CHAPTER 1

INTRODUCTION

> We need to explore emerging technologies that can more economically overcome the "availability gap" and support effective learning. New handheld and embedded-chip technologies that enable mobile and active learning seem quite promising in this regard (Wiley, Sanchez, & Moher, 2005, p.245).

Technology has advanced at a tremendous rate. Devices, like computers, are getting smaller in size but its capability and storage is increasing. New technologies can be adapted for learning but suitable instructional design theories are required for learning with new technologies to be effective. Instructional design theories have reflected trends in the field of learning and instruction. Early theories of instructional design have focused on achieving observable and measurable outcomes using Gagne's events of instruction (1970) or Dick and Carey's model (1985). However, recent theories focus on the learner as the processor of information (Driscoll & Brunner, 2005). Hence, the design of instruction emphasized manipulating the internal processes within the learner to facilitate learning. The learning environment should support these social interactions using social and cultural variables, and the appropriate tools.

Learning theories seem to have shifted from a transmission model towards an active learning approach for understanding (Jarvis, 2002a; Royer, 2005; Wiley, Sanchez & Moher, 2005). This form of learning encourages the use of cognitive processes by the learner in applying technology in understanding the subject.

Technology for the cognitive revolution should allow for interaction and collaboration among learners, as well as personal reflection in the individual learner. The learner should be exposed to multiple representations of content in the learning environment so that he can actively construct his own understanding (Wiley, Sanchez & Moher, 2005). The use of internet technology can allow access to various forms of content and views. For collaborative learning and problem solving activities, the learner can interact with the content, and with his peers using social networking platforms. Further, learning can be individualized with the use of mobile and portable devices which allows the learner to access information anytime and anywhere (BECTA, 2004; Saedah Siraj, 2004; Wagner, 2005). Hence, collaborative mobile learning may signal the way forward to address the technology needs for the cognitive revolution.

In the Malaysian context, the use of technology in teaching and learning was stressed upon with the implementation of the 'Smart School' flagship application of the Multimedia Super Corridor (MSC) launched in 1996. Malaysia was to be transformed into a knowledge-based society using information and communications technology (ICT) as an enabler (Multimedia Development Corporation/ MDeC, 2008a). The student-centered teaching methods in the Smart School varied, and took into account individual differences such as learning styles, and multiple intelligences (Smart School Project Team, 1997). The "*pembestarian*" or "making schools smart" process was undertaken from 2006 onwards to ensure that all schools would be smart schools by 2010 (Ministry of Education/MOE, 2008). Teachers were trained to improve their ICT skills in order to assist in developing a knowledgeable and skilled generation of learners, and to decrease the

digital divide (MOE, 2006). Hence, teachers have been trained to address the learners' needs for student-centered learning in the cognitive revolution.

Technology for teaching and learning can be easily implemented as almost all schools have computer hardware and internet access. Schools in Malaysia have been equipped with ICT hardware such as computer laboratories, laptops, School Access Centers, and broadband internet access through the SchoolNet (MOE, 2008). In addition, the teaching and learning materials developed during the Smart School Pilot Project included courseware for the four subjects: Malay Language, English Language, Mathematics, and Science for self-accessed, self-directed, and self-paced learning (MOE, 2006). The hardware and software supplied enabled teaching to be more individualized and relevant to the learner.

The resources used for teaching and learning, and the teaching practices in Malaysia in the last decade have changed. During the Smart School Pilot Project (SSPP), courseware was developed for learning. After the pilot project, the emphasis was on SCORM-compliant e-materials up-loaded onto Learning Management Systems (LMS) to facilitate individualized learning (MOE, 2008). In recent years, MOE has supported several smart partnerships with organizations employing project-based learning, and web-based collaborative learning (Fong, Raja Maznah, Raja Hussain, Rozhan Idrus, Shekaran, & Chong, 2008; MOE, 2007; MOE & Intel Malaysia, 2008; MOE & Oracle Education Foundation, 2008). The number of schools involved in using project-based learning and collaborative learning was few, but it signaled the start of a more social and interactive form of online learning in schools. Online learning promotes the cognitive processes of learning, encouraging collaboration, and development of problem solving skills.

However, the emphasis given by the government to develop knowledge workers does not seem to be reflected in ownership of technology equipment in the population. The majority of Malaysians do not seem to own personal computers nor subscribe to broadband internet service. Although Malaysia was promoted as a technology-hub in the region since the 1990s with the launch of the MSC, and has grown since then to encompass 7 cyber cities in 2008 (MDeC, 2008c), the country's broadband internet penetration for the Malaysian population showed a different perspective. At the end of 2004 there was only 1% penetration, which had risen to 6% at the end of 2008 (Paul Budde Communication Pty. Ltd., 2009). Personal computer penetration in 2009 was at 25% (Business Monitor International, 2009). This was surprising given the government's interest in the development of knowledge-workers and the ICT sector. Moreover, the digital divide between the rural and the urban areas still exists as majority of broadband subscription is in the Klang valley.

On the other hand, the mobile phone market penetration differed greatly. In 1998, there were only two million mobile phone subscribers in Malaysia, but in 2008 there was 100% penetration as almost all 27 million Malaysians subscribed to mobile services (Paul Budde Communication Pty. Ltd., 2009). In contrast, fixed line penetration was only 15% at the start of 2009 with 4.3 million fixed line subscribers (Paul Budde Communication Pty. Ltd., 2009). The mobile phone market penetration seemed to be much higher than the ownership of personal computers. Hence, this indicates that there is a large potential in the use of mobile learning with mobile devices.

The government has implemented projects in rural areas to provide the community with the opportunity to interact and communicate with ICT in an effort to narrow the digital divide and reduce technophobia among Malaysians (Business Monitor International, 2009). Furthermore, the government hoped that the implementation of the Smart School initiative would contribute to the development of skilled citizens of tomorrow for the knowledge-based economy, and hence assist in balancing the urban-rural digital divide. As yet, these ICT initiatives do not seem to have made an obvious impact in the rural areas, as the use of ICT seems low.

On the other hand, there is potential in using mobile devices for teaching and learning. Mobile device ownership is higher than that of the computer, and the mobile is not limited to rural areas or different age groups. As more people have access to mobile devices, mobile learning may be the way forward for teaching and learning for the future in Malaysian secondary schools.

Problem Statement

The staggering speed of advancement in technology in the complex world we live in suggests that the way we learn would have to change (Rose & Nicholl, 1997). Knowledge is increasing rapidly (Halpern, 1992), and technologies like the internet, makes this knowledge accessible to the public immediately (Rose & Nicholl, 1997). The role of the teacher may have to change from being the ‘keeper’ and ‘transmitter’ of knowledge to a facilitator of learning. This is because knowledge itself is transient and constantly changing as new discoveries are made (Jarvis, 2002a). The teacher now has a different role, and must develop new skills, and realize the impact of social, culture and individual differences on learning (Jarvis, 2002b).

The rapid growth of knowledge is obvious in the field of science and technology. This means that for the teacher or the learner to have all knowledge of science would be impossible. Hence, a change in the emphasis in the teaching of science may be required, that is from memorization and practice, to scientific reasoning and communication (Ford & Forman, 2006).

Traditional instructional design theories emphasized the external conditions rather than the internal processes of learning, and may not be suitable for this approach (Ragan & Smith, 2004). The traditional theories of instruction are prescriptive and condition-based, and the analysis of knowledge is emphasized. Tasks given need to be subdivided to determine the goals and outcomes of learning (Driscoll & Burner, 2005).

On the other hand, developments in the field of cognitive psychology give rise to instructional design theories which emphasize the learner, the analysis of the learning process, and the learning environment (Driscoll & Burner, 2005). Though the analysis of knowledge and the tasks is important, the core of instruction should emphasize the process of instruction. Tools and systems which could make learning authentic and applicable in the workplace and in the real environment should be considered for learning (Driscoll & Burner, 2005).

The emphasis of the process and the environment for learning is most critical in the design of instruction for science. Science uses a set of processes to make discoveries about the "natural world" (Abruscato, 2000), hence, the core aspect of science instruction should be the processes of scientific reasoning in order to build knowledge (Etkina, Mestre, & O'Donnell, 2005; Howe & Jones, 1993). In this process of building new scientific knowledge, the scientific community

communicates and collaborates (Etkina, Mestre, & O'Donnell, 2005; Hogan & Fisherkeller, 2005; Scanlon, 1997).

The teaching of science should reflect the nature of science, which is not only the transmission of knowledge, but the building of knowledge through the processes of inquiry and communication (Ford & Forman, 2006). Science learners when provided the opportunity to communicate and collaborate in the process of inquiry to construct knowledge, develop the scientific processes (Etkina, Mestre, & O'Donnell, 2005; Hogan & Fisherkeller, 2005; Kozma, 2003; Osbourne & Henessy, 2003).

The Malaysian Integrated Curriculum for Secondary School Science emphasizes the content and the scientific processes. However, the reality is that in Malaysia, students do not understand the nature of science and only study for scientific facts (Chong, 2005). The method of instruction used by teachers also does not reflect the nature of science. Science teachers would present the facts of science, and stress more on memory work (Lee, 1991; Ling, 2002; Tan, 2002). Secondly, the development of the processes of scientific inquiry does not seem important. This is because teachers prefer to explain concepts first before attempting experiments (Sopia Mohd. Yasin, 2002), or to demonstrate experiments rather than allow the students to design or attempt the experiments (Lee, 1991; Sopia Mohd. Yasin, 2002). This shows that there seems to be little emphasis on the scientific processes of acquiring knowledge.

There also seems to be a lack of understanding of the language of science as students do not have enough practice in using scientific language. Students who found the language of science confusing would also have many misconceptions in

science (Pathmini, 1999). Therefore, there is a need to provide the students opportunities to use the language in science.

By having more opportunities to communicate and use the language of science while solving problems in science, students can build their knowledge of science. Unfortunately, teachers do not seem to teach the process of science and students are not given the opportunity to communicate and collaborate. One reason might be that the teacher feels that there is not enough time during school hours, as only 5 periods or 230 minutes a week is allocated for science teaching. In addition, there is a large amount of science content to be taught and the teacher's perception of the nature of science is related to factual knowledge.

Collaborative learning and problem solving may be beneficial in promoting the learning of scientific processes. The scientific processes of inquiry and reasoning are developed when learners collaborate to solve problems in science (Belland, Glazewski, & Richardson, 2008; Halpern, 1992; Hogan & Fisherkeller, 2005; Osbourne & Hennesy, 2003; Nadelson, 2009). Collaborative learning is a natural form of learning that arises from the social interaction in the group (Johnson & Johnson, 2004). When learners discuss and build better explanations, they resolve their conflicts and misconceptions in science they are learning (Waight & Abd-El-Khalick, 2007). In addition, collaboration allows learners to be more actively engaged (Olitsky, 2007; Waight & Abd-El-Khalick, 2007), and have higher self-efficacy (Brown, 2006; Dunlap, 2005).

Collaborative learning supported by computer-mediated communications (CMC) (Jonassen, Lee, Yang, & Laffey, 2005) can make learning mobile. This is because learning can occur anywhere and anytime (Geddes, 2004; Saedah Siraj, 2005), either in the privacy of their homes, in school access centre's, or while on

the move with the appropriate tool. Tools such as collaborative workspace or wikis, online discussion forums, and text messaging through mobile phones can be utilized. The advantages of collaborative mobile learning are many as it is an enriching form of learning which allows evaluation and feedback (Driscoll, 2007; Grabe & Grabe, 2004; Kaye, 1992) and supports the learning process (Attewell, 2005; Harrison, 2004; Naish, 2005; O'Nuallain & Brennan, 2005; Savill-Smith, Attewell, & Stead, 2006).

Hence, a collaborative mLearning module, which uses CMC tools, might assist science instruction by providing more time for students to use the language of science in discussion as they attempt problem solving tasks. The problem solving tasks can stimulate discussions and collaboration to mimic the processes of reasoning for developing scientific knowledge.

In Malaysia, there has not been much research done on the use of collaborative mLearning in science instruction. Nevertheless, CMC tools for collaboration have been used to improve communication and thinking skills (Jonassen, 2000; Jonassen, Howland, Moore, & Marra, 2003; Romiszowski & Mason, 2004; Grabe & Grabe, 2004; Inglis, Ling & Joosten, 2002). Hence, there is a possibility that CMC tools could be used for communicating and stimulating discussions to develop scientific concepts.

Collaborative mLearning is a relatively new area of research in Malaysia. This study will contribute to the body of knowledge in the field of educational technology and science instruction in Malaysia. The module for collaborative mLearning is developed based on the First Principles of Instruction (Merrill, 2002) and the social constructivist learning theory is used to design instruction.

Purpose of the Study

The purpose of this study is firstly, to design and develop a collaborative mLearning module using information from subject matter and technical experts based on experts' opinions on the topic of Nutrition in Form 2 Science. Secondly, the collaborative mLearning module developed would be implemented in an urban school to explore students' learning and perception of the activities and tools in a collaborative mLearning environment.

In this study, the developmental process would be documented according to phases of analysis, design and development, and evaluation. The findings from the analysis of each phase or the study would be recorded.

Objectives of the Study

This study takes on a developmental research approach (Ritchey, 1997) which is a form of design-based research to produce knowledge for a specific context and to solve a need or a problem (Ritchey, 1997; Wang & Hanafin, 2005). This form of research is used to produce knowledge through models and principles after the processes of analysis, design, development and implementation (McKenny & Van der Akker, 2005; Ritchey, 1997; Richey, Klein, & Nelson, 2004; Wang & Hanafin, 2005). In this study, a model for collaborative mLearning is developed, and the principles for the implementation of collaborative mLearning are iterated.

This study will be divided into three phases: the analysis phase; the design and development phase; and the evaluation phase. The objectives of each phase are as follows:

A: Analysis Phase

1. To describe the situation regarding the use of technology of a group of students in the context of the study in the following areas:
    a. the perception of the level of technology (ICT) skills.
    b. the frequency of use of the forms of CMC tools the group of students has access to.
2. To describe the perceptions of the use of computers and mobile phones in teaching and learning by the group of students in the context of this study.

B: Design and Development Phase

3. To describe the information Subject Matter and Technology experts can give to assist the development of the collaborative mLearning module for Form 2 Nutrition.

C: Evaluation Phase

4. To explore the perceptions of the activities and CMC tools used in the collaborative mLearning module for Form 2 Nutrition of the participants in the context of the study.
5. To determine the difficulties in the implementation of the activities in the collaborative mLearning module for Form 2 Nutrition faced by the participants in the context of the study.
6. To explore collaborative mLearning among the participants in the context of the study.

Research Questions

The following research questions have been identified for this study according to the phases of the study:

A: Analysis Phase

1. What is the situation regarding the use of technology of the group of students in the context of this study in the following areas:
    a. the level of technology (ICT) skills?
    b. forms of CMC tools the group of students has access to?
    c. the frequency of use of the forms of CMC tools the group of students has access to?
2. What are perceptions of the use of computers and mobile phones for teaching and learning by the group of students in the context of this study?

B: Design and Development Phase

3. What information can the Subject Matter and Technology experts give to assist the development of the collaborative mLearning module for Form 2 Nutrition?

C: Evaluation Phase

4. What are the perceptions of the participants in the context of the study on the activities and CMC tools in the collaborative mLearning module for Form 2 Nutrition?
5. What are the difficulties in the implementation of the activities in the collaborative mLearning module for Form 2 Nutrition faced by the participants in the context of the study?

6. What is collaborative mLearning to the participants in the context of the study?

Significance of the Study

The findings of this study is useful to policy makers, teachers, instructors and instructional designers as it not only determines the feasibility of the collaborative mLearning module, it also provides the guidelines and considerations that are required in a collaborative mLearning environment.

Policy makers in the Educational Technology Division, MOE will be able to determine whether collaborative mobile technology for communication can be used for teaching and learning, and to decide based on any difficulties identified during the implementation of this study, the feasibility of its implementation in Malaysia.

This study will also be useful for teachers in providing useful information such as the type of content, assessment and feedback that is suitable for instruction. The features and characteristics of online communications and the collaborative mLearning environment are also provided.

The role of the teacher has changed from being the provider of knowledge to a facilitator of learning to scaffold students as they collaborate on problem tasks. This study would enable teachers and facilitators to identify the considerations needed to manage a collaborative mLearning environment.

Instructional designers can benefit from the findings of this study as design features and instructional activities for a collaborative mLearning environment are provided. The findings from this study enable lessons and learning events to be designed to provide for collaboration and discussions which can encourage student

reflection and learning. Furthermore, these designs can also be applied to not only science, but to different subjects and levels of education.

Students will benefit in knowing that a learning environment that is meaningful and relevant, which can be accessed anywhere, anytime for learning can be used. Besides interaction among their peers, expert help can also be obtained. Parents and other stakeholders may need to be convinced that this form of learning is beneficial and effective.

The key issues identified in the implementation of collaborative mLearning in secondary schools can be the basis for a set of guidelines for teachers, instructional designers and policy makers.

Scope of the Study

This study focuses on the development of a collaborative mLearning module and documents the processes in the three phases of development. The focus in the first phase, the analysis, is only on the use of technology and the perceptions of level of technology skills, and use of computers and mobile phones for learning of the students in the context of the study. In addition, the choice of the topic is justified. The second phase focuses on the design of the module where the subject matter and technology experts' opinion are described to assist in development of the module. In the final phase, the module was implemented on a selected group of students in the context of the study, and the participants' perceptions of the activities and tools, difficulties, and collaborative mLearning were identified.

The collaborative mLearning module makes use of free online tools which can be accessed through the use of the internet from desktop computers or laptops.

The forms of communications may include online discussion forums, wikis, e-mails and text messaging. The use of online discussion forums is limited to posting announcements, queries, comments, views, assignments and answers to questions during the learning experience. The collaborative work on the group problem task will be done on the wiki**.**

The concept of mobility in this study is that the learner can learn anywhere and at anytime. Hence, collaborative mLearning includes the use of mobile devices, as well as computers and laptops at home, in the school and at other locations. However in this study, the function of the mobile phones for learning is limited to text messaging or SMS (Short Messaging System) and is not used to access the internet or the online collaborative groups. In this respect, collaborative mLearning is a blend of mobile learning with mobile devices, and collaborative learning using CMC tools.

Limits of the Study

A developmental research approach focuses on the process of development starting from the analysis phase, followed by the design and finally the evaluation phase. As such, the study focuses on the development of a product, the collaborative mLearning module.

The study is limited by the participants of the study. The findings of a developmental study are context-specific and only refer to the participants in the context of this study, as the context may have certain unique conditions. Although the findings cannot be used to generalize to other situations, it may still be beneficial as there may be some conditions which may be similar in other contexts, and the findings can be used for these conditions.

Another limitation is the unique nature of the sample of the study. Firstly, only Form 2 students in a selected urban school were surveyed for the analysis phase. Later, in the third phase, only 20 were selected from the 158 Form 2 students surveyed, who had access to mobile phones and computers were invited to participate in the implementation of the module. As the selected students were volunteers, they might have already had prior knowledge on the use of ICT, which could influence the findings of the study. In addition, each participant was different as each had different learning styles and preferences, and abilities in science.

The experts involved in the development of the module were selected based on the experience in content and instructional design. The experts selected in the second phase were teachers and most had some background in educational technology. Their experiences influenced their opinions on the design of the module.

Another limitation is in the implementation of the module which was mostly done online. However, the selected participants may have had face-to-face discussions on the problem tasks assigned while in school, which is not be captured in this study.

Definitions of Terms

Computer-Mediated Communication (CMC)

Computer-mediated communication is used to describe all forms of two-way interaction using the computer and the mobile phone to deliver information and to socialize (Romiszowski & Mason, 2004). These include synchronous, or real-time communication such as internet relay chat; and asynchronous, or delayed time communication such as e-mails as well as text messaging.

Collaborative Learning

Collaborative learning is the acquisition of new knowledge, skills and attitudes by the learner occurring as a result of interactions among members within a group (Jonassen, Lee, Yang, & Laffey, 2005; Kaye, 1992). This learning arises from the process of group interaction and is different from communication, as communication alone does not ensure a collaborative environment (Johnson & Johnson, 2004).

mLearning

Mobile learning, or mLearning, is the acquisition of new knowledge and skills by the learner anywhere and anytime, through the use of mobile communication devices (Geddes, 2004; Saedah Siraj, 2005). This refers to any form of the learning and administration of the learning process from any location and at any time. For mLearning mobile phones, or networked computers to access the internet from the home, at a library, at access centers, a friend's home or at a cybercafé, may be used at any time of the day.

Collaborative mLearning

Collaborative mLearning is the acquisition of new knowledge and skills by the learner anywhere and anytime as a result of interactions in a group. These interactions are through computer-mediated communications which include discussions and text messages online or through the mobile phone.

Online Discussion Forum

An online discussion forum is an asynchronous communication where messages and comments can be posted and viewed by the members of the forum. Messages posted by members of the groups can be viewed, feedback can be given, and new messages can be posted to add on information. In this way, the members of the group can view each other's answers, and work together and communicate to complete tasks.

Collaborative Work Space, or Wiki

The collaborative work space is a website that enables participants to contribute and edit ongoing work. Reports can be written, rewritten and viewed by all participants. In this study, the collaborative work space is also referred to as the wiki.

Technology Skills

Technology skills refer to the five areas of skills based on the standards of the International Society for Technology in Education / ISTE (2005), which are: (a) basic computer operations and concepts; (b) technology productivity tools; (c)

technology communication tools; (d) technology research tools; and (e) technology problem solving and decision making tools.

Learning Modules

Learning modules are self-contained components of a collaborative mLearning system on a topic (Sazilah & Saharah, 2009; Stead, 2006). In this study, the module developed is on Nutrition and is divided into eight lessons. The learning module would include problem tasks, discussion questions, and Short Messaging System / SMS Quizzes; face-to-face meetings for coordination and problem solving; and the online environment for collaborative mLearning using CMC tools. The CMC tools used are online discussion forums, wiki, and text messaging.