Collaborative mLearning: A Module for Learning Secondary School Science

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ABSTRACT
Collaborative learning has been shown to be effective for the construction of knowledge. In science instruction, collaboration and knowledge-creation needs to be done in the language of science. A collaborative mLearning (CmL) science module employed uses three computer-mediated communication (CMC) tools: wiki, discussion forum and text messaging. This study seeks to determine the forms of communication and learning in the use of these CMC tools in the CmL module. Twenty (20) Form 2 students of different science abilities participated in the study. Data were collected from student interviews; online communications on the wiki, discussion forums, and text messages; students and researchers’ journal records; and a survey of students’ perception of communication with the CMC tools and learning. The findings showed the learners’ frequency of communication was highest in the wiki and text messaging. The combination of three CMC tools was effective as it catered to learners’ preferred learning styles. Group work and the collaborative activities enabled learning. The CmL module was effective for learning as verified by the improvement in post-test results. The findings of this study provide insights into group interactions in a CmL environment and show that peer interactions scaffold learners in building their knowledge in science.

Keywords
Collaborative mobile learning, Computer-mediated communication tools, Mobile learning, Informal learning

Introduction
Collaborative learning enables learning experiences to be interpreted for the construction of knowledge (Palloff & Pratt, 1999). However, the effect of computer-mediated communication (CMC) tools for collaborative learning, or collaborative mobile learning (CmL), is less explored. Studies have shown that CmL is useful for peer support in scaffolding learning (Boticki, Looi, & Wong, 2011; Timmis, 2012), generating ideas (So, Tan, & Tay, 2012), and knowledge-creation (Rogers, Connelly, Hazlewood, & Tedesco, 2010). Different CMC tools have different affordances: discussion forums (Guzdial & Turns, 2000; Slotta & Linn, 2000), wikis (Bonk, Lee, Kim, & Lin, 2009; Pifarré & Li, 2012; Zhang, Scardamalia, Lamon, Messina, & Reeve, 2007) and text messaging (Capuano, Gaeta, Miranda, & Pappacena, 2005; Timmis, 2012) have been used for learning.

CMC tools have been used for teaching science (Guzdial & Turns, 2000; Slotta & Linn, 2000). However, text messaging, and mobile devices which have been used for learning language (Arrigo, Gentile, Taibi, Chiappone, & Tegolo, 2005; Boticki, Looi, & Wong, 2011; Capuano et al., 2005; Gerosa, Filippo, Pimentel, Fuks, & Lucena, 2010), are not used much in science instruction. A combination of two tools: text messaging with a wiki (Arrigo et al., 2004), and text messaging with a discussion forum (Gerosa, Filippo, Pimentel, Fuks, & Lucena, 2010; Rau, Gao, & Wu, 2008), has been shown to be effective for science learning. This study will investigate the combination of three tools in developing the CmL Science module.

Collaborative learning is rarely implemented in the Malaysian scenario. Teachers perceive that there is insufficient time to complete the science syllabus and allot little time for social interaction in the science classroom. Teachers emphasize the memorization of facts rather than the scientific processes (Chong, 2005). Hence this study seeks to extend previous research by investigating the use of three CMC tools for learning in the CmL environment: the wiki, discussion forum and text messaging. In addition, it will determine if CMC tools are effective for collaborative and mobile learning in science, and whether these interactions can take place out of the formal classroom environment.

Collaborative learning is the acquisition of knowledge, skills and attitudes as a result of group interactions (Johnson & Johnson, 2004). When CMC tools are employed for interactions, learning becomes mobile and hence, collaborative mobile learning (CmL) occurs; CmL allows group interactions outside the formal classroom.
environment and learning happens anytime, anywhere (Ally, 2004; Siraj, 2005; Siraj & Alias, 2005) and is situated in the environment (Chang, 2010; Jeng, Wu, Huang, Tan, & Yang 2010). This study is significant as it would determine whether CmL can be conducted in Malaysian schools.

**The language of science**

In scientific discoveries, scientists collaborate with other scientists through scientific processes (Emdin, 2010; Nielsen, 2012; Sharma & Anderson 2009). Hence, the language of science is required for discussions and collaboration.

A similar approach of discovery and collaboration should be used for science instruction in schools. Instruction should be focused on scientific methods and processes, built upon social interactions (Hogan & Fisherkeller, 2005; Sharma & Anderson, 2009). Hence, science learners need to be able to communicate socially, interact and debate issues regarding science and society, as well as use science for their personal needs. Social interactions enable learners to attempt to link the newly acquired knowledge with their existing knowledge, and be scaffolded individually (DeWitt & Siraj, 2008).

The language of science enables scientists to construct science concepts. Scientific verbal knowledge is required for planning and for sharing ideas (Ellerton, 2003; Hoyle & Stone, 2000). While scientific terms can be defined and taught formally in the classroom, the vocabulary and language structures in science, which enable critical thinking, are acquired informally. The advantage of student-centered discussions is that learners construct meaningful phrases and sentences to communicate, and resolve differences of opinions to reach mutual understandings as science concepts are developed (Hoyle & Stone, 2000; Karpov & Haywood, 1998).

The vocabulary and structures of the language of science are informally modeled by learners through interactions with the materials, teachers and peers (Karpov & Haywood, 1998). Vygotsky’s view is that scientific knowledge and procedures should not be taught directly but should be constructed by learners in the course of a discussion (Karpov & Haywood, 1998). The interactions between other learners, the tutor and learning materials on a suitable platform can enhance the learners’ current understandings of concepts and principles.

**Design of instruction for learning science**

The CmL Science module is based on social constructivist learning theories. Sufficient activities are provided for patterning and modeling the language of science, with individualized support and scaffolding, as well as opportunities for discussion to assist learners in building their personal understanding of scientific concepts and principles (Ellerton, 2003; Hoyle & Stone, 2000). The activities allow learners to link the science knowledge with their own personal experiences (Ellerton, 2003). These social interactions motivate and engage learners in carrying out activities while building meaningful science knowledge (Brown, 2006).

CMC tools have been used for teaching science. The Knowledge Integration Environment (KIE), a platform for web resources, has a discussion forum for the social environment and context for collaborative mLearning in science, has been shown to be useful for learning science (Slotta & Linn, 2000). CaMILE, another platform for collaborative mLearning which uses discussion forums for learners to collaborate on science inquiry projects, is effective for learning (Guzdial & Turns, 2000). However, both these platforms do not have text messaging.

Text messages may be combined with other CMC tools in a science module. Presently, text messaging has been used for language instruction where messages can be pushed as textual learning objects (Capuano et al., 2005). Text messaging has been combined with wikis (Arrigo et al., 2005), and with discussion forums (Rau, Gao, & Wu, 2008). The use of text-messaging motivated learners, and with online discussion groups, improved examination performance (Rau et al., 2008). Hence, there is a possibility that a combination of CMC tools, with text messaging, could be used for learning science.
Research is lacking on the use of a combination of CMC tools on a CmL platform, especially in the Malaysian context. It is hoped that this study will provide insights in the use of a combination of CMC tools, namely wiki, discussion forums and text messaging.

**Theoretical framework**

*Collaborative learning*

Collaborative learning is dependent on social interactions. Collaborating in groups has been shown to improve memory, produce fewer errors and motivate learners (Bligh, 2000). Background factors, such as age, activeness and values; internal influences such as leadership and communications; and consequences on why collaboration is required will influence the group interactions (Tubbs, 1995).

Communications is not just the transfer of information but interactions that enable the process of meaning-making in science (Sharma & Anderson, 2009; Tubbs, 1995). As learners interact, both face-to-face and online, and reflect on their discussions, a learning community for sharing learning experiences is built (So & Bonk, 2010, Palloff & Pratt, 1999). CMC tools facilitate CmL outside the classroom (Anastopoulou, Sharples, Ainsworth, Crook, O’Malley & Wright, 2012; Arrigo et al., 2005; Capuano et al., 2005; Guzdial & Turns, 2000; Slotta & Linn, 2000).

New models of CmL are required as CMC may not be supported by conventional face-to-face learning environments (Li, Dong & Huang, 2011). The challenge is addressing the diversity of online learners to achieve a common goal (Kuo, Huang, Chen, & Chen, 2102; Palloff & Pratt, 1999). Similar to conventional learning, learners need to conform to group norms according to standard behaviors and conduct, to avoid conflict and tension in the group (Tubbs, 1995). Adapting to the use of new technologies may cause disorientating dilemmas and psychic distortions (Palloff & Pratt, 1999) which requires learners to change their attitudes to learning (Tambouris, Panopoulou, Tarabanis, Ryberg, Buus, Peristeras, Lee, & Porwol, 2012). The instructor’s role is to support and allow a conducive practicing environment (Mostmans, Vleugels, & Bannier, 2012).

Support in a CmL environment is required to engage learners outside of the social context of the classroom (Li et al., 2011). Hence, a structured support system is required for scaffolding learning, supported by peers (Boticki, Looi, & Wong, 2011; Timmis, 2012).

In social constructivist theory, dialogue and interaction internalizes learning (Gredler, 1997; Schunk, 2000). Cultural tools such as computers and mobile phones; and abstract social tools, such as language, assist in developing the learners’ thinking. CMC tools enable cognitive change in the learner as ideas are exchanged and debated upon to create new knowledge (Zhu, 2012; Gredler, 1997; So & Bonk, 2010; So, Tan, & Tay, 2012; Rogers, Connelly, Hazlwood, & Tedesco, 2010). Although CmL enhances student learning achievement, it may be influenced by the culture of the community (Zhu, 2012). It was noted that there might be gaps between western and certain eastern cultures (Zhu, 2012).

*The social constructivist theory of learning*

Social dialogue and interaction internalizes learning (Gredler, 1997; Schunk, 2000). In the external environment, cultural tools such as computers and mobile phones; and abstract social tools, such as language and the school, assist in developing the learners’ thinking. CMC tools encourage the process of cognitive change in learners (Gredler, 1997).

In this study, learners interact socially in a group through peer collaboration (Schunk, 2000) to complete tasks which develop their understanding. Instructional scaffolding related to science is given for support to accomplish the tasks. This is in line with collaborative learning which assumes that human intelligence originates in society or culture, and individuals’ cognition results from interpersonal interaction within that culture and community (Vygotsky, 1981).
The research questions

The purpose of this research is to determine the forms of communication and learning among learners during the implementation of the CmL Science module. This study seeks to answer the following research questions:

- How are the learners communicating in the CmL Science module?
- How do learners learn with the CmL Science module?

Methodology

Design of the study

The study is part of developmental research where the CmL module was designed (Wang & Hanafin, 2005). An urban secondary school with a multiracial composition was selected for implementation of the CmL Science module in the topic of nutrition. A survey of the communication tools the learners accessed contributed to the design of the CmL module. The module was implemented with twenty Form 2 students. The participants’ use of the module and their perceptions regarding learning and communications were captured through observations, online communications, interviews and a survey of the module. The responses given were triangulated with data from online communications in the module and a pre-test and post-test design.

Data collection

A pre-test on the knowledge items in the module was conducted before the module implementation. During implementation, data from the online communications on forums, wikis, and text messages; as well as participants’ and researchers’ journals, were recorded. At the end of the module, a post-test was conducted followed by a survey to determine the learners’ perception of their understanding and support required for learning. The participants were then interviewed to glean further information. Triangulation of data was done through analysis of online communications to verify that the users were learning.

Development of the module

The CmL Science module took into account the CMC tools the learners accessed. This module was on a webpage, with links to resources including content, videos, animations, and tasks on CMC tools. The topic of Nutrition was selected as learners had misconceptions in this topic. Secondary school children were confused about the concept of food: Water and vitamins were inaccurately considered as food (Lee & Diong, 1999), and many had bad dietary habits (Melby, Femea, & Siacca, 1986). Even trainee teachers had misconceptions on the function of proteins (Lakin, 2004). In addition, Nutrition was rated as the most difficult topic in science since it involved a lot of factual knowledge (DeWitt & Siraj, 2007).
CMC tools in the CmL science module

The CmL Science module consists of online lessons and face-to-face meetings (Table 1). Activities in the CmL module are the problem task, assigned as group work on the wiki; related questions on the discussion forum; and text messaging quizzes pushed to individual learners’ mobile phones (Figure 1). Feedback and support in all the tasks were given by the tutor. Table 2 provides a summary of the CMC tools used in the CmL Science module.

<table>
<thead>
<tr>
<th>Lessons</th>
<th>Title</th>
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<tbody>
<tr>
<td>Initial</td>
<td>Orientation to module</td>
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<tr>
<td>1</td>
<td>The classes of food</td>
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<tr>
<td>2</td>
<td>Special diets (balanced meals)</td>
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<tr>
<td>3</td>
<td>Tests for food classes</td>
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<tr>
<td>4</td>
<td>Counting calories</td>
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<tr>
<td>5</td>
<td>Food in customs and cultures</td>
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<tr>
<td>Final</td>
<td>Summary</td>
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</table>

Table 1. List of lessons in the CmL science module

<table>
<thead>
<tr>
<th>Platform</th>
<th>CMC tool</th>
<th>Activity</th>
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<tbody>
<tr>
<td>Wiki</td>
<td>Group Activity: Groups of 3 – 4 students. Task is to analyze the nutrients in a given meal and post findings on the wiki. Each group has a wiki page for the task, and can add additional pages.</td>
<td></td>
</tr>
<tr>
<td>The CmL Science Module</td>
<td>Discussion forums Individual Activity: Discussion questions based on the lessons.</td>
<td></td>
</tr>
<tr>
<td>Text messaging</td>
<td>Individual Activity: SMS Quiz Questions pushed to students with immediate feedback.</td>
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</tbody>
</table>

Table 2. Tools and activities in the CmL science module

Module implementation

The CmL Science module was implemented with a group of twenty Form 2 students from a selected urban school with a multi-racial composition. The participants were volunteers with equal numbers of high, medium and low-achievers in science.

Most of the students in the selected school (81.6%) owned a mobile phone, and more than half had access to computers (63.9%). Laptops and mobile phones were made available during the implementation for students to access. Mobile phones were required for text messaging after school hours. Participants who needed a mobile phone could borrow one.

Data analysis

Data collected from the interviews and interactions in the CMC tools, participants’ and researchers’ journal records were transcribed and analyzed to identify how students in the context of the study communicated and learnt in the CmL environment. In addition, the results of the pre-test conducted before the implementation of the module, was compared to the post-test at the end of the module to determine if there was a difference in the scores. This would determine if learning was effective. The survey conducted after the implementation of the module, was analyzed using descriptive analysis.
Results and discussion

The discussion is focused on studying two areas in CmL module: communications and learning. The findings may provide insights regarding the communications in the CmL module and the contribution to learning science.

Communications in the CmL module

In order to investigate how learners communicate in the CmL module, two domains were analyzed: the frequency of use of the CMC tools, and types of group activities.

CMC Tools

The frequency of using the CMC tools for the assigned tasks varied among participants (Figure 2). Participants were most active in the SMS Quiz (65 log-ins). The increased participation in the SMS Quiz was due to the accessibility of the mobile device: “Our phone is just in our pockets, so we can reply immediately. Using the computer to access the internet takes time”. In addition, personalized feedback was given during the SMS Quiz.

There were a large number of postings on the discussion forum (33 responses) but analysis showed that only an average of 8 participants had responded. Most of responses to the questions were shared responses posted by two or more learners, indicating the participants preferred group work. Participants collaborated with their peers before posting in the discussion forum.

The interviews revealed that the lack of activity on the forum compared to the SMS Quiz was because the forum questions were difficult, and the reluctance of participants contributing after reading others’ posts:

S: Because I don’t really know the answer.
DD: But do you read your friend’s answers?
S: No. It’s because if I read their answers, they may think I’m copying their work.

The concept of copying answers was a situational cue from prior experience in the classroom. Learners lacked confidence and had the fear of being accused of cheating.

DD: Did you read the other participants’ answers?
I: Sometimes. It’s alright to read if I don’t know the answer. But if I do know the answer, then I’ll just write it, and won’t read the others’ work.

The wiki was accessed less often (17 log-ins) by only 12 participants compared to the other tools. However, the participants were engaged with the task as in the first week, they had started to edit their group wiki, changing font types, adding colors, graphics and animation. Only in one group, the members had difficulty cooperating and no activity was detected.

In summary, the mobile phone was a personal device which was easily accessible, hence most frequently used. There were fewer posts in both discussion forums and wiki as the learners were working in groups. However, both these tools were useful for group responses. In addition, the wiki enabled artifacts such as graphics and text to be used for communication.
**Working in groups**

Participants preferred working and collaborating in groups (Figure 3). The group task on the wiki was attempted by most of the participants. In addition, contributions to the discussion forum were posted by groups of twos or threes participants.

The frequency of participation in the wiki differed among the groups. In two groups (Groups 1 and 5), all members participated online while in other groups (Groups 1 and 4) only one member was assigned to post the solution after the face-to-face discussion. The reason for the lack of online activity in some wikis is because one member is assigned to the posting, as explained: “We do the discussions in a group. We don’t use the computer yet. We talk and sit face-to-face, and one person will write what we discussed about.”

Group discussions and collaboration was also conducted through other CMC tools. Group 1 used Instant Messaging for discussions. “Sometimes I’m online at MSN, then I ask my friends what I should do. And my group members tell me what to do.”

![Figure 3. Participants' perception of group work (n = 20)](image)

There was a preference for group work. Results from the survey showed participants liked group work for both the online tasks (80%) and discussion forum (87%), and did not perceive group work as difficult (67%) (Figure 3). Although there were some who did not like to depend on others (“I dislike the online tasks because I need the group members”), most perceived group members as willing to contribute ideas (87%). Group discussions were conducted in face-to-face discussions and extended to the text messages on SMS and on MSN chat.

**Learning with the CmL science module**

Learning with the CmL Science module is investigated under two domains: Understanding science and support for learning.

**Understanding science**

The CmL Science module improved understanding as shown in the results of a survey, interview as well as pre and post-test results of students.

The survey showed most learners (84.3%) believed their understanding in science improved on completion of the module (Figure 4): “Because when I do this module, it improves my knowledge. In addition, the module helped me to revise the topic.”
Further, in using the module, learners interacted with online learning materials and books. As one learner reported: “It makes me open my book: I won’t open books if I don’t have exams.” In addition, they viewed other participants’ answers in the discussion forum.

![Figure 4. Learning using the collaborative mLearning science module](image)

The learners believed that the discussions in the CmL Science module facilitated learning. “Honestly, I think the SMS Quiz makes me remember. Because we like to talk to our friends, and this chit-chat helps us recall better. Well, one thing for sure, with the questions, you can always ask people, or you can refer to your Science text book. At least it helps us to brainstorm a bit.” One participant explained how the module had helped him in answering test questions: “There’s this one question on the walls of the organ in the objective section. I picked C as the answer. And in the subjective questions, they asked about the name of the movement of food in the organs, so I recalled it- peristalsis.”

A pre-test and post-test on the similar concepts showed an increase in the mean scores of participants. The $t$-test for independent samples for statistical analysis was not computed as only 16 participants completed both pre-test and post-tests. However, the difference in the mean scores showed an increase which might indicate the module was effective for learning science concepts (Table 3).

<table>
<thead>
<tr>
<th></th>
<th>Mean scores</th>
<th>Increase in mean scores</th>
</tr>
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<tbody>
<tr>
<td>Pre test</td>
<td>61.97</td>
<td></td>
</tr>
<tr>
<td>Post test</td>
<td>83.07</td>
<td>21.09</td>
</tr>
</tbody>
</table>

Note. Number of participants, $n = 20$

The CmL module enhanced understanding of science concepts related to nutrition. Learners made references to materials, both online and print; and had discussions in science. Reference to materials enabled learners to formally model their answers while informal discussions in the search for knowledge contributed to understanding science. In this way, learners are able to build knowledge and scientific verbal language.

Support for learning

Support during the learning process provided the scaffolding for the novice learner to reduce the zone of proximal development (Schunk, 2000). The expert might be their peers or the instructor from whom they receive support and verification for what they were doing. The survey and interview would be used to determine if learners required support while additional data would be collected through observation of the online interactions to determine learners’ interactions.

Learning is supported through their peers’ interactions as evidenced from the group tasks on the wiki. Group work seemed to be effective for learning (Bligh, 2000; Sharma & Anderson, 2009; Tubbs, 1995). Group members who were cooperative were able to collaborate well and contribute to better solutions on the wiki. In addition, groups with members of similar interests and background were more active and seemed to perform better. This was because group members who worked well together online had a shared goal.
In the CmL module, the tutor monitored the learners’ activities online and provided support when necessary. Assistance was provided when asked, or when the tutor perceived the learner required assistance. Scaffolding in the form of exemplars, hints and suggestions of strategies were given to assist in constructing the solution. In the discussion questions, the tutor suggested aspects of the question which the participant might not have considered.

However, learners perceived they required more support from the tutor. Novice learners wanted more help and feedback from the tutor on the wiki (73%) and the discussion forum (80%) (Figure 5). The tutor was the “provider of knowledge” and learners expected the tutor’s continuous presence. In addition, Malaysian learners seem to require more scaffolding, perhaps because of the social norms, beliefs, and behavior of a teacher-centered education system, where the teacher is the source of knowledge.

![Figure 5. Assistance from tutor (n = 15)](image)

Scaffolding needs to be gradually withdrawn to allow learners to build their knowledge through the thinking processes. Learners were not used to the absence of a teacher. However, learners will be forced to think for themselves without the teacher’s continuous presence. As one learner reflected: “When the teacher’s not there, I have to go solo and have to think to get the answer.”

Scaffolding supports the informal learning of science through conversations, discussions and other online communication as it provides opportunities for modeling science in the learning materials and the discussions in the CmL Science environment. These patterns of language and concepts formed when learners collaborate on their tasks contribute to the understanding and learning of science.

**Implications and conclusions**

The findings of this study indicate that the CmL Science module can be implemented in secondary school science. Learners participated in the discussions in science using CMC tools showing that CmL can effectively be used to support communication for learning (Anastopolou et al., 2011; Arrigo et al., 2005; Guzdial & Turns, 2000).

Communications on the wiki and discussion forums could be viewed by the public and formed a permanent representation of the tasks, or the answer to the problem. At the same time, informal communications in constructing the solution contributed to the thinking process. These interactions and discussions were beneficial for learning and constructing science knowledge (Hoyle & Stone, 2000). This was proven from the results of the pre-test and post-test. Although there were only twenty participants, the findings are relevant as the participants are of different science abilities. However, future studies could be done to determine the effectiveness of the CmL module with a larger sample.

Private discussions were also conducted, both face-to-face and through text messages. The discussions for solving the task enabled the learners to have a shared goal and form a learning community which contributed to knowledge building (Johnson & Johnson, 2004; Kuo, Hwang, Chen, & Chen, 2012; Palloff & Pratt, 1999).
The comparison of the frequency of use of the CMC tools showed text messaging was the preferred communication tool. Text messages were pushed to learners who owned the cultural tool, the mobile phone, which was with them most of the time (Capuano et al., 2005). Hence, the ease of accessibility and use was a factor for increased use. On the other hand, the wiki and discussion forum was a little more difficult to access as a computer was required. The wiki was preferred compared to discussion forum as it was easier, more attractive to use, and encouraged group work.

Previous studies have combined the use of several tools for learning. The use of a combination of three tools was more effective than one or two. Not all learners used all the CMC tools during implementation. Hence, by providing a choice of several tools, we allowed learners to respond using the tool most suitable or preferred for learning. Wiki lends itself to collaborative problem solving; discussion forums were best for debates and arguments while text messaging was for factual and conceptual knowledge. This study also confirms that text-messaging could be used for informal discussions for building knowledge, as well as a stimulus through formal learning when quizzes are answered.

The preference for different CMC tools was related to the learners’ learning styles and convenience. The influence of learning styles and the convenience of the tool could be an area for further research. In addition, further studies could be done to investigate if there are any significant differences when only one, two or three CMC tools are used.

Use of CMC tools affords collaborative mobile learning (Guzdial & Turns, 2000; Slotta & Linn, 2000). Learners prefer working in groups when attempting the tasks with the CMC tools. Collaborative mlearning, as a result of using CMC tools for group interactions, was effective (Ally, 2004; Johnson & Johnson, 2004; Siraj, 2005; Siraj & Alias, 2005). There was some disorientating dilemmas in some groups when the group did not cooperate and coordinate well (Tubbs, 1995). This implies that group dynamics and group building should be conducted in order to establish specific behavioral norms. Support from the instructor could maintain the group’s dynamics.

In addition, silent observers, who did not seem to participate but observed the social interactions, were also involved in the informal learning process. This was evidenced as when they viewed other participants’ answers, the patterns and use of scientific verbal language was observed (Karpov & Haywood, 1998). It was also noted that lack of participation in discussions could be attributed to the learners’ perception that there was only one correct answer in science. These learners have to be given more scaffolding and encouragement to participate in the communication and learning process and to be made aware of the nature of science knowledge (Schunk, 2000). In addition, considerations may have to be made in the social and cultural tools to include more exemplars and guidance for discussion questions (Gredler, 1997). Orientation to the module should also include more group activities to get to know the members and develop a shared goal in learning (Tubbs, 1995). Future studies should investigate the difference in having heterogeneous groups, and groups which are formed according to participants’ choice in CmL. In addition, methods to engage the silent observers in order to ensure full participation have to be considered.

The findings of the study reinforce the fact that communicating in science is important for learners to plan, share ideas, develop their understanding and promote critical thinking through the language of science in a collaborative environment (Ellerton, 2003; Hoyle & Stone, 2000). The communication contributed to the learning of science. Hence, the CmL module can be used for learning science out of school hours, to address the problem of lack of time for classroom discussion.

The CmL module was developed for online communication and collaboration with appropriate tools to encourage learning of science. Most learners seemed to prefer to collaborate while attempting the activities. Learners discussed when solving the problem task on the wiki and attempted answering the discussion questions in small groups. The patterning and modeling of the language of science was developed during group discussions (Karpov & Haywood, 1998).

In summary, social learning in the use of the collaborative mLearning module could be used to teach science to address the learning needs in the field. This aspect of social interaction for building knowledge thorough formal and informal learning can be extended to other subjects as well. Elements in the environment, including participants’ answers were artifacts to “mediate” learning. Hence, in the CmL Science module, non-participation did not mean the learner was inactive. Learning could take place formally and informally when other learners’ answers and interactions mediated learning.
Acknowledgments

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