong et al. (2006) found that students gained more satisfaction from their use of online applications when adequate training had been provided on how to use media appropriately. Seet and Quek (2010) also observed in their study of secondary school students involved in project with some group members located in an overseas school, that when students were proficient in using online portals or applications, they were better able to focus on the content of their projects. It is clear that training students to be competent to use the tools and facilities on social media adds to the effectiveness of learning.

Beyond providing the required training to use online applications to the students, students in the present study also recommended that the same training be extended to their project group members from the other schools as well. They highlighted that even when the school provided training for them, their group members who were not their schoolmates were not included in these training sessions. Consequently, their non-schoolmate group members found themselves handicapped throughout their collaboration process unless their lack of familiarity with the use of the online applications and all its implements were identified during the early stages of the project process and addressed accordingly. Otherwise, these shortcomings not only affected the students from the other schools but also impacted on the general progress of their project groups.

A case in point included those students in the current study whose American group members were not familiar with the use of Wikispaces for their project collaboration. Not fully understanding the communication and sharing features

of the online application, which in that instance was the use of Wikispaces, their American counterparts appeared to be 'slow' or 'sluggish' with their responses.

This impact was also observed in studies by Jamaludin and Quek (2006) and Thomas and MacGregor (2005). Wang (2009) also found that the inadequacy of communication among group members in a project group impeded the progress of the group in carrying out their respective assigned tasks. This appears to happen regardless of the number of members in the project groups; in Wang's (2009) study, the students worked in pairs; those in the present study involved groups of three or four members. In either case, where effective communication among group members via social media was impeded, the progress of the group projects was significantly affected, thus highlighting the importance of prompt responses to communications. This practice of responding promptly in the project groups' online discussions and also by sharing thoughts and ideas to enhance the groups' projects does nurture and develop in the students the discipline of learning independently. It trains the students to actively collaborate and provide timely sharing among their group members albeit in the virtual space.

Apart from the fundamentals of online applications and social media that the case study students had learned in their previous Computer Studies and InfoComm Studies courses, it is important to provide training on the more advanced features and tools. This applies not only to the school's in-house e-learning portal and applications, but also to the various online applications and portals that students commonly use for their project work and collaborations. Going beyond the basics of communication and resource repositories, the students also need to learn how to use such online media and tools to collaborate in areas such as: idea generation; critically assessing and evaluating discussions; developing propositions and arguments; manipulation of resources across various formats and media, and incorporating these resources back to their projects; and perhaps consulting and engaging authorities and experts in their respective research and projects. Enabling and empowering the students with the appropriate use of the relevant technology will allow them to focus less on the mechanics of the online application and portal, and redirect their time and efforts to more productive engagement in their research.

PROPOSITION 6

The sixth proposition is that students rely on their teacher mentors to varying degrees to 'guide' them in their project work, and not all teachers provide similar levels of 'guidance'. Levels of reliance on mentors are influenced by factors including initial anxieties about project work and the practicalities of specific projects and research activities, expertise of the mentor, and the need to stay 'on track'. Over time, teacher mentors effect a shift from the 'hand-holding' stage to independent learning.

With the emphasis on having students who are engaged in project work initiate their own learning, the role of teacher mentors is crucial in providing the guidance necessary to develop student capacities in this learning approach (Howard, 2002;

Thomas, 2000). Whether in the classroom or mentoring their project groups, teachers continue to assume the integrated role of a guide, a mentor and a resource to scaffold their students' learning process (Wong et al., 2006). Apart from the key influence that teachers play in educating their students, engaging them in cooperative or collaborative learning requires the teacher to shift their role from being a knowledge transmitter to a facilitator who provides feedback and guidance (Smith & MacGregor, 1992).

The students in the present study shared their apprehensions when they first started on project work in Secondary 1. As they did not yet understand the particular demands and requirements of project work, they relied heavily on their teachers to provide the necessary guidance. Some students recalled that there were cases when their teacher had to 'hand-hold' them at the initial stages of their research as their understanding of project work then was based on their experiences in their primary schools. Their anxieties were compounded when they realized the marked differences in the requirements and demands of their school project work compared to that of their friends in other secondary schools. Whereas their friends in the other schools were assigned to groups and projects by their teachers, the case study school requires students to form their own project groups and to investigate and initiate potential research projects.

While students found this 'freedom' quite encouraging at the start, their excitement quickly turned to concern when they had to delve into the practicalities of organizing themselves and planning their projects against the backdrop of a school-wide project work timeline. Although the school conducted project planning workshops and training sessions for students, many of them still found this new experience daunting. Added to that, as Secondary 1 students, they were already in a new schooling experience that is different from their primary school days. Against all these 'new' experiences and demands, the role of their teachers, especially those who mentored them in their projects in their initial years, became even more crucial in easing them through the various initial stages of their project work experience. The students explained that, as part of the 'hand-holding' stage, their earlier teacher mentors in Secondary 1 had to help them scope their projects which, due to the students' inexperience and enthusiasm, were often too ambitious and unfeasible. As such, their teachers would assist them in setting realistic goals and timelines.

The issues cited above are similar to those identified in the study by Turvey (2006) where students in a primary school in the United Kingdom (UK) worked in groups and used the tools provided by a virtual platform to create websites on topics of their research. Turvey (2006) observed that teachers played the key role in determining the quality of learning and ensuring that their young charges remained on the right track.

As the case study students advanced to their senior years and joined the various special programmes that their school offers, the nature and scope of their projects increased in complexity as they engaged in research work albeit in the various categories and different types of research approaches. While the school arranged for

students who were involved in research-based projects to attend workshop sessions in their specific research areas, the students stated that, just as they did when they were in the lower levels, they had likewise turned to their teacher mentors to guide them. For example, even though they had learned to refer to literature to source for possible projects and research areas, they nevertheless still turned to their respective teacher mentors to discuss possible research areas and topics to initiate their projects. As such, many students consulted their teacher mentors to affirm and validate their proposed research areas and projects. Nonetheless, in line with findings of Thomas and Mergendoller (2000) there was still a high level of initiative from students as well as a great deal of instructional responsibility being shifted from the teacher to the student.

Among the criteria that the students referred to when they approached teachers to be their mentor was the teacher's perceived competency and knowledge in their proposed research areas. This is in addition to the teacher's familiarity and competency in the specific research techniques and protocols that they intended to use. Students agreed that knowing the competency or expertise of the teacher who they had selected as mentor provided them with the confidence to consult them as a reference resource person. The students also sought their teacher mentor's advice regarding the scope and nature of their proposed projects, and to point them in the right direction. Additionally, they were confident that their teacher mentor would keep them on task amid their numerous commitments and obligations. Apart from their teacher mentor's advice and engaging them in their research and projects, the students in the present study also related that they had sought the guidance and help of their mentors in preparing for the oral presentations of their projects at the various stages in the project timelines.

The important role that teacher mentors play in facilitating project-based learning is reinforced by Postholm, Pettersson, Gudmundsdottir and Flem (2004), who investigated the role of the teacher in facilitating project-based learning in a Norwegian secondary school. Postholm et al. (2004) stressed that, aside from implementing suitable project designs that are appropriately scaffolded to suit the abilities of the students, the guidance provided by the teacher across all aspects of the students' learning when they conduct their projects is crucial. These aspects include, for example, setting realistic goals for students and ensuring that the projects assigned for the students are appropriately thought-provoking yet within their abilities. In Postholm et al.'s study, where Information and Communication Technology (ICT) was presented as a mediating artefact in project work, it was observed that teachers could challenge their students by requiring them to demonstrate their understanding of the subject matter that they had learned through the use of various ICT-based artefacts. These artefacts included, for example, producing a video or film or a multimedia presentation, and documenting the planning and decision-making processes that the students go through within their groups. Postholm et al. conclude that, even as students use online media or virtual learning communities (VLCs) to engage in meaningful discussions and interaction for their projects, one of the key

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roles of a teacher is to maximise students' learning. The importance of the role of the teacher in making the use of VLCs a success was also highlighted in the case of primary school students (Ligorio & Van der Meijden, 2007) as described above in relation to Proposition 5.

Another challenge that some of the students in the present study related in regard to their teacher mentors was that due to the complexity and nature of their research projects, the teachers they had approached and selected to be their mentor were not familiar with the specifics of the research work that the students were engaged in. In those cases, their mentor and the school would source for an external professional or expert in the particular subject matter to advise the students. In instances where the teacher mentor was not familiar with the subject matter, the mentor would refer their mentees to the external mentor for advice. The teacher mentor in that situation would then be an active participant in the project and assume the role of co-researcher in the study with their students (Thomas & Mergendoller, 2000).

Foo and Hussain (2010) argue that, in addition to building knowledge and acquiring life skills like interpersonal skills and reflection in the course of project work, there needs to be a change in the role of the teachers to empower learners to take charge of their own learning in a socio-constructivist environment designed by the teachers to motivate and support the learners. While Foo and Hussain's research was carried out in a tertiary setting, the points appear relevant to a secondary school context as well, especially among more able students at the upper secondary levels as demonstrated by the students in the present study.

PROPOSITION 7

The seventh proposition is that, beyond the guidance from their teachers, students engaged in project work benefit from physical, network and infrastructural supports, including: laboratories and equipment; sound library facilities and access to relevant online resources and social media; appropriate computing facilities; and training and workshops in project work learning.

While the rationale of getting students to engage in project work is to provide them with opportunities for, and skills in, self-directed authentic learning, meaningful engagement and purposeful learning is best achieved with appropriate guidance provided by their teachers (Savery, 2006; Netto-Shek, 2004; Howard, 2002). This requires teachers to plan suitable approaches and scaffold the learning process for their students. The discussion of Proposition 6 provided the rationale and basis of the teacher's role in guiding students in project work. This study found that, while teachers provide the appropriate pedagogical and even affective guidance to their students, additional supplementary support further enhances the learning process for students. Although providing appropriate and adequate facilities is extremely important, this supplementary support framework should extend beyond the physical and infrastructural. Students in the present study cited several key facilities of the case study school that enhanced and supported their project work. Among these

facilities is the Science Research Centre (SRC), established in 2007, which provides students who are conducting science experimental research projects with access to on-campus laboratories; without this resource students would be required to go to off-campus laboratories at the local polytechnics or universities.

Besides having the research laboratories, the students in the present study also acknowledged the guidance they received from the laboratory staff in providing technical support and inputs, especially with experiment procedures and protocol as many of them were quite inexperienced with the use of the equipment in the various laboratories.

The other facility that the students singled out was the school library, which provides liberal access to relevant online resources that the school has subscribed. As the sample school has emphasized research-based project work for quite a number of years, the school librarians have also been working closely with teachers to provide a collection of appropriate resources that students will find useful for their projects.

It is also observed that in recent years students have leveraged on online social media to enhance communication and collaboration within and outside their project groups. As discussed previously in this chapter, students today tend to be involved in a range of activities with increased commitments and obligations. As a consequence, many of the participant students found it challenging to arrange group meetings to discuss their projects.

Moreover groups with members either not within the same school community or from overseas schools typically found such 'in-person' meetings not only challenging but also impractical. As such, engaging and collaborating over the online social media or application was a practical approach.

Thomas (2000) noted that the accessibility of technology as an avenue to collaborate, research, organize and communicate would also facilitate a project-based-friendly environment for the students. This technology infrastructure where possible, ought to provide ubiquitous campus-wide access to all learners. In their study of undergraduates interacting across online platforms to develop a website, Thomas and MacGregor (2005) observed that the students were continuously interacting online either synchronously or asynchronously. Even for younger students, accessibility to appropriate virtual infrastructure does influence successful outcomes of their projects, as reported by Ligorio and Van der Meijden (2007) when they scrutinized successful project partnerships among middle school pupils of age nine to 14 years across seven schools in Italy and the Netherlands. The pupils in their studies collaborated with each other and engaged in discussion on two online platforms; the first facilitated discussions, while the other provided the students with tools to construct three dimensional, virtual, cultural houses with chat tools and a discussion forum. Ligorio and Van der Meijden observed that the pupils enhanced their interaction across the online platform through their respective school's network infrastructures to engage in their project work. Ligorio and Van der Meijden emphasise that while having competent teachers as facilitators is key to ensuring the success of their pupils project work, it is just as important to provide the appropriate

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computing facilities and infrastructure to support the teacher and students who are engaged in project work.

Beyond these physical, network and infrastructural supports, it is equally important for schools to put in place a learning environment that favours the project-based learning approach. David (2008) alluded to this in arguing that such an environment ought to provide spaces where students and teachers can work together. These ‘collaboration spaces’ should also be infused into the planning of the curriculum and schedules to allow students and teachers with the flexibility to engage, interact and collaborate (David, 2008).

In line with previous discussions in this chapter, another possible instructional support that schools could usefully provide to help incorporate a project-based curriculum is adequate and appropriate training and workshops to both teachers and students. Such workshops, especially for students, would aim initially to ground the students with the fundamentals of planning and carrying out a project, and subsequently, introduce them to the processes and procedures of genre-specific research work. Schools could also arrange for programmes and training opportunities to teachers to provide better guidance and mentoring to their project groups as part of their professional development. Furthermore, David (2008) has suggested that a school could significantly promote the project learning culture by incorporating students’ project work output, for example the grade that they obtained for project work, into the school’s assessment system, where the students’ project grade would impact their overall assessment outcome and progression (David, 2008).

CONCLUSION

This chapter drew on the case study findings to develop seven theoretical propositions pertaining to the impact of a research-based project work learning curriculum on independent learning, from the student perspective. The propositions are closely interrelated, dealing with features including independent learning, group dynamics, collaborative learning and knowledge building, learner interaction, use of social media, the role of teacher mentors, and resources and support.

CHAPTER 7

SUMMARY AND CONCLUSION

INTRODUCTION

This chapter concludes the book in four main sections. The first main section provides an overview of the study, including the background, aim and research questions, and methods of data collection and analysis. The second section presents the theoretical findings of the study. The third section details recommendations for practice, based on the outcomes of the study, and the fourth section discusses the implications for further research.

OVERVIEW OF THE STUDY

Background

Hwa Chong Institution, the Singapore school in which the present study was conducted, has incorporated and infused project work within its curriculum since 1984. The school offers a 6-year comprehensive secondary school programme that caters to academically-able students aged 13 to 18 who are within the top 3% of the national cohort. While project work in the initial years was an enrichment activity to enhance learning opportunities, the school has since incorporated it as an integral part of both the curriculum and the students' assessment protocol. The primary reason for the school including project work in the curriculum was to provide opportunities for the students to develop skills in the cognitive and affective domains, and to equip them with 21st Century Skills/Competencies (MOE, 2010) which the school believes to be vital in preparing its students to become effective members in a global economy. By the late nineties the school had fine-tuned project work to focus specifically on research-based project work, with the key aim being to nurture the students to be independent learners. This enables learning beyond textbooks and provides students with the opportunity to apply and synthesize the knowledge gained from their thinking and research lessons to solve real-life problems. As students embark on research work, they are also provided with the opportunity to connect with their mentors within and beyond the school. These exposures and engaged conversations with mentors, who may themselves be researchers and professionals, extends the perspectives and outlook of students, and offer in-depth research skills and knowledge. This engaged experience furthers the students' interest and passion in their learning journeys.

As the students in the school in question progress through the various stages of their projects, they hone skills such as communication and presentation, and are

better able to articulate and defend concepts and ideas with confidence. Working in collaborative groups also allows the students to learn team dynamics and appropriate attitudes and social skills that are vital in their future pursuits. This inter-disciplinary approach of the project work curriculum introduces students to the rigours of applying concepts and contents, and to transferring knowledge and skills across disciplines. The students are thus made to realize and appreciate the relevance and inter-relatedness of what they have learned in class. The study reported in this book investigated the perspectives of a sample of students on whether the 'experiential' learning approaches of research-based project work within their curricula promoted independent learning, and investigated the impact of these approaches their learning attitudes.

This book thus reports research aimed at developing understandings of the impact of a research-based project work curriculum on independent learning. The study primarily investigated how the students dealt with research-based project work learning used in a social constructivist approach designed to foster independent learning attitudes. The study further examined, from the students' perspectives, the role of their teachers as project group mentors and how their teachers facilitated independent learning. The study also sought to ascertain the impact of the various resources in the school, and how these resources contributed to the process.

Aim and Research Questions

The aim of the study was to develop understandings of academically-able students' perspectives on their independent learning from participating in a research-based project work curriculum at an independent secondary school in Singapore.

The main focus of this study was guided primarily by the central research question which was: How do students engaged with a research-based project work curriculum deal with independent learning?

Generating from the central research question, the study was guided by the following specific research questions:

- What were the students' *intentions* prior to the implementation and their participation in authentic and experiential learning, particularly that of the infusion and incorporation of research-based project work approach to their curriculum? What reasons did they give for their intentions?
- What *strategies* did the students developed to manage and 'deal with' the research-based project work approach in their curriculum? What reasons did they give for utilizing those strategies?
- What was the *significance* that the students attached to their intentions, and their strategies, and what reasons did they give for this?
- What *outcomes* did the students achieve as a result of their actions, and what reasons did they give for this?

Overview of the Method

The study adopted a qualitative research methodology in the interpretivist paradigm. With the definition of perspectives as the frameworks through which the participants made sense of the world (Woods, 1983), this research investigated the students' perspectives on how they understood project-based curriculum vis-à-vis their classrooms and school situations. A purposeful sampling approach was used to select a credible representative sample of participants in the case study school for in-depth study (Miles & Huberman, 1994; Patton, 2002; Punch, 2009). The case study comprised a sample of 30 Secondary 4 students (Grade 10), each of whom was engaged in one of the five special programmes or courses of studies that the sample school offered to Secondary 3 and 4 students. The 30 student participants were randomly sampled from students across the five programmes, namely: the Science Talent Programme; the Mathematics Talent Programme; the Humanities Programme; the Bicultural Studies Programme; and the Language Elective Programme (High School Talent Development Programmes, HCI, n.d.).

Data-Gathering Methods

Semi-structured interviews were conducted with students in five focus groups, with each group comprising six students from the same talent programme. Follow up individual and group informal interviews and discussions provided supplementary data. Documentary evidence was gathered to complement the interview data, thereby providing the 'conceptual density' required for authentic research (Strauss, 1987). The documents reviewed included the school's policy of the introduction and implementation of project work into the mainstream curriculum. In addition, the students' project reports also provided evidence of their reflections and learning as they engaged in project work.

Data Analysis

This study utilized the three-staged inductive analysis approach to manage and analyse data (Miles & Huberman, 1994, p. 428) which included data reduction, data display, and drawing and verifying conclusions (Miles & Huberman, 1994). The collected data were reduced through coding and memoing, leading to the identification of emergent themes. The themes were then developed into theoretical propositions.

FINDINGS

The empirical findings of the study, presented in Chapter 5, led to the development of the following propositions.

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Proposition 1

Understanding the rationale and processes of project work allows students to determine their own learning outcomes and motivates them to learn independently and 'go beyond' the contents of the syllabus. Engagement in research-based project work develops characteristics of independent learning, as learning becomes more informed and involved.

Proposition 2

Students leverage on the differing strengths of their group members and perform different roles to complete their projects. Beyond group dynamics, the students with complementary strengths and abilities work synergistically to ensure alignment in and enhance the quality of their projects.

Proposition 3

As students work on their projects in groups, they engage in collaborative learning which in turn leads to knowledge building. This contributes to collective wisdom which is evident in the products that are jointly produced by project groups.

Proposition 4

Having project groups comprised of members from different peer groups, classes, schools or countries provides students with an experience in collaboration beyond their immediate 'comfort circles', and facilitates interaction and understanding. Such interaction prepares students with the necessary skills to enable them to function well in the future in a more globalized environment.

Proposition 5

When students are not able to find time to meet in-person as a group, they rely heavily on virtual social media to 'meet'. Adequate training to use the tools and facilities on social media is necessary before the commencement of project work in order to maximise their use once the project commences. This enhances learning efficiency.

Proposition 6

Students rely on their teacher mentors to varying degrees to 'guide' them in their project work, and not all teachers provide similar levels of 'guidance'. Levels of reliance on mentors are influenced by factors including initial anxieties about project work and the practicalities of specific projects and research activities, expertise of

the mentor, and the need to stay ‘on track’. Over time, teacher mentors effect a shift from the ‘hand-holding’ stage to independent learning.

Proposition 7

Beyond the guidance from their teachers, students engaged in project work benefit from physical, network and infrastructural supports, including laboratories and equipment; sound library facilities and access to relevant online resources and social media; appropriate computing facilities; and training and workshops in project work learning.

RECOMMENDATIONS

Recommendations for practice, based on the empirical and theoretical findings from the current study, are as follows.

Recommendation 1

Where possible, and at the appropriate levels, schools should encourage students to engage in research-based project work to encourage collaborative learning which in turn leads to knowledge building and contributes to collective wisdom.

Studies show that having students engage in project work, especially when the project extends over a significant period of time, allows them to inquire and generate questions that address the concepts and principles that they encounter in their course of study (Wong et al., 2006; Netto-Shek, 2004). In so doing, they get to form the understanding and perhaps generate new knowledge to build upon or reinforce their investigations. The present study confirms that this gives students the autonomy to collaborate and generate solutions, and make decisions independently. Moreover, as students collaborate in groups to undertake a project, this process provides them with real-world learning experience and gives them the opportunity to hone and develop their problem-solving skills.

Being involved in collaborative learning through researching for their projects greatly enhances learning style, learning experience and learning outcomes for the students. Regardless of the programme and subject area in which the students conducted their projects, all of the groups of students in the present study went through almost the same stages during the course of their projects; namely, exploration, project planning, collection of data, analysis of data and finally coming up with the results and conclusions. Notwithstanding the nature of their projects, being involved in developing their respective projects allowed the students to engage in collective wisdom to construct new knowledge. The collective wisdom described by the students in the present study showed the capacity of their group members to cooperate intellectually in creation, innovation and invention; a process that Gan and Zhu describe as the “divergence, convergence, integration and creation of individual

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member's multiple intelligences in a group/team" (2007, p. 208). This book shows that this collective wisdom stems in part from the discussions, discourse and development of students' respective projects through the various stages, providing them with an enhanced learning experience.

Recommendation 2

Schools should engage students in research-based projects so as to provide students with a better understanding of the relationship between the research activities and procedures, and the research outcomes. This will also help students identify how their learning attitudes have changed.

Engaging students in research-based projects where they have to link and integrate their research to match the concept and principles that they learned in their classes requires them to perform at a higher order thinking (Helle et al., 2006). The present research has also highlighted that students who are enabled in such learning experiences develop ownership of their learning, thus enhancing their motivational level. As such, having students understanding the rationale and processes of project work allows them to determine their own learning outcomes and motivates them to learn independently and 'go beyond' the contents of the syllabus. Engagement in research-based project work develops characteristics of independent learning, as learning becomes more informed and involved.

Recommendation 3

Where project work is included as part of the school curriculum, schools should communicate to students the application and relevance of the skills and competencies involved and also surface the challenges so as to prepare the students to manage expectations.

The present study found that having students understand the school's rationale and processes of project work was important to developing the characteristics of independent learning. This understanding by the students, along with their growth as independent learners, was honed over four years in the case study school. The students believed that engaging in the various processes of research-based project work provided them with a better understanding of the relationship between the research activities and procedures, and the outcomes or the 'end-products'. The students also highlighted that they valued their own role in the research process, and also in generating and developing their own hypotheses in their respective research areas and projects. There was a strong agreement that this makes their learning meaningful and worthwhile. Many of the students shared that they understood that the school's rationale for adopting the research and project-based approach was to provide them with the opportunity to develop essential lifelong skills and foster independent learning. As such, it is recommended that where students are required to undertake project work as part of their curriculum and assessment, the school ought

to educate the students on the relevant skills and competencies that they are expected to acquire and develop, and also to manage challenges and expectations.

Recommendation 4

There should be sufficient training on the use the features and tools of the online platform for all students who are engaged in project work. This training should be delivered to students before the commencement of their project, with subsequent guidance during research activities as needed, so as to allow them to use the online application more efficiently to augment their work.

It was observed that students found it challenging to organise project group meeting sessions among themselves, let alone with their teacher mentors. In part, this was due to the differing schedules among the group members. The problem was especially acute for those who had group members who were not their schoolmates from other local or overseas partner schools. As a result, almost all the students relied quite heavily on online social media, virtual portals or applications to conduct their meetings and discussions, and also to share resources. Many of them were quite comfortable with the asynchronous nature of such media as it allowed them to engage in discussions on their projects at various times and differing locations depending on their respective schedules. While most virtual applications and portals today have synchronous facilities to allow everyone within their groups to meet at the same time, for groups that had members from other countries, such synchronous meetings were also quite impractical due to time-differences.

While the study revealed that almost all the students were engaged in social media such as Facebook or Wikis and were quite familiar with these online media for their social interactions, many of them felt that they lacked the knowledge on how to use these online platforms for their project collaborations and interactions. Some students who were required to use specific online applications such as Wikispaces or Google Docs believed that their lack of familiarity with the features of the online applications impeded their abilities to optimize the use of the platform for effective collaboration among their group members.

Discussions with the students also revealed that while they had received some training to use some of these online applications when they were in Secondary 1 or 2, they considered it to be 'quite basic' in that it did not address the challenges that they faced when they did their projects at higher levels. Challenges included, for example, working collaboratively on common online documents, which requires the students to share and work on data across different applications, and to critically comment on and evaluate their group members' propositions and ideas. As such, it is recommended that adequate training to use the tools and facilities on social media is necessary before the commencement of project work in order to maximise their use once the project commences. This enhances learning efficiency. Follow up training can be provided at point of need as research activities are undertaken.

Recommendation 5

Schools should be encouraged to allow students who are engaged in project work to recruit team members who are beyond their own school or country. This provides students with the opportunity to gain and develop cross-cultural competencies so that they may hone essential skills and attitudes to function well in the global economy in future.

In recent years while schools in Singapore may have implemented project work across the different levels from primary schools to junior college levels (Ho et al., 2004; Liu et al., 2006; MOE Education Programme Website, 2009; Wong et al., 2006; Yeong, 2005) with the objective to develop and hone the students with skills and competencies listed in the 21st Century Competencies Framework (MOE, 2010), many of the collaborations are largely limited to students within their same school. In the present study, while many of the groups comprised students in the case study school, albeit in different classes and programmes, there were groups that had members from other local or overseas partner schools.

The learning outcomes derived from the research collaboration included the students benefiting from the intellectual exchanges, such as brainstorming for ideas and solving problems, they had with their non-schoolmate partners. Where the group members were from overseas partner schools, the rest of the group members also learned much about working with people from different cultures. In the process, these students would have also forged friendships with their overseas counterparts which may develop into future working partnerships. As such, it is recommended that schools that engage students in project work should encourage them to form project groups comprised of members from different peer groups, schools or countries to provide students with an experience in collaboration beyond their immediate 'comfort circles', and to facilitate interaction and understanding. Such interaction prepares students with the necessary skills to enable them to function well in the future in a more globalized environment.

Recommendation 6

Education authorities and school managements should encourage and provide relevant and timely resources and support to enable and empower teachers to implement research-based project work to students.

To roll out and implement similar research-based programme successfully, apart from having suitable students, an adequate and appropriate professional development programme should be in place to help teachers to design and plan the programme and guide the students involved. In this respect, the Education authorities and / or the school management may consider providing teachers with such opportunities and sponsor teachers for programmes that would equip them with the necessary skills. Alternatively schools that wish to initiate such programmes could engage relevant

experts in their fields of study to provide consultancy and advice, and also to conduct planned professional development programmes for the teachers.

Recommendation 7

Aside from providing physical, infrastructural, IT and technical support, schools can also look at other areas such as teacher training, provision of research facilities and enabling connections with a potential network of external expertise to students, especially those who engage in research areas beyond the scope of the school.

As students rely on their teacher mentors in varying degrees to ‘guide’ them in their research and project work, it is noteworthy that some of the students in the present study related that not all teachers provides similar levels of ‘guidance’. It was found that the levels of reliance on teachers as mentors were influenced by factors including initial anxieties about project work and the practicalities of specific projects and research activities. The expertise of the mentor to provide relevant and appropriate guidance to their respective mentees and to have them stay ‘on track’ is critical to the successful completion of the projects. This study has shown that over time, teacher mentors effect a shift from the ‘hand-holding’ stage, in the initial years, to independent learning.

In addition, it was observed in the study that where the teachers or the school lacked the required expertise to guide students who were engaged in research or projects beyond the scope of the school, the school referred these groups of students to relevant experts as resources. These external resources were developed and cultivated over time from the school’s network of contacts that included the vast networks of parents support and the alumni.

Recommendation 8

Beyond upskilling teachers to mentor students in their research, there should also be appropriate training for ancillary staff such as teaching assistants, laboratory technicians, librarians, etc. to provide advice and support to students in their research work.

A number of the students in the present study have credited the support and guidance that they had received from the ancillary staff from the case study school, including the laboratory and IT technicians, the library staff, and even the administrative support officers. Having understood the research and project culture in the case study school, all members of the school including the support staff have committed to providing the students with the environment and support to aid them in their research and project work. This has helped the students in their research work, especially with experiment procedures and protocol as many of them were quite inexperienced with the use of the equipment in the various laboratories, or technical difficulties in IT as they engaged and collaborated in the virtual spaces, or access

to relevant online resources that the school has subscribed. As the case study school has emphasized research-based project work for quite a number of years, the school support staff themselves have also been upgrading and upskilling their knowledge and competencies to work closely with teachers to provide the appropriate resources and support that the students found useful.

IMPLICATIONS FOR FURTHER RESEARCH

Supplementary research can usefully be conducted to identify issues and influences that may successfully impact inter-school or cross-border student research collaboration. The present study described the students' experiences in research-based project work across one school setting. The approach also encouraged student collaboration beyond the case study school to students from other local schools, as well as cross-border research collaboration programmes with overseas partner schools. There are numerous facets of such research-based project learning to discover and study. Additional research could be carried out to identify the factors and challenges that contribute to the success of similar student research collaborations so as to provide appropriate learning opportunities and resources for schools that wish to initiate and facilitate such research collaboration programmes.

The roles of teachers as mentors to students undertaking research projects can be investigated and promoted so as to add to resources that may be of value to schools who may consider initiating similar programmes. In the present study, while teacher mentors provided guidance to their students, the consultation and support was normally done face-to-face during project group meeting sessions. It was not often that teachers participated in the online exchanges on the various online applications or portals though many of their students engaged and collaborated online. Previous studies have reported that the roles of teachers in student research collaboration programmes should not be overlooked (Ligorio & Van der Meijden, 2007; Postholm et al., 2004). These studies maintained that teachers should also be involved in ensuring the success of project-based learning even online. As research collaborations involving schools across borders are not often recounted or publicised, with limited knowledge of the roles of teachers in such collaborations, it is recommended that future studies of similar nature carry out investigations in this aspect. The research from such studies will add to limited literature and will be of value to schools that plan to initiate similar programmes.

In order to gather deep insights into students' perspectives, the student sample for this study was deliberately small. While the aim of the study was to develop theory, and hence a qualitative approach was adopted to obtain rich data from the available sample, further investigations with other cohorts of students in the same school across the various special programmes would help 'test' the theoretical propositions presented in this book.

CONCLUSION

The present study through a qualitative research approach documented the insights and perspectives of academically-able students as they dealt with research-based project work to inculcate an independent learning attitude. The students in the case study related the impact of their learning experience and provided a snapshot of the challenges that they had encountered in the course of their engagement in project work over four years of their secondary school journey. The issues faced by the students in the various stages and processes were discussed and suggestions for improvements, based on students' responses, were presented.

A point that distinguishes the current study from others is that, instead of embarking on prescribed projects, the student participants had to research and initiate their own research projects, and see through the entire process albeit with the guidance from their teacher mentors. This approach of empowering the students to take ownership and accountability of their learning could be adopted in its various permutations to students across the various spectrums of abilities.

The experiences of the students in collaboration among their group members both within and beyond the boundary of the school, using a virtual platform to engage and work together to build upon concepts and theories that they learned in class and apply these to generate new knowledge, bring about the authentic scenarios in which these students will be functioning in the future. The prospect of engaging beyond geographically, spatial and chronological boundaries are real challenges that students have to learn to manage. The findings of this research have the potential to guide schools and teachers in planning for future collaboration programmes involving students across different schools and borders. The outcomes will also provide understandings to other schools that wish to set up similar research-based project work collaboration programmes. The present study also contributes to literature on engaging secondary school students in research-based projects, and serves as a reference for further exploration.

REFERENCES

- Academy of Science. (2012). Overview of AOS. *Academy of Science*. Retrieved June 12, 2012, from <http://www.loudoun.k12.va.us/domain/4871>
- Adams, P. (2006). Exploring social constructivism: Theories and practicalities. *International Journal of Primary, Elementary and Early Years Education*, 34(3), 243–257.
- Anderson, G. (1998). Case study. In G. Anderson (Ed.), *Fundamentals of educational research* (2nd ed., pp. 152–160). London: The Falmer Press
- Angus, M. (1995). Devolution of school governance in an Australian state school system: Third time lucky? In D. Carter & M. O'Neill (Eds.), *Case studies in educational change: An international perspective*. London: The Falmer Press.
- Assumption Pathway School. Retrieved June 12, 2012, from <https://www.aps.edu.sg/>
- Australia's National Report on the Development of Education. (2004). Prepared by The Australian Government Department of Education, Science and Training for the International Conference of Education, Geneva. Retrieved June 28, 2006, from <http://www.ibe.unesco.org/International/ICE47/English/Natreps/reports/australia.pdf>
- Aviv, R., Erlich, Z., Ravid, G., & Aviva, G. (2003). Network analysis of knowledge construction in asynchronous learning networks. *Journal of Asynchronous Learning Network*, 7(3), 1–23.
- Babbie, E. R. (2001). *The practice of social research*. Belmont, CA: Wadsworth Thomson Learning.
- Barbour, M., & Rich, P. (2007). Social constructivist e-learning: A case study. *International Electronic Journal for Leadership in Learning*, 11(5), 1–15.
- Barron, B. J. S., Schwartz, D. L., Vye, N. J., Moore, A., Petrosino, A., Zech, L., & Bransford, J. D., & CTGV. (1998). Doing with understanding: Lessons from research from problem- and project-based learning. *The Journal of the Learning Sciences*, 7(3&4), 271–311.
- Barrow, R. (1984). *Giving teaching back to teachers: A critical introduction to curriculum theory*. Brighton: Harvester.
- Barrows, H. S., & Myers, A. C. (1993). *Problem-based learning in secondary schools* (Unpublished monograph). Springfield, IL: Problem-Based Learning Institute, Lanphier High School and Southern Illinois University Medical School.
- Barrows, H. S., & Tamblyn, R. M. (1980). *Problem based learning: An approach to medical education*. New York, NY: Springer.
- Bartlett, F. C. (1932/1995). *Remembering*. Cambridge, UK: Cambridge University Press.
- Bassani, P. B. (2010). Interpersonal exchanges in discussion forums: A study of learning communities in distance learning settings. *Computers and Education*, 56(2011), 931–938.
- Beare, H., & Boyd, W. L. (1993). *Restructuring schools: An international perspective on the movement to transform the control and performance of schools*. London: Falmer.
- Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House*, 83, 39–43.
- Benson, A., & Blackman, D. (2003). Can research methods ever be interesting. *Active Learning in Higher Education*, 4, 39–55.
- Blackledge, D., & Hunt, B. (1985). *Sociological interpretations of education*. London: Routledge.
- Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palinscar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist*, 26(3&4), 369–398.
- Blumer, H. (1969). *Symbolic interactionism: Perspectives and method*. Englewood Cliffs, NJ: Prentice Hall.
- Bodner, G. M. (1986). Constructivism: A theory of knowledge. *Journal of Chemical Education*, 63(10), 873–878.
- Bogdan, R. C., & Biklen, S. K. (1992). *Qualitative research for education: An introduction to theory and methods* (2nd ed.). Boston, MA: Allyn & Bacon.

REFERENCES

- Boud, D., & Feletti, G. (Eds.). (1991). *The challenge of problem based learning*. New York, NY: St. Martin's Press.
- Boud, D., & Feletti, G. (2003). *The challenge of problem based learning*. London: Kogan Page.
- Brewer, J., & Hunter, A. (1989). *Multimethod research: A synbook of styles*. Newbury Park, CA: Sage.
- Bridges, E., & Hallinger, P. (1992). *Problem based learning for administrators*. ERIC Clearinghouse on Educational Management, University of Oregon.
- Brindley, J. E., Walti, C., & Blaschke, L. M. (2009). Creating effective collaborative learning groups in an online environment. *International Review of Research in Open and Distance Learning*, 10(3), 1–18.
- Brown, P., & Lauder, H. (1997). Education, globalization, and economic development. In A. H. Halsey, H. Lauder, A. Brown, & T. Wells (Ed.), *Education: Culture, economics and society*. Oxford: Oxford University Press.
- Bryman, A. (2001). *Social research methods*. Oxford: Oxford University Press.
- Burbules, N., & Torres, C. A. (Eds.). (2000). *Globalisation and education: Critical perspectives*. New York, NY: Routledge.
- Callison, D. (2006). Project-based learning. *School Library Media Activities Monthly*, 22(5), 42–45.
- Case, S. B., & Miller, W. R. (1999). Partners in research. *The Science Teacher*, 66(8), 42–45.
- Cavalli, M. O. (2001). *A critical stance for approaching research in Japanese physical education: The politics of method as a determinant of experience*. Retrieved July 5, 2009, from <http://www.efdeportes.com/efd29/japan.htm>
- Chai, C. S., Lim, W., So, H., & Cheah, H. M. (2011). *Advancing collaborative learning with ICT: Conception, cases and design*. Singapore: Educational Technology Division, Ministry of Education.
- Chan, C. K. K., & Chan, Y. Y. (2010). Students' views of collaboration and online participation in knowledge forum. *Computers & Education*, 57(2011), 1445–1457.
- Chan, H. C. (1971). *Singapore: The politics of survival, 1965–1967*. Kuala Lumpur: Oxford University Press.
- Chang, C. (2003). Towards a distributed web-based learning community. *Innovations in Education and Training International (IETI)*, 40(1), 27–42.
- Chang, C. C. (2008). A case study on the relationships between participation in online discussion and achievement of project work. *Journal of Educational Multimedia and Hypermedia*, 17(4), 477–509.
- Chang, C. S., Wong, W. T., & Chang, C.Y. (2011). Integration of project-based learning strategy with mobile learning: Case study of mangrove wetland ecology exploration project. *Tamkang Journal of Science and Engineering*, 14(3), 263–273.
- Chapman, A. P. (2003). *Language practices in school mathematics: A social semiotic approach*. New York, NY: The Edwin Mellen Press.
- Chen, H. L. S. (1999). *Into knowledge conceptions and curriculum development: Examining the epistemological assumptions behind the curriculum reform in Taiwan*. Paper presented at the 1999 Taipei International Conference on Educational Science: Internationalization and Indigenization. Taipei, Taiwan.
- Chen, H. L. S., & Chung, J. (2000, January 4–8). *The implementation of school-based curriculum development. School improvement in Taiwan: Problems and possibilities*. Paper presented at the Annual Meeting of the International Congress for School Effectiveness and Improvement, Hong Kong, China.
- Chen, I. Y. L., Chen, N., & Kinshuk. (2009). Examining factors influencing participants' knowledge sharing behaviour in virtual learning communities. *Educational Technology & Society*, 12(1), 134–148.
- Cheng, Y. C. (1998). The pursuit of a new knowledge base for teacher education and development in the new century. *Asia-Pacific Journal of Teacher Education*, 1(1), 1–16.
- Chu, S. K. W., Tse, S. K., Loh, E. Y. L., & Chow, K. (2011). Collaborative inquiry project-based learning: Effects on reading ability and interests. *Library & Information Science Research*, 33(2011), 236–243.
- Chua, G. K., & Chua, G. B. (2008). *Organising collaborative learning spaces for knowledge construction: Deep learning and online behaviour*. Proceedings of 16th International Conference on Computers in Education, Taipei, Taiwan. Retrieved August 5, 2012, from http://www.apsce.net/icce2008/contents/proceeding_0285.pdf

REFERENCES

- Cibulka, J. (1995). The evolution of education reform in the United States: Policy ideals or realpolitik? In D. Carter & M. O'Neill (Eds.), *International perspectives on educational reform and policy implementation*. London: The Falmer Press.
- Cleary, Y., & Marcus-Quinn, A. (2008). Using a virtual learning environment to manage group projects: A case study. *International Journal on E-Learning*, 7(4), 603–621.
- Coffey, A., & Atkinson, P. (1996). *Making sense of qualitative data: Complementary research strategies*. Thousand Oaks, CA: Sage.
- Cohen, L., & Manion, L. (1989). *Research methods in education* (3rd ed.). London: Routledge.
- Creswell, J. W. (1994). *Research design: Qualitative and quantitative approaches*. Thousand Oaks, CA: Sage.
- Creswell, J. W. (1998). *Qualitative inquiry and research design: Choosing among five traditions*. Thousand Oaks, CA: Sage.
- Cuban, L. (1984). *How teachers taught: Constancy and change in American classroom 1890–1980*. New York, NY: Longman.
- Darling-Hammond, L. (1993). Reframing the school reform agenda. *Phi Delta Kappan*, 74(10), 753–761.
- David, J. (2008). What research says about project-based learning. *Educational Leadership*, 65(5), 80–82.
- Deci, E. L., Koestner, R., & Ryan, R. M. (2001). Extrinsic rewards and intrinsic motivation in education: Reconsider once again. *Review of Educational Research*, 71(1), 1–27.
- DeLyser, D. (2001). “Do you really live here?” Thoughts on insider research. *The Geographical Review*, 441–453.
- Denzin, N. K., & Lincoln, Y. S. (Eds.). (2003). *Strategies of qualitative inquiry* (2nd ed.). Thousand Oaks, CA: Sage.
- Dillenbourg, P. (1999). What do you mean by ‘collaborative learning?’ In P. Dillenbourg (Ed.), *Collaborative learning: Cognitive and computational approaches* (pp. 1–19). Oxford: Elsevier.
- Dominguez-Flores, N., & Wang, L. (2011). Online learning communities: Enhancing undergraduate students’ acquisition of information skills. *Journal of Academic Librarianship*, 37(6), 495–503.
- Duffy, T. M. (1994). *Corporate and community education: Achieving success in the information society* (Unpublished paper). Bloomington, IN: Indiana University.
- Elgort, I., Smith, A. G., & Toland, J. (2008). Is wiki an effective platform for group course work? *Australasian Journal of Educational Technology*, 24(2), 195–210.
- Ellis, C., & Bochner, A. P. (2000). Autoethnography, personal narrative, reflexivity: Researcher as subject. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed., pp. 733–768). Thousand Oaks, CA: Sage.
- Elmore, R. F. (1996). Getting to scale with good education practice. *Harvard Education Review*, 66(1), 1–26.
- Erickson, F. (1986). Qualitative methods in research on teaching. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd ed., pp. 119–161). New York, NY: Macmillan.
- Ertmer, P. A., Newby, T. J., Yu, J. H., Tomory, A., & Lee, Y. M. (2011). Facilitating students’ global perspectives: Collaborating with international partners using Web 2.0 technologies. *Internet and Higher Education*, 14(2011), 251–261.
- Etzioni, A. (2000). *The third way to a good society*. Great Britain: Redwood books. Retrieved May 18, 2012, from http://books.google.com.sg/books?hl=en&lr=&id=cA92qTFtYC&io=fnd&pg=PA4&dq=etzioni+1993+virtual+comunities+a-etzioni&ots=fzv0GW6MJe&sig=g_tMaov-q-j8V92keCj5jEKOrT4#PPA3,M1
- Etzioni, A., & Etzioni, O. (1999). Face-to-face and computer-mediated communities, a comparative analysis. *The Information Society*, 15, 241–248.
- Evenson, D. H., & Hmelo, C. E. (2000). *Problem based learning: A research perspective on learning interactions*. Mahwah, NJ: Laurence Earlbaum Associates.
- Fontana, A., & Frey, J. H. (2005). The interview, from neutral stance to political involvement. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (3rd ed.). London: Sage.
- Fontana, D. (1981). *Psychology for teachers* (p. 147). London: British Psychological Society.
- Foo, S.-Y., & Hussain, R. M. R. (2010). Self-directed learning in a socioconstructivist learning environment. *Procedia Social and Behavioural Sciences*, 9(2010), 1913–1917.

REFERENCES

- Gan, Y., & Zhu, Z. (2007). A learning framework for knowledge building and collective wisdom advancement in virtual learning communities. *Education Technology and Society*, 10(1), 206–226.
- Gannon-Leary, P., & Fontainha, E. (2007). Communities of practice and virtual learning communities: Benefits, barriers and success factors. *e-Learning Papers*, 5, 1–13. Retrieved December 12, 2012, from http://www.elearningpapers.eu/index.php?page=doc&doc_id=10219&doclng=
- Ge, X. (2011). Creating, supporting, sustaining and evaluating virtual learning communities. *Knowledge Management and E-Learning: An International Journal*, 3(4), 507–511.
- Gerrish, K. (1997). Being a ‘marginal native’: Dilemmas of the participant observer. *Nurse Researcher*, 5(1), 25–34.
- Gifted Education Programme in Singapore. (n.d.). Retrieved from Ministry of Education of Singapore Website: <http://www.moe.gov.sg/education/programmes/gifted-education-programme/>
- Goh, C. T. (1997). Speech by Prime Minister Goh Chok Tong at the opening of the 7th International Conference on Thinking. *Ministry of Education Speeches*. Retrieved April 20, 2012, from <http://www.moe.sg/media/speeches/1997/020697.htm>
- Goh, K. S. (1979). *Report on the ministry of education*. Singapore: Ministry of Education.
- Good, T. L., & Brophy, J. E. (1990). *Educational psychology: A realistic approach* (4th ed.). White Plains, NY: Longman.
- Gopinathan, S. (1999). Preparing for the next rung: Economic restructuring and education reform in Singapore. *Journal of Education and Work*, 12(3), 295–308.
- Green, A. (1999). Education and globalization in Europe and East Asian convergent and divergent trends. *Journal of Education Policy*, 14(1), 55–71.
- Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 105–117). Thousand Oaks, CA: Sage.
- Gubrium, J. F., & Holstein, J. A. (Eds.). (2001). *Handbook of interview research, context and methods*. Thousand Oaks, CA: Sage Publications, Inc.
- Har, H. P. (2013). Project-based learning through a cross-continental partnership for science project work. In W. C. Chung, J. Tey, C. W. Chow, & C. W. Hon (Eds.), *A borderless and passion-driven learning institution: Lessons from Hwa Chong's future school 2008–2012* (pp. 213–222). Singapore: Kepmedia International.
- Hargreaves, A. (1994). *Changing teachers. Changing times: Teachers' work and culture in the postmodern age*. London: Cassell.
- Hassard, J. (2000). *Science as inquiry*. Hoboken, NJ: Pearson Learning.
- Helic, D., Krottmaier, H., Maurer, H., & Scerbakov, N. (2005). Enabling project-based learning in WBT systems. *International Journal on E-Learning*, 4(4), 445–461.
- Helle, L., Tynjala, P., & Olknuora, E. (2006). Project-based learning in post-secondary education: Theory, practice and rubber sling shots. *Higher Education*, 51, 287–314.
- Heo, H., Lim, K. Y., & Kim, Y. (2010). Exploratory study on the patterns of online interaction and knowledge co-construction in project-based learning. *Computers & Education*, 55, 1383–1392.
- Herold, J., & Ginestie, J. (2011). Help with solving technological problems in project activities. *International Journal of Technology and Design Education*, 21, 55–70.
- High School Assessment Criteria, Hwa Chong Institution. (n.d.). Retrieved July 27, 2013, from http://www.hci.edu.sg/admissions/high_school/academic-programmes-highschool#assessment-promotion-criteria
- High School Bicultural Studies Programme. (n.d.). In the Hwa Chong Institution wiki. Retrieved July 27, 2013, from <http://bsp.wiki.hci.edu.sg/home>
- High School Humanities Programme. (n.d.). In the Hwa Chong Institution wiki. Retrieved July 27, 2013, from <http://humanities.wiki.hci.edu.sg/>
- High School Language Elective Programme. (n.d.). In the Hwa Chong Institution wiki. Retrieved July 27, 2013, from <http://hscf.wiki.hci.edu.sg/>
- High School Science and Math Talent Programme. (n.d.). In the Hwa Chong Institution wiki. Retrieved July 27, 2013, from <http://hssmtp.wiki.hci.edu.sg/>
- High School Talent Development Programmes, Hwa Chong Institution. (n.d.). Retrieved July 27, 2013, from <http://www.hci.edu.sg/advantage/talent-development>

REFERENCES

- Hirtle, J. P. (1996). Coming to terms. *English Journal*, 85(1), 91–92.
- Hmelo, C. E. (1994). *Development of independent learning and thinking: A study of medical problem solving and problem-based learning* (Unpublished doctoral dissertation). Vanderbilt University, Nashville, TN.
- Ho, B. T., Netto-Shek, J., & Chang, S. K. A. (2004). *Managing project work in schools: Issues and innovative practices*. Singapore: Prentice Hall.
- Holstein, J. A., & Gubrium, J. F. (2004). The active interview. In D. Silverman (Ed.), *Qualitative research practice: Theory, method and practice* (2nd ed., pp. 140–161). London: Sage.
- Hord, S. M. (1995). From policy to classroom practice: Beyond the mandates. In D. Carter & M. O'Neill (Eds.), *International perspectives on educational reform and policy implementation*. London: The Falmer Press.
- Hou, H., Chang, K., & Sung, Y. (2007). An analysis of peer assessment online discussions within a course that uses project-based learning. *Interactive Learning Environments*, 15(3), 237–251.
- Howard, J. (2002). Technology-enhanced project-based learning in teacher education: Addressing the goals of transfer. *Journal of Technology and Teacher Education*, 10(3), 343–364.
- Hwa Chong Institution. (2005). *Shaping a new generation: The Hwa Chong Integrated Program*.
- Jamaludin, A., & Quek, C. L. (2006). Using asynchronous online discussions in primary school project work. *Australasian Journal of Educational Technology*, 22(1), 64–87.
- Janesick, V. J. (2000). The choreography of qualitative research design. In K. Denzin & Y. Lincoln (Eds.), *Handbook of qualitative research* (2nd ed.). London: Sage.
- Jenkins, H. (2006). *Convergence culture: Where old and new media collide*. New York, NY: New York University Press.
- John, Y., & Sim, W. K. (Eds.). (1994). *Evolution of educational excellence: 25 years of education in the Republic of Singapore*. Singapore: Longman.
- Johnson, S. D., Suriya, C., & Yoon, S. W. (2002). Team development and group processes of virtual learning teams. *Computers & Education*, 39(2002), 379–393.
- Jonassen, D. (1991). Objectivism vs. Constructivism. *Educational Technology Research and Development*, 39(3), 5–14.
- Jonassen, D. (1991, September). Evaluating constructivist learning. *Educational Technology*, 36(9), 28–33.
- Jones, B. F., Rasmussen, C. M., & Moffitt, M. C. (1997). *Real-life problem solving: A collaborative approach to interdisciplinary learning*. Washington, DC: American Psychological Association.
- Kamberelis, G., & Dimitriadis, G. (2005). Focus groups: Strategic articulations of pedagogy, politics and inquiry. In N. K. Denzin & Y. S. Lincoln (Eds.), *The Sage handbook of qualitative research* (3rd ed., pp. 887–914). Thousand Oaks, CA: Sage.
- Kang, T. (2005). Diversification of Singapore's upper secondary landscape. In J. Tan & P. T. Ng (Eds.), *Shaping Singapore's future: Thinking schools, learning nations* (pp. 52–66). Singapore: Pearson Prentice Hall.
- Kang, T. (2008). Integrated programmes in Singapore: Choices and challenges. In J. Tan & P. T. Ng (Eds.), *Thinking schools, learning nations – Contemporary issues and challenges* (pp. 191–205). Singapore: Pearson Prentice Hall.
- Kanselaar, G. (2002). *Constructivism and socio-constructivism*. Retrieved March 23, 2009, from <http://igitur-archive.library.uu.nl/fss/2005-0622-183040/12305.pdf>
- Kennedy, K. J. (1995). An analysis of the policy contexts of recent curriculum reform efforts in Australia, Great Britain and the United States. In D. Carter & M. O'Neill (Eds.), *International perspectives on educational reform and policy implementation*. London: The Falmer Press.
- Kesten, C. (1987). *Independent learning: A common essential learning: A study completed for the Saskatchewan Department of Education Core Curriculum Investigating Project, Saskatchewan*. Retrieved December 20, 2008, from www.learnhigher.ac.uk/Download-document/117-Independent_Learning.htm
- Khan, S. (2009). Wonderful wikis and internet forums. *Science and Children*, 46(9), 27–31.
- Kim, P., Hong, J., & Lim, G. (2011). Effects of group reflection variations in project-based learning integrated in a Web 2.0 learning space. *Interactive Learning Environments*, 19(4), 333–349.

REFERENCES

- Kim, Y. C. (1999). *Educational strategies for developing human resources needed in the knowledge-based economy*. Seoul: Korean Educational Development Institute.
- Knowles, M. S. (1975). *Self-directed learning: A guide for learners and teachers*. New York, NY: Association Press.
- Koh, J. H. L., Herring, S. C., & Hew, K. F. (2010). Project-based learning and student knowledge construction during asynchronous online discussion. *Internet and Higher Education*, 13(2010), 284–291.
- Kolk, M., & Bias, G. (n.d.). *Collaboration during student project work*. Retrieved October 7, 2013, from <http://creativeeducator.tech4learning.com/v03/articles/Collaboration>
- Law, N., Ma, M., & Yuen, H. K. (2000). *What happen in Project-based Learning?* CITE, Hong Kong University, China. Retrieved March 24, 2009, from <http://hub.hku.hk/handle/123456789/44083>
- Lee, H. L. (2004 August 22). *Prime Minister's national day rally speech*. Singapore Government Media Release, Singapore.
- Lee, K. Y. (1966a). *New bearings on our education system*. An Address by the Prime Minister to Principals of Schools in Singapore Ministry of Culture, Singapore.
- Lee, K. Y. (1966b). *Opening address at the 3rd Asian Leadership Training Seminar of the World Confederation of Organisations of the Teaching Profession*, at the Conference Hall in November 1966.
- Levin, B. (2001). *Reforming education: From origins to outcomes*. London: Routledge Falmer.
- Lévy, P. (1997). *Collective intelligence: Mankind's emerging world in cyberspace*. New York, NY: Plenum Trade.
- Lewis, D., & Allan, B. (2005). *Virtual learning communities: A guide for practitioners*. Berkshire, England: Open University Press.
- Li, A. (1996). PROGRESS REPORT on the Education Reform (4), December 2006. Learning for Life, Learning through Life. *Education Commission. Hong Kong Special Administrative Region of The People's Republic of China*. Retrieved December 12, 2011, from [http://www.e-c.edu.hk/eng/reform/Progress%20Report%20\(Eng\)%202006.pdf](http://www.e-c.edu.hk/eng/reform/Progress%20Report%20(Eng)%202006.pdf)
- Ligorio, M. B., & Van der Meijden, H. (2007). Teacher guidelines for cross-national virtual communities in primary education. *Journal of Computer Assisted Learning*, 24, 11–25.
- Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Beverly Hills, CA: Sage.
- Litosseliti, L. (2003). *Using focus groups in research*. London: Continuum.
- Liu, W. C., Wong, A. F. L., Divaharan, S., Peer, J., Quek, C. L., & Williams, D. (2006). Student's intrinsic motivation in project-based learning using an asynchronous discussion platform. *Education Research Journal*, 21(2), 217–234.
- Lou, Y., & MacGregor, S. K. (2004). Enhancing project-based learning through online between-group collaboration. *Educational Research and Evaluation*, 10(4–6), 419–440.
- Louden, W., & Browne, R. K. (1993). Developments in education policy in Australia. In H. Beare & W. L. Boyd (Eds.), *Restructuring schools: An international perspective on the movement to transform the control and performance of schools*. London: Falmer.
- Luppicini, R. (2003). Categories of virtual learning communities for educational design. *Quarterly Review of Distance Education*, 4(4), 409–416.
- Male, S. A., & Guzzomi, A. L. (2012). *Facilitator – more than a trivial merging of a facilitator and a tutor*. Paper presented at 2012 Australasian Association for Engineering Education (AAEE) Annual Conference, Melbourne, Victoria. Retrieved November 29, 2012, from <http://www.aeee.com.au/conferences/2012/documents/abstracts/aeee2012-submission-197.pdf>
- Mallow, J. V. (2001). Student group project work: A pioneering experiment in interactive engagement. *Journal of Science Education and Technology*, 10(2), 105–113.
- Marshall, C., & Rossman, G. (1995). *Designing qualitative research* (2nd ed.). Thousand Oaks, CA: Sage.
- Martinez, M. (2000). Designing learning objects to personalize learning. In D. A. Wiley (Ed.), *The instructional use of learning objects*. Retrieved January 10, 2009, from <http://www.reusability.org/read/chapters/martinez.doc>
- Maudsley, G. (1999). Roles and responsibilities for the problem based learning tutor in the undergraduate medical education curriculum. *British Medical Journal*, 318, 657–661.

REFERENCES

- Maxwell, J. A. (1998). Designing a qualitative study. In L. Bickman & D. J. Rog (Eds.), *Handbook of applied social research methods*. Thousand Oaks, CA: Sage.
- Maykut, P., & Morehouse, R. (1994). *Beginning qualitative research: A philosophic and practical guide*. London: Falmer Press.
- Mead, G. H. (1934). *Mind, self, and society: From the standpoint of a social behaviorist* (C. W. Morris, Ed.). Chicago, IL: University of Chicago Press.
- Mergel, B. (1998). *Instructional design and learning theory*. Educational Communications and Technology, University of Saskatchewan. Retrieved March 23, 2009, from <http://www.usask.ca/education/coursework/802papers/mergel/brenda.htm>
- Merriam, S. B. (1988). *Case study research in education: A qualitative approach*. San Francisco, CA: Jossey Bass.
- Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Thousand Oaks, CA: Sage.
- Miller, J., & Glassner, B. (2004). The “Inside” and the “Outside”: Finding realities in interviews. In D. Silverman (Ed.), *Qualitative research: Theory, method and practice* (2nd ed., pp. 125–139). London: Sage.
- Mills, J., & Treagust, D. (2003). Engineering education: Is problem-based or project-based learning the answer? *Australasian Journal of Engineering Education* (online). Retrieved February 24, 2012, from http://www.aace.com.au/journal/2003/mills_treagust03.pdf
- Milner, R. G., & Stinson, J. E. (1993). Educating leaders for the new competitive environment. In G. Gijsselaers, S. Tempelaar, & S. Keizer (Eds.), *Educational innovation in economics and business administration: The case of problem-based learning*. London: Kluwer Academic Publishers.
- Ministry of Education. (1974). *Restructure of the education system statement*. Singapore: Ministry of Education.
- Ministry of Education. (1987). *Pre-U seminar: Towards excellence in schools*. Singapore: Ministry of Education.
- Ministry of Education. (1991). *Improving primary school education: Report of the review committee*. Singapore: Ministry of Education.
- Ministry of Education. (1997). Report by the external review team. *Learning, creating and communicating: A curriculum review*. Singapore: Ministry of Education.
- Ministry of Education. (1998). *Learning to think, thinking to learn: Towards thinking schools, learning nation*. Singapore: Ministry of Education.
- Ministry of Education. (2004). *20 years of gifted education: From promise to flow*. Singapore: Ministry of Education.
- Ministry of Education. (2005). *A flexible and diverse system. Ministry of Education Yearbook 2005*. Retrieved February 24, 2012, from <http://www.moe.gov.sg/about/yearbooks/2005/pdf/flexibility-and-choice.pdf>
- Ministry of Education. (2007). MOE selects five future schools @ Singapore. *MOE Press Release*. Retrieved February 24, 2012, from <http://www.moe.gov.sg/media/press/2007/pr20070522.htm>
- Ministry of Education. (2010). MOE to enhance learning of 21st century competencies and strengthen art, music and physical education. *Ministry of Education Press Release*. Retrieved February 24, 2012, from <http://www.moe.gov.sg/media/press/2010/03/moe-to-enhance-learning-of-21s.php>
- Ministry of Education. (2012). Project work. *Ministry of Education (Singapore)*. Retrieved February 24, 2012, from <http://www.moe.gov.sg/education/programmes/project-work/>
- Moon, S. M. (1991). Case study research in gifted education. In N. K. Buchanan & J. F. Feldhusen (Eds.), *Conducting research and evaluation in gifted education: A handbook of methods and applications* (pp. 157–178). New York, NY: Teachers College Press.
- Morgan, D. L. (2002). Focus group interviewing. In J. F. Gubrium & J. A. Holstein (Eds.), *Handbook of interview research* (pp. 141–159). Thousand Oaks, CA: Sage.
- Morse, J. M., & Richards, L. (2002). *Readme first for a users' guide to qualitative methods*. Thousand Oaks, CA: Sage.
- Mortimer, J. (2003). *How school administrative team manage their work in restructured education system: A Western Australian study* (Unpublished doctoral dissertation). University of Western Australia, Australia.

REFERENCES

- Murphy, J. (1991). *Restructuring Schools: Capturing and assessing the phenomena*. New York, NY: Teachers College Press.
- Musante, S. (2006). Cultivating plant scientists. *Bioscience*, 56, 10.
- Neo, M. (2005). Engaging students in group-based co-operative learning: A Malaysian perspective. *Educational Technology and Society*, 8(4), 220–232.
- Netto-Shek, J. (2004). Making projects work: Structuring learning. In B. T. Ho, J. Netto-Shek, & S. K. A. Chang (Eds.), *Managing project work in schools: Issues and innovative practices* (pp. 1–11). Singapore: Prentice Hall.
- Ngeow, K., & Kong, Y. (2001). Learning to learn: Preparing teachers and students for Problem-based Learning. *ERIC Digests* (ERIC Identifier ED 457524). Retrieved December 13, 2008, from <http://www.eric.ed.gov/>
- Northlight School. (n.d.). Retrieved December 3, 2011, from <https://www.nls.edu.sg/home/>
- NUS High School of Math and Science. Retrieved December 3, 2011, from <http://www.nushigh.edu.sg/>
- O'Doherty, M. (2006). Definitions of independent learning – Initial overview. *LearnHigher*. (The University of Manchester)
- O'Donoghue, T. A. (2007). *Planning your qualitative research proposal: An introduction to interpretivist research in education*. London: Routledge.
- O'Donoghue, T. A., & Clarke, S. (2009). *Leading learning, process, themes and issues in international contexts*. London: Routledge.
- O'Donoghue, T. A., & Dimmock, C. (1998). *School restructuring: International perspectives*. London: Kogan Page
- Oliveira, I., Tinoca, L., & Pereira, A. (2011). Online group work patterns: How to promote a successful collaboration. *Computers & Education*, 57(2011), 1348–1357.
- Ota, H., & Kobayashi, T. (1988). Secondary education in Japan. In R. Lawson (Ed.), *Changing patterns of secondary education: An international comparison* (pp. 143–164). Canada: The University of Calgary Press.
- Palinscar, A. S. (1998). Social constructivist perspectives on teaching and learning. *Annual Review of Psychology*, 49, 345–375.
- Palloff, R. M., & Pratt, K. (2007). *Building online learning communities: Effective strategies for the virtual classroom* (2nd ed.). San Francisco, CA: Jossey-Bass.
- Patton, M. Q. (2002). *Qualitative research and research methods* (3rd ed.). Thousand Oaks, CA: Sage Publications, Inc.
- Pintrich, P., & De Groot, E. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology*, 82, 33–40.
- Pitman, G. E. (2002). Outsider/insider: The politics of shifting identities in the research process. *Feminism and Psychology*, 12, 282–288.
- Postholm, M., Pettersson, T., Gudmundsdottir, S., & Flem, A. (2004). The need for structure and guidance when ICT is used in project work. *Mind, Culture and Activity*, 11(3), 178–200.
- Preece, J., Maloney-Krichmar, D., & Abras, C. (2003). History and emergence of online communities. In K. Christensen & D. Levinson (Eds.), *Encyclopaedia of community: From village to virtual world* (pp. 1023–1027). Thousand Oaks, CA: Sage Publications.
- Punch, K. F. (1998). *Introduction to social research: Quantitative and qualitative approaches*. London: Sage.
- Punch, K. F. (2005). *Introduction to social research: Quantitative and qualitative approaches* (2nd ed.). London: Sage.
- Punch, K. F. (2006). *Developing effective research proposals* (2nd ed.). London: Sage.
- Punch, K. F. (2009). *Introduction to research methods in education*. London: Sage.
- Punch, M. (1986). *The politics and ethics of fieldwork: Muddy boots and grubby hands*. Beverly Hills, CA: Sage.
- Punch, M. (1994). Politics and ethics in qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 83–97). Thousand Oaks, CA: Sage.
- Quek, C. L. (2010). Analysing high school students' participation and interaction in an asynchronous online project-based learning environment. *Australasian Journal of Educational Technology*, 26(3), 327–340.

REFERENCES

- Ruddock, J. (1993). The theatre of daylight: Qualitative research and school profile studies. In M. Schratz (Ed.), *Qualitative voices in educational research* (pp. 8–23). London: The Falmer Press.
- Sarantakos, S. (1998). *Social research* (2nd ed.). China: Macmillan Publishers.
- Savery, J. R. (2006). Overview of problem-based learning: Definitions and distinctions. *The Interdisciplinary Journal of Problem-Based Learning*, 1(1), 9–20.
- Scardamalia, M., & Bereiter, C. (1996). Student communities for the advancement of knowledge. *Communications of the ACM*, 39(4), 36–37.
- Scardamalia, M., & Bereiter, C. (2006). Knowledge building: Theory, pedagogy and technology. In K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 97–118). New York, NY: Cambridge University Press.
- School of Science and Technology, Singapore. Retrieved June 12, 2012, from <http://www.sst.edu.sg/>
- School of the Arts. Retrieved December 3, 2011, from <http://www.sota.edu.sg/>
- Schoppa, L. (1991). Education reform in Japan: Goals and results of the recent reform campaign. In E. Beauchamp (Ed.), *Windows on Japanese education* (pp. 51–75). Westport, CT: Greenwood Press.
- Schuman, L. (1996). *Perspectives on instruction*. [On-line]. Retrieved from <http://edweb.sdsu.edu/courses/edtec540/Perspectives/Perspectives.html>
- Schwandt, T. A. (1994). Constructivist, interpretivist approaches to human inquiry. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (pp. 118–137). Thousand Oaks, CA: Sage.
- Seet, L. Y. B., & Quek, C. L. (2010). Evaluating students' perceptions and attitudes toward computer-mediated project-based environment: A case study. *Learning Environment Research*, 13, 173–185.
- Serfeith, M. (1997). *Palo Alto College critical thinking resource homepage*. Retrieved December 11, 2008, from <http://lonestar.texas.net/~mseifert/crit.html>
- Shanmugaratnam, T. (2006). *Keynote address by minister for education at the teachers' mass lecture 2006*.
- Shanmugaratnam, T. (2006). *Speech by minister for education at the ministry of education work plan seminar*.
- Sharpe, L. (2002). After effectiveness: New directions in the Singapore school system? *Journal of Educational Policy*, 17(2), 151–166.
- Sharpe, L., & Gopinathan, S. (1996). Effective island, effective schools: Repairing and restructuring in the Singapore school system. *International Journal of Educational Reform*, 5(4), 294–402.
- Shimahara, N. K. (1997). Japanese lessons for educational reform. In A. Hargreaves & R. Evans (Eds.), *Beyond educational reform: Bringing teachers back in* (pp. 94–104). Buckingham: Open University Press.
- Singapore Sports School. Retrieved December 3, 2011, from <http://www.sportsschool.edu.sg/>
- Sivaraman, J. (2008). Independent learning: Self-learning is self-reliance (CDTL Brief, newsletter). *Independent Learning*, 11(1). Retrieved December 11, 2008, from <http://www.cdtl.nus.edu.sg/brief/v11n1/sec6.htm>
- Smith, B. L., & MacGregor, J. T. (1992). What is collaborative learning? In A. Goodsell, M. Maher, V. Tinto, B. L. Smith, & J. MacGregor (Eds.), *Collaborative learning: A sourcebook for higher education*. Pennsylvania, PA: National Center on Post-secondary Teaching, Learning and Assessment, Pennsylvania State University.
- Snelling, C., & Karanicolas, S. (2008). *Why wikis work: Assessing group work in an online environment*. Proceedings of Australian Technology Network Conference 2008, Adelaide, Australia. Retrieved August 5, 2013, from <http://www.ojs.unisa.edu.au/index.php/atna/article/viewFile/298/276>
- So, H. J., Seah, L. H., & Toh-Heng, H. L. (2009). Designing collaborative knowledge building environments accessible to all learners: Impacts and design challenges. *Computers & Education*, 54(2010), 479–490.
- Sonmez, D., & Lee, H. (2003). Problem-based learning in science. *ERIC Digests* (ERIC Identifier ED482724). Retrieved December 11, 2008, from <http://www.vtaide.com/png/ERIC/PBL-in-Science.htm>
- Soon, T. W. (1988). *Singapore's new education system: Education reform for national development*. Singapore: Institute of Southeast Asian Studies.
- Stake, E. E. (1988). Case study methods in educational research: Seeking sweet water. In R. M. Jaeger (Ed.), *Complementary methods for research in education* (pp. 253–300). Washington, DC: American Educational Research Association.

REFERENCES

- Strauss, A. L. (1987). *Qualitative analysis for social scientists*. New York, NY: Cambridge University Press.
- Strauss, A. L., & Corbin, J. (1990). *Basics of qualitative research: Grounded theory procedures and techniques*. Newbury Park, CA: Sage.
- Strauss, A. L., & Corbin, J. (1998). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (2nd ed.). Thousand Oaks, CA: Sage Publications.
- Sung, K. H. (1998). Recent education reform. In *Korean education: Perspectives on educational development*. Seoul: Korean Educational Development Institute.
- Sweeting, A., & Morris, P. (1998). Educational change in the Pacific Rim: Meeting the challenges. In K. Sullivan (Ed.), *Oxford studies in comparative education*. Oxford: Triangle Books.
- Tan, J. (1998). Independent schools in Singapore: implications for social and educational inequalities. In J. Tan, S. Gopinathan, & W. K. Ho (Eds.), *Education in Singapore*. Singapore: Prentice Hall.
- Tan, J., & Ng, P. T. (Eds.). (2005). *Shaping Singapore's future: Thinking schools, learning nation* (pp. 52–67). Singapore: Prentice Hall.
- Tan, J., Gopinathan, S., & Ho, W. K. (Eds.). (1997). *Education in Singapore – A book of readings*. Singapore: Prentice Hall.
- The Young, Gifted and Talented Programme. Retrieved March 24, 2009, from <http://www.nagc.org/>
- Thomas, J. W. (2000). *A review of research on project-based learning*. Retrieved April 10, 2009, from <http://www.autodesk.com/foundation>
- Thomas, J. W., & Mergendoller, J. R. (2000). *Managing project-based learning: Principles from the field*. Paper presented at the Annual Meeting of the American Educational Research Association, New Orleans, LA. Retrieved March 3, 2012, from http://www.bie.org/research/study/principles_from_the_field
- Thomas, J. W., Mergendoller, J. R., & Michaelson, A. (1999). *Project-based learning: A handbook for middle and high school teachers*. Novato, CA: The Buck Institute for Education.
- Thomas, W. R., & MacGregor, S. K. (2005). Online project-based learning: How collaborative strategies and problem-solving processes impact performance. *Journal of Interactive Learning Research*, 16(1), 83–107.
- Trivina, K. (2005). Diversification of Singapore's upper secondary landscape: Introduction of the integrated programmes, specialised independent schools and privately-funded schools. In J. Tan & P. T. Ng (Eds.), *Shaping Singapore's future: Thinking schools, learning nation* (pp. 52–67). Singapore: Prentice Hall.
- Turvey, K. (2006). Towards deeper learning through creativity within online communities in primary education. *Computers and Education*, 46, 309–321.
- Twenty-First Century Children. (n.d.). *Partnership for 21st century skills*, Para 4. Retrieved October 23, 2013, from <http://www.p21.org/about-us/press-kit>
- Tyack, D., & Cuban, L. (1995). *Tinkering toward Utopia: A century of public school reform*. Cambridge, MA: Harvard University Press.
- Underwood, J., Smith, H., Luckin, R., & Fitzpatrick, G. (2007). E-Science in the classroom: Towards viability. *Computers & Education*, 50(2008), 535–546.
- vonGlaserfeld, E. (1989). Cognition, construction of knowledge, and teaching. *Synthese*, 80, 121–140.
- Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Cambridge, MA: Harvard University Press.
- Wang, M., Poole, M., Harris, B., & Wangermann, P. (2001). Promoting online collaboration learning experience for teenagers. *Educational Media International*, 38(4), 203–215.
- Wang, S. L., & Hwang, G. J. (2011). The role of collective efficacy, cognitive quality, and task cohesion in computer-supported collaborative learning. *Computers & Education*, 58(2012), 679–687.
- Wheatley, G. H. (1991). Constructivist perspectives on science and mathematics learning. *Science Education*, 75(1), 9–21.
- Wong, A. F. L., Quek, C. L., Divaharan, S., Liu, W. C., Peer, J., & Williams, M. D. (2006). Singapore students' and teachers' perceptions of computer-supported project work classroom learning environments. *Journal of Research on Technology in Education*, 38(4), 449–479.

REFERENCES

- Wood, P. (1983). *Sociology and the school – An interpretivist viewpoint*. London: Routledge and Kegan Paul.
- Woodward, A. (1998). Infants selectively encode the goal object of an actor's reach. *Cognition*, *69*, 1–34.
- Yeo, H. J. (2013). Global academy. In W. C. Chung, J. Tey, C. W. Chow, & C. W. Hon (Eds.), *A borderless and passion-driven learning institution: Lessons from Hwa Chong's future school 2008–2012* (pp. 9–19). Singapore: Kepmedia International.
- Yeo, K. W., & Lau, A. (1991). From colonialism to independence, 1945–1965. In E. C. T. Chew & E. Lee (Eds.), *A history of Singapore*. Singapore: Oxford University Press.
- Yeong, A. (2005, May 31–June 3). *The promise of the project work initiative in Singaporean education: A critical reflection*. Centre for Research, Pedagogy and Practice (CRPP) Conference (pp. 1–17). National Institute of Education, Singapore. Retrieved August 5, 2012, from <http://conference.nie.edu.sg/paper/new%20converted/ab00286.pdf>
- Yin, R. K. (1984). *Case study research: Design and methods*. Newbury Park, CA: Sage.
- Yip, J. S. K., Eng, S. P., & Yap, J. Y. C. (1997). 25 years of education reform. In J. Tan, S. Gopinathan, & W. K. Ho (Eds.), *Education in Singapore – A book of readings Singapore* (pp. 3–32). Singapore: Prentice Hall.
- Zhang, J., Scardamalia, M., Reeve, R., & Messina, R. (2009). Designs for collective cognitive responsibility in knowledge-building communities. *The Journal of the Learning Sciences*, *18*, 7–44.
- Zhang, K., Peng, S. W., & Hung, J. (2009). Online collaborative learning in a project-based learning environment in Taiwan: A case study on undergraduate students' perspectives. *Educational Media International*, *46*(2), 123–135.

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