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Learners' perceptions of technology for design of a collaborative m-learning module

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Abstract

In Malaysian schools the learning of science does not reflect the nature of science. An instructional module which could address the need for teaching science through a process of scientific discovery and collaboration is required. A developmental research approach with three phases was used to design a collaborative m-Learning module for a topic in science. In the first phase of analysis, a survey of 158 students' use of technology and the perception of the use of computers and mobile phones was completed. Data from the analysis phase indicated the students' readiness in using online tools such as discussion forums and text messaging with mobiles for learning. Computers were perceived to be useful for learning, but mobile phones were not. The findings from the first phase were used to determine the learning tools to utilize in the design of the module in the second phase. The online learning tools used are wikis and discussion forums. In addition, text messaging using the mobile phone was also employed for individualized quizzes. The collaborative m-Learning module designed, was evaluated by experts for further improvements. The findings indicate that the experts agree that a collaborative Learning module with a variety of learning tools such as wikis, discussion forum and text messaging, could be used for teaching science. In addition, this module could also be used for teaching other subjects.

Keywords: Collaborative learning; educational technology; instructional design; mobile learning; needs analysis

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1. INTRODUCTION

An instructional module for science should reflect the nature of science. The design of the module should allow for communication and the development of scientific reasoning processes, as construction of knowledge occurs through collaboration and discussion. Hence, an eclectic theory of instructional design allows for tasks which enable scientific reasoning, and with the aid of information communication technology (ICT), collaboration and discussion is encouraged.

1.1. Science instruction to reflect the nature of science

Scientific knowledge is built upon using scientific reasoning processes, and it occurs usually in collaboration with other scientists (Abruscato, 2000). When science is taught, the nature of science should be emphasized. Knowledge should be built upon using the scientific process of discovery among peers (Hogan & Fisherkeller, 2005).Science learners should be provided the opportunity to communicate and collaborate in the process of inquiry and discovery (Hogan & Fisherkeller, 2005; Kozma, 2003; Osbourne & Henessy, 2003)

In the construction of science knowledge, being able to communicate effectively is important in ensuring the learner undergoes the scientific reasoning processes (Champagne & Kouba, 2005). Knowledge construction is supported by the social and cultural processes of communication such as language and non-verbal cues (Champagne & Kouba, 2005). Firstly, the learner needs to acquire scientific verbal knowledge to construct meaningful phrases and sentences using scientific terms (Karpov & Haywood, 1998). Then, the science learner would be able to participate in scientific discussions. By patterning and modelling the communication of his teachers and other learners, the learner is able to participate in scientific discourse, and thereby develop science concepts and principles through collaboration (Karpov & Haywood, 1998).

The design of instruction for science which provides the learners sufficient activities for scientific discussions, assist the learner to build his science vocabulary, and practice the language of science while constructing understanding of scientific concepts and principles (Greeno, 1992). This provides the opportunity for learners to experience the language. Patterning and modelling should be provided (Hoyle & Stone, 2000).The tasks given to the learner should start from simple problem tasks and progress to more difficult problems while maintaining interest and motivating learners to interact socially (Greeno, 1992).

1.2. The problem

In Malaysian schools, science is taught starting at the primary school in Standard 1 for 7 year-olds, right through Standard 6 for 6 years, and in the secondary school, starting at Form 1 for 13 year-olds until Form 5 for an additional five years. Malaysian students do not seem to understand the nature of science and only study for factual knowledge (Chong, 2005). In addition, teachers seem to be concerned in teaching for memorizing facts (Lee, 1991; Ling 1999; Tan, 1999). Even though more practice is required in the use of the language of science to develop the reasoning processes, but the teaching of science seemed to emphasize acquisition of factual knowledge.

There also seemed to be insufficient time for the practice of the language of science in the classroom. The Integrated Curriculum for Secondary Schools (Ministry of Education Malaysia/MOE, 2002) from Form 1 to Form 5covers nine themes. There is a large amount of content knowledge to be covered in the Malaysian science curriculum, but only five periods of about 30 minutes each is allotted for science in Malaysian schools. There does not seem to be sufficient time for social learning to occur using the principles of science learning. Changing the conditions of instruction in the classroom would be difficult so other alternatives have to be considered for providing more discussions and use of the language of science.

ICT has the potential to facilitate communication in the form of computer-mediated communications (CMC) for the learning of the processes of science, outside the classroom. Online discussions can be conducted for students to work together on science projects. Discussion forums, e-mails and wikis allow project work in progress to be shared and improved among peers. The advantage of online discussions enable learners to undergo processes of authentic collaboration and knowledge-building similar to that used by scientists, thus, reflecting the nature of science.

1.3. Operational definitions

Collaborative learning refers to learning through activities and discussion which require learners to work towards a common goal (Palloff & Pratt, 1999). As learners cooperate and achieve learning goals, they construct their own knowledge structures (Kaye, 1999; Palloff & Pratt, 1999). This form of learning is not structured or teacher-centered but is dependent on the culture and community of learners (Johnson & Johnson, 2004).

In this study, m-learning refers to learning that can occur in any individual anywhere and anytime, either with a mobile device or a computer connected to the internet (Geddes, 2005; Siraj, 2005). M-learning can take on several forms. The personal and portable form of m-learning requires the use of portable mobile devices such as mobile phones, laptops or Personal Digital Assistant, while personal and static would refer to computers in the home or at school, with a system that allows for personalization. The portable and shared form of mobile learning would refer to computers in access centres and kiosks that allow for sharing and learning in a variety of locations. In this discussion, m-learning refers to learning that can take place at home or at school, using personal or shared devices which may be static or not.

A communications system using the internet or a text messaging system enables CMC. M-learning requires CMC and can be conducted either with a mobile device, or a computer connected to the internet to access learning materials anywhere and anytime. Collaborative learning, which is when learners work to achieve a shared goal, can be implemented with or without computers. When collaborative learning is conducted with mobile devices and applications accessed from the internet, collaborative m-Learning is enabled (Figure 1). Collaborative m-learning is the acquisition of new knowledge and skills anywhere and anytime by an individual as a result of interactions in a group using CMC. Collaborative m-Learning can be implemented in class or at home through CMC activities such as forums and wikis on the internet, and through text messaging. M-learning can also be used for individual self-paced learning, which occurs without collaborative learning.

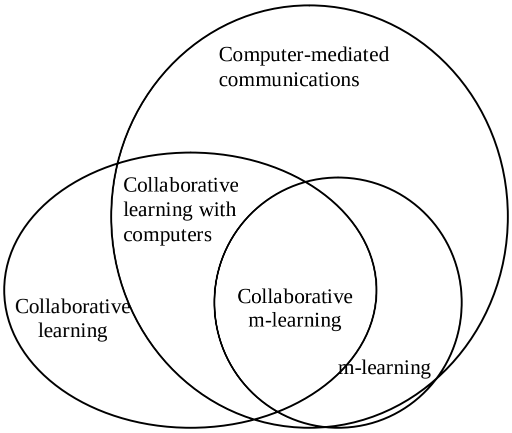

Figure 1.Therelationship between CMC, collaborative learning and m-learning

1.4. The purpose of the research

In Malaysia, not much research has been done with the use collaborative learning with CMC in secondary school science. On the other hand, collaborative learning using CMC has been used for teaching English language writing at elementary school level (Lee, 1999) in Malaysia. However, collaborative m-learning, using CMC has been used successfully in teaching science in other countries. In the Knowledge Integration Environment (Slotta, & Linn, 2000) and CaMILE (Guzdial, & Turns, 2000), modelling in the use of the language of science was provided in the social context, and this increased learning and engagement among students.

The First Principles of Instruction (Merrill, 2002) is an approach that can be utilized for designing instruction which require collaboration and discussion. For successful collaborative m-learning to occur, learners must be involved in solving real-world problems using CMC and work towards a shared goal (Figure 1). Lack of use of CMC, or mobility would change the concept of collaborative m-learning. The First Principles of instruction implemented for web-based courses in Medical Sciences (Frick, Watson, Cullen, & Han, 2008) for collaborative m-learning, using a problem-based approach, was shown to improve student engagement and learning.

In this study, a module for collaborative m-learning to address the need for more activities and scientific discussions using the principles for science instruction was developed. Firstly, a needs analysis to ensure "data-driven and responsive recommendations" (Rossett, 1995) on the context and environment was conducted. The needs of 14 year-old learners at the Form 2 level in a Malaysian secondary school on both the use and perception of technology was taken into account.

Based on the data collected, a module was designed to enable collaborative mobile learning based on Merrill's first principles (2002) as in Figure 2. The module was then evaluated by a team of experts. The experts' opinion on the module would determine whether the collaborative m-learning module for science, designed using the first principles of instruction, could be used for teaching science.

The aim of this research is to develop a module for collaborative m-learning to address the need of Malaysian students in learning science. The research questions are:

- What is the situation on the use of technology tools among the group of students in the context of the study?
- What are the perceptions of teaching and learning using computers of the group of students in the context of the study?
- What are the perceptions of teaching and learning using mobile phones of the group of students in the context of the study?
- What are the opinions of the experts on the design of the collaborative m-learning module for the topic of Nutrition?

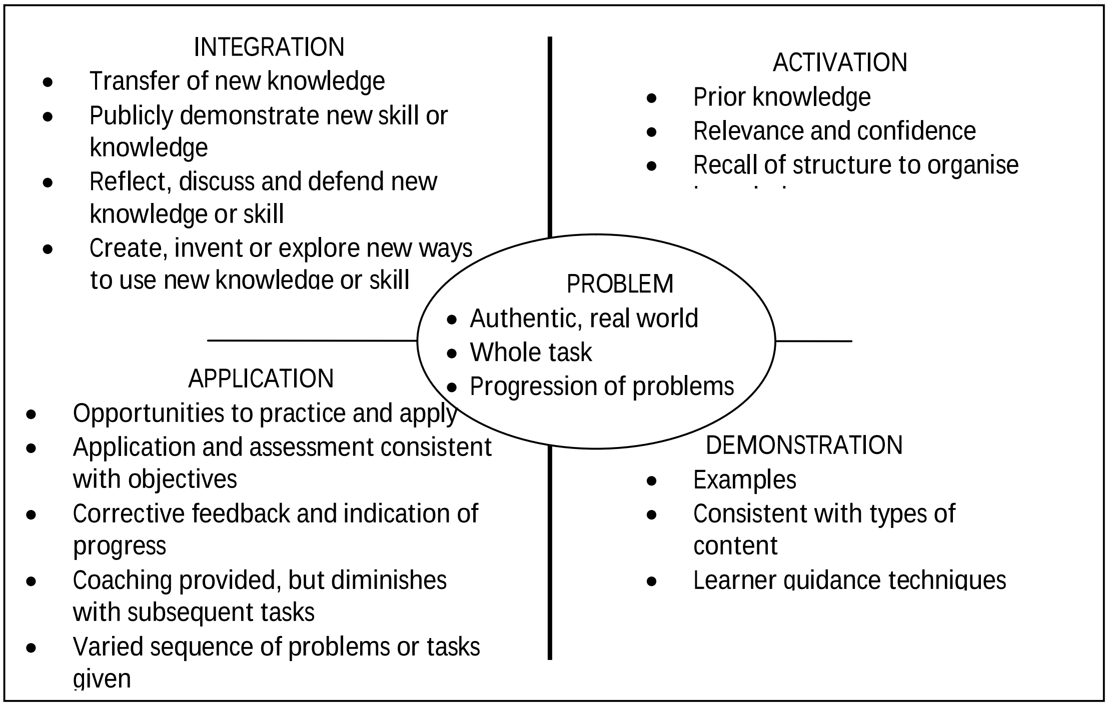

Figure 2.First Principles of Instruction, synthesised (Merrill, 2002)

2. METHODOLOGY

This research takes on a developmental research approach (Wang & Hanafin, 2005) withthree phases: analysis, design and evaluation. The sample and methodology of each phase differed.

2.1. Participants and sample of the study

Different groups of participants were utilized for the first and third phase of the study. In addition, the approach for data collection in each group differed.

- The Analysis Phase: The secondary school selected was an urban school which had a multi racial community of students which reflected the racial composition of Malaysia. The students in the context of the study were 158 fourteen year-old students, and their marks in tests for science and English Languages how a normal distribution. The sample was surveyed to determine the use of technology tools and the perception towards teaching and learning using computers and mobile phones.

- The Evaluation Phase: The experts were selected from educators who had at least 10 years teaching experience, and were well versed in the use of technology tools for teaching and learning. Three subject matter experts were selected for their experience in teaching secondary school science, and integrating the use of ICT in teaching. Two technical experts were selected based on their knowledge on instructional technology, with at least 5 years experience in the use of CMC for teaching and learning.

2.2. Instrument

Two different approaches for data collection were used in each phase. In the analysis phase a quantitative approach was used while in the evaluation phase, data collection was qualitative in nature.

- The Analysis Phase: The Technology Skills and Usage Questionnaire (TSUQ) was used to determine students perception in technology usage, and the use of both computers and the mobile phones for learning. The use of technology in two areas was surveyed: in the use of research and problem-solving tools, and technology communication tools. Frequency is recorded on a scale of 1 to 4, where 1 is “never doing a certain item”; 2 “only once a month”; 3 “once a week”; and 4 is “more than once a week”. On the perception of the use of computers, and mobile phones, a Likert scale of 1 to 4 was used from “Not True” to “Very True”. This questionnaire was adapted from a previous questionnaire (Norizan Ahmad, 2005) which had a high Cronbach Alpha coefficient of .882 for reliability, which was maintained in the updated instrument at .892. The TSUQ was validated by two experts in the field of educational technology.

- The Evaluation Phase: The evaluation was conducted by the experts after the module was designed. The design documents prepared included the syllabus, and eight online lessons with activities. These documents and the module's web page were submitted to the experts for their comments. The experts' written comments were analysed and an interview schedule was developed based on the comments given. The experts were then interviewed on their comments to determine their concerns on the module.

2.3. Data analysis

In the analysis phase, the quantitative data from the TSUQ was analysed and presented according to the use of technology and the perception of the use of computers and mobile phones for learning. Means and percentages were used for reporting the frequency of use of technology while percentages were used in the perception of beliefs of the use of computers and mobile phones for learning. The data was tabulated.

In the evaluation phase, qualitative data from the interviews with the experts were transcribed and validated by the experts. The written comments and the transcript of the interviews were coded, and analysed. The emergent themes were then reported.

3. FINDINGS

In the analysis phase, the answers to the research questions on the situation on the use of technology tools among Malaysian schools students in the context of the study, as well as the perceptions of teaching and learning using computers, and using mobile phones, are addressed. The final research question is to discover the opinions of the experts on the design of the collaborative m-learning module for Form 2 Nutrition. This research question is addressed in the final evaluation phase, after the development of the module. A description of each phase is outlined in the following section.

3.1. Analysis Phase : Perception of technology

In answering the first research question on the use of technology tools among Malaysian school students, it was found that using the computer to access the internet was frequently used for learning. This was because accessing search engines on computers ($\bar{x}$ = 3.15) were frequently used for research, followed by evaluating materials on the internet ($\bar{x}$ =2.27) (see Table 1). The use of phones for discussions ($\bar{x}$ = 2.97) and text messaging ($\bar{x}$ = 2.95) was high. Other forms of communication over the internet using computers were also used by the students in the context of the study. However, e-mails were less popular than online discussion tools. The use of online discussion tools on the computer was higher ($\bar{x}$ = 1.99) compared to e-mails ($\bar{x}$ = 1.64).

Table 1. Analysis of frequency of use of technology in basic computer operations, research and problem-solving tools, and communication tools

Skill	Level of usage*, (%) 1	2	3	4	*M*
Research and problem solving tools					
Referencing using CD-ROM on computers	56.3	19.0	15.2	9.5	1.78
Search engines on computers	13.3	13.9	17.1	55.7	3.15
Evaluating materials on internet from computers	39.9	19.0	15.8	25.3	2.27
Technology communication tools					
E mails: sending & receiving from computers	67.7	11.4	9.1	11.4	1.64
Online Discussion tools – sending and receiving information on computers	53.2	13.3	13.3	19.6	1.99
Presentations (newsletter, web pages) using computers	74.1	11.4	3.8	10.1	1.50
Discussions on phones	15.8	20.3	14.6	48.7	2.97
Text messaging on mobile phones	21.8	15.8	15.5	45.9	2.95
Access internet on mobile phones	67.7	11.4	5.7	13.3	1.64

*1 - Never doing a particular item, 2 – Once a month, 3 – Once a week, 4 - Frequently used, that is more than once a week.

To answer the second and third research question on the Malaysian school students' perception of teaching and learning using computers, and using mobile phones, a table of comparison of the students' perceptions was done. Most respondents believed that computers were important for learning but not the mobile phone. From Figure 3, most respondents (89.8%) felt that all students should be given the opportunity to use computers for learning activities, and that knowing how to use the computer assists learning with others (72.2%). The respondents had a positive attitude towards learning with computers as they believed computers helped improve learning (79.1%).

In comparison, mobile phones were not considered useful in improving learning (57.0%) as only some (44.9%) felt that students need not be given the opportunity to use it for learning activities (see Figure 4). This was felt even though a majority felt that knowing how to use the mobile phone was a useful skill (85.5%), and that that the mobile phone could assist in learning with others (53.8%).

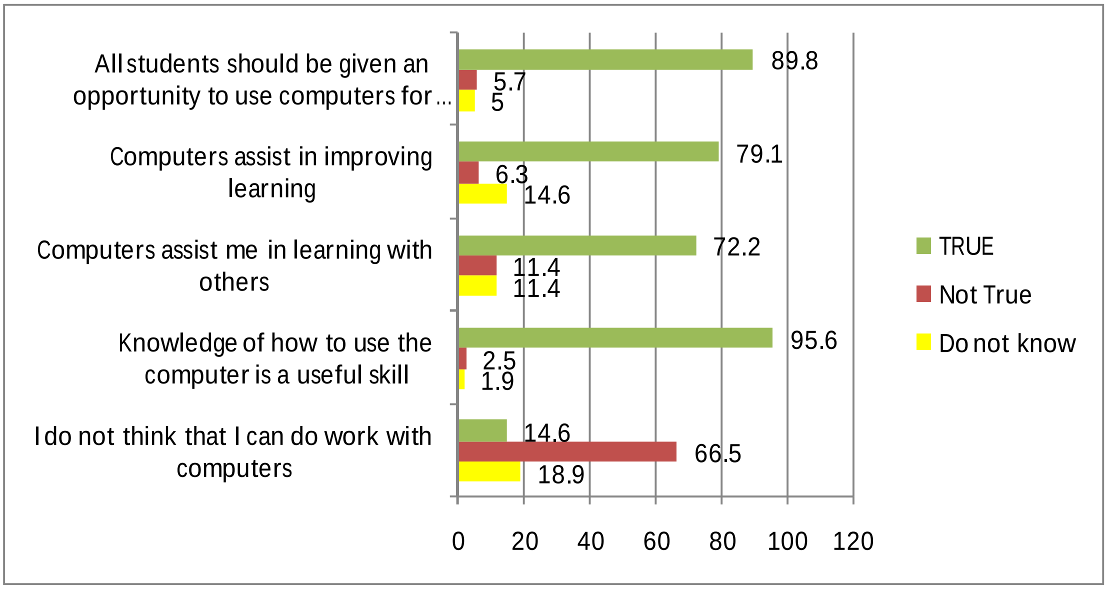

Figure 3: Students' beliefs on the use of computers

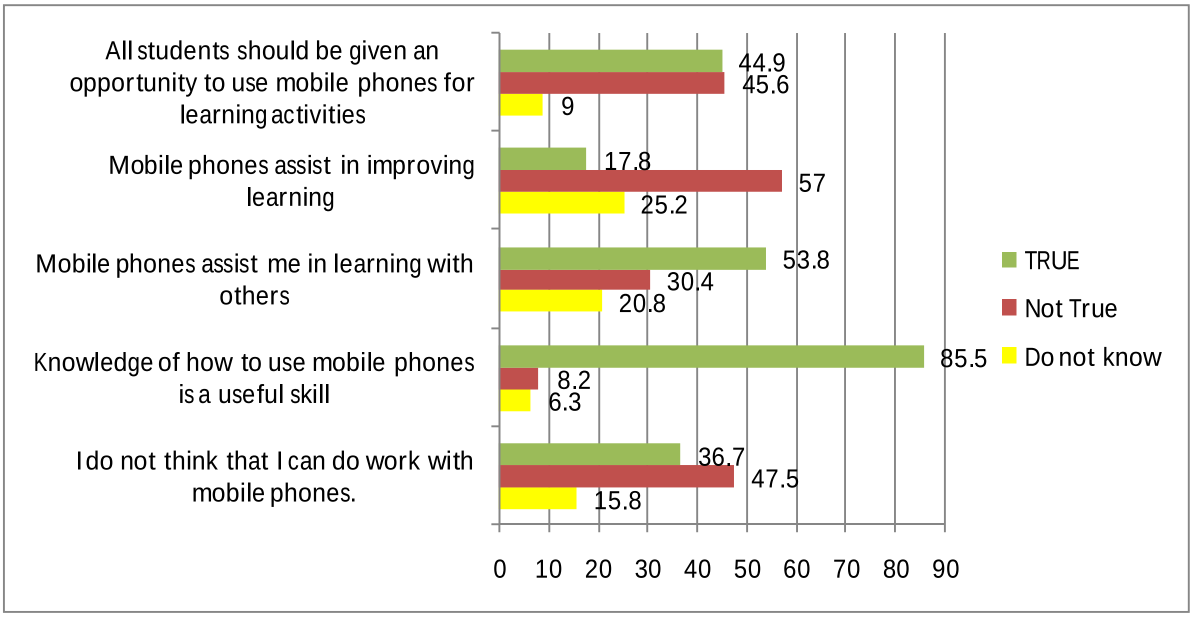

Figure 4: Students' beliefs on the use of mobile phones

There is a difference in perception of the use of computers and mobile phones in learning. Computers have been used for teaching and learning in Malaysian schools. On the other hand, even though phones were already used for learning by some of the respondents, most of those surveyed were not confident and had no experience in using mobile phones for formal learning.

In conclusion, both internet tools and text messaging on mobile phones were frequently utilized by the respondents. Computers were perceived to be useful for learning, while mobile phones were not. From the findings, it was recommended that computers for accessing the internet at school and at home, and mobile phones for text messaging be used in the implementation. In this study, the use of search engines, and online discussions forums were limited to the computer, and text messaging for the mobile phone, can be utilized for learning.

3.2. Design Phase: Design of the collaborative m-learning module

The topic of Nutrition in Form 2 Science was selected as it was a meaningful topic to students. The Curriculum Specifications of the Ministry of Education (MOE, 2002) was analyzed, and mapped into eight lessons designed for a four-week period of implementation. The syllabus and policies for a collaborative environment was designed based on collaborative learning principles (Kaye, 1999; Palloff & Pratt, 1999). In designing the tasks for the collaborative m-learning module, the First Principles of Instruction (Merrill, 2002) was taken into account (see Table 2). The activities were designed to encourage collaboration.

Based on the analysis phase, it was recommended that discussion forums on the internet and text messaging be used in the collaborative m-learning module. These tools were widely used by the students in the context of the study. Hence, in this study the technology tools utilized are a wiki for an online collaborative group problem task, shorter discussion questions in a forum, and text-messaging quizzes.

Table 2. Application of First Principles of Instruction

	First Principles of Instruction (Merrill, 2002)	Application in the collaborative m-learning module
1.	Learning is promoted when learners are engaged in solving real-world problems	An online problem task is a real-world problem that would be solved through group-work on the wiki.
2.	Learning is promoted when existing knowledge is activated as a foundation for new knowledge	Smaller problems as discussion questions on the online forum.
3.	Learning is promoted when new knowledge is demonstrated to the learner	An instructional module on webpage with links to other web pages, videos, and interactive software.
4.	Learning is promoted when new knowledge is applied by the learner	Smaller problems for discussion questions on the online forum.
5.	Learning is promoted when new knowledge is integrated into the learner's world	Quiz pushed through text messages to the learners and group-work on the wiki.

The activities were designed to incorporate a main problem task, which was a group task to be attempted collaboratively on the wiki. Other smaller tasks were designed to activate, demonstrate, apply and integrate knowledge using discussion questions on a forum, and individual quiz through text messaging. An example of a lesson following the First Principles of Instruction is shown in Appendix A. In this lesson, activation of prior knowledge was done through questions on the discussion forum to recall and link to prior knowledge. Demonstration was done on the web page where links to interactive tools to calculate and analyze calorie content, and compare nutritional content in different foods were provided. Application of knowledge was through practice questions on the discussion forum, and integration of knowledge where the opportunity to reflect and use the knowledge learnt through questions on the discussion forum and SMS Quiz.

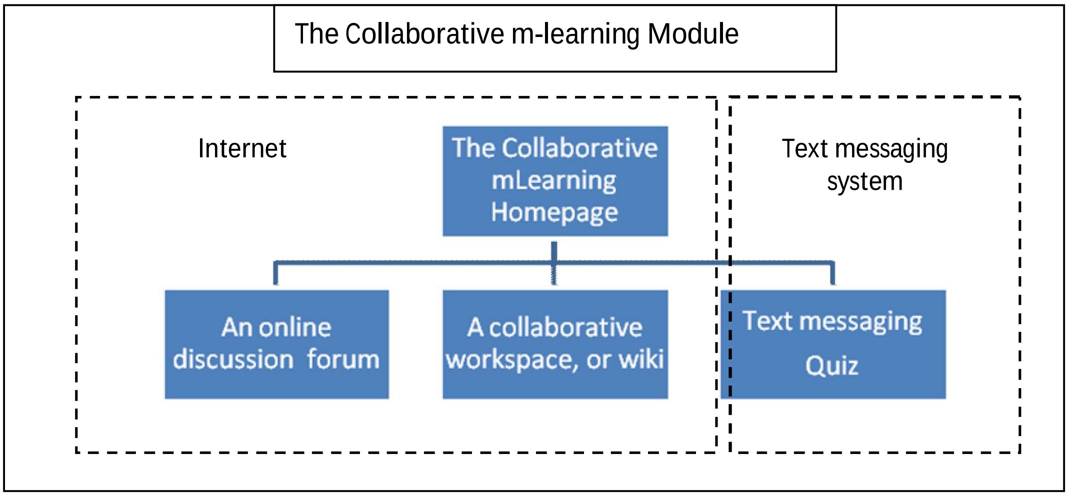

Figure 5.Tools in the collaborative m-learning module

3.3. Evaluation Phase: Evaluation of the collaborative m-learning module

The module developed for the eight lessons, which included the problem tasks, discussion questions and quiz, and syllabus and guidelines was given to the experts to evaluate. The analysis of the experts' written comments and the transcript of the interviews showed that there was concern on the management of the module and several instructional issues as in Table 3.

There was concern on the management of the amount of data that would be collected from the participants' responses and evaluation of the module. On the aspect of instruction, English, the medium of instruction in science in this module, was considered difficult. The suggestion was to use simpler sentences. Inaccuracies in the content were corrected, including shortened forms in text messaging. The experts also requested a separate instructional module be provided for reference and that videos, sound and graphic be included in the activities to cater to the multiple intelligences theory.

All the experts' agreed that the collaborative m-learning module could be implemented with improvement on the issues mentioned. In addition, the amount of activities meant that more time would have to spend on the activities.

Table 3. Concerns of the experts on the design of the collaborative m-learning module

Area	Concerns	Quotes
Management	The amount of data collected	*Can you imagine how many answers will come in. I'm only afraid you have problems. I wonder how you will be able to manage the responses.*
	The amount of activities	*If in the class, no time... No time as rushing to finish syllabus.*
Instruction	Difficulty of medium of instruction in science	*maybe shorter sentences lah, ... When you have so many things we also don't know what is the focus of the sentence already*
	Inaccuracies in the content and the use of shortened forms	V I T" was used for "Vitamin." *When you use short forms you defeat another purpose of your research where you want to promote the use of English.*
	A separate learning module for presentation of content	*Do you have an online teaching module on your website? So that if the learners want to do it, they can have revision first....otherwise you have to summarize all. You're asking question, question, so if they don't have time to search all these things.*
	The use of other theories and modalities in the instruction.	*Some they (learners) prefer writing...Over here we can apply this theory, the seven Intelligences?*

4. DISCUSSION AND CONCLUSION

The students in the context of the study use CMC. The internet is a tool widely used, but emails were less popular. Online discussion forums, phone discussions, and text messaging were more frequently used. This means that online tools and text messaging could be employed to encourage collaborative m-learning in science. The students in the context of the study had a positive perception towards the use of computers for learning, but not the use of mobile phones. However, as ownership and use of mobile phones was high, the collaborative m-learning module would incorporate text messaging on mobile phones as one of the tools. Hence, it is possible that CMC tools could be used for building science knowledge through scientific discussions.

In the design of the activities in the module, an eclectic instructional design theory, the First Principles of Instruction (Merrill, 2002) was used. In the design of the collaborative m-learning module, a main problem task was given to enable collaboration. Discussion questions and quiz were used for activation, application, and integration of knowledge. From the experts' suggestion, an instructional module with various media and links to relevant sites was developed for demonstration of knowledge.

The experts agreed that the collaborative m-learning module could be implemented with some improvement. The concerns that arose when the experts evaluated the module were mainly on the management and instructional aspects. The concern on the management of the large amount of data was addressed by using a spreadsheet to manage the responses, while the activities were done outside the classroom time. The module was improved to take into account of the experts' opinion in using shorter and simpler sentences, and emphasizing the accuracy of content.

In science instruction, sufficient activities should be given to allow for discussions in the practice of the language of science, and to develop scientific concepts (Greeno, 1992). This module consists of many tasks which had to be completed. The main problem task and the discussion questions required collaboration among peers. In these tasks and in the text messaging quiz, modelling and patterning of the language of science could be observed (Hoyle & Stone, 2000). The science learner had the opportunity to use scientific reasoning processes to communicate and collaborate to solve problems, just like scientists in the real world. In this manner, science instruction reflects the nature of science.

The significance of the study is for instructors and instructional designers to realize that communication and collaboration can be designed in an instructional module for secondary school science. In this study, a variety of technology tools were used to encourage collaboration in the tasks. A main problem task engaged the learners and a variety of smaller tasks were used to activate, demonstrate, apply and integrate the knowledge. The learning tools such as a discussion forum and text messaging were used.

Further studies would be required on the implementation of the module to determine its usability among students in the context of the study. This study is important as it employed a developmental approach starting from the analysis of the students' use and perception of technology. The module was designed based on the findings in the analysis phase, and was evaluated by experts in the subject matter and in educational technology to determine if this module could be used for science instruction. However, the study would be more meaningful if the intended users were asked to evaluate the usability of the module.

The limitation of developmental research is that it is context-specific, and the findings apply to the learners in the context of the study only. The findings on the use of technology and the beliefs on the use of computers and mobile phones can only apply to similar environments in urban schools with a multi-racial group of learners. These findings cannot be generalized to all schools as further studies would have to be conducted to determine if the situation was the same in rural schools, or with a different racial composition in the population.

Notwithstanding the limitations, the collaborative m-learning module can be used in science instruction as it did provide the opportunity for learners to construct knowledge of science in a meaningful manner. As one expert stated:

"*I want students to learn in a fun way that they will enjoy learning and not doing it as a very heavy task, probably for exam, I think they have enough of it from the teachers! It is good to give them something interesting, at least it is like a reward to them. Make their time worth it."*

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APPENDIX 1
Sample Lesson with Tasks

Designing Lesson 4: Counting Calories

Section	Description
Objective	To estimate the amount of calories in a given meal using information given on amount of calories.
[a]Outcomes	A student is able to estimate the calories of food taken in a meal.
[b]L4 Outcomes	A student is able to estimate the amount of calories contained in a given meal from a given energy table.
Problem 4 (Tool: Wiki)	Using the meal that your group was given in Task 1, estimate the total amount of calories in the meal from the energy table provided in the link in the class web page. Show your calculations.

Phases	Tasks
Activation (Tool: Discussion Forum)	Discussion 1a: Compare food labels on several drinks and determine the number of calories for a 250 ml glass of the following: 1. A cup of chocolate beverage, example, milo 2. A can of aerated water, example, Coke, Pepsi, etc. 3. A can of isotonic drink, example 100 Plus.
Demonstration (Tool: Webpage)	1. Web page demonstrating examples with table showing calorie content of different food. 2. Links to tools: Nutrition and energy analyzer tool Energy food comparison tool Nutrients and calories search tool at *Nutrient Data Lab* Interactive software to compare nutrition in food Calories required on *Daily Needs Calculator.* 3. Links to websites: Calorie requirement of people with different activities. 4. Examples from peers answer in discussion forums.
Application (Tool: Discussion Forum)	1. Discussion question 1b: Find out which drinks have the most energy by comparing the calorific value for a 250 ml glass of the following: 1. A cup of chocolate beverage, example, milo 2. A can of aerated water, example, Coke, Pepsi, etc. 3. A can of isotonic drink, example 100 Plus. Problem 4: Estimate the total amount of calories in the meal given to your group from the energy table given.

Integration (Tool: Discussion Forum, Text Messaging)	Discussion question 2: How many calories does an average teenager require? Do you think you are consuming enough calories? SMS Quiz 1: Which class of food has the highest energy per gram? REPLY by choosing ONE answer: Carbohydrates, Protein , Fats

Note.

[a]Outcomes refer to learning objectives and learning outcomes from the Form 2 Science Malaysian Integrated Curriculum Specifications.

[b]L4 Outcomes are expected learning outcomes from Lesson 4.

[c]Phases refer to the phases in Merrill's First Principle (2002).