DESIGNING A COLLABORATIVE MLEARNING ENVIRONMENT FOR FORM 2 SCIENCE

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This paper discusses the need for communication in learning science, and whether online learning tools could address this need. The learning of science should emphasize the scientific process as well as science knowledge. The scientific process occurs when a community of peers collaborates and discusses a problem. Science learners in schools should be given opportunities to collaborate and discuss in order to construct their own knowledge. When participating in scientific discussions, learners have the opportunity to use scientific verbal knowledge to build their understanding of scientific concepts. At the same time, the teacher scaffolds and provides opportunities for patterning and modeling. However, there is insufficient time for communication in the science classroom. Computer-mediated communications tools enable the scientific process to be extended outside the classroom. With these tools, collaborative learning can be carried out through synchronous or asynchronous communications. The collaborative learning tasks for science in this paper were designed using Merrill's First Principle of Instruction. The benefits and affordances of the communication tools are taken into account in task design. The use of online learning tools, such as discussion forums and wikis, scaffolded by text messaging through mobile devices, were considered useful for designing a collaborative mobile learning environment. A collaborative mLearning environment which uses collaborative online tools while the learner is mobile improves the learning of science based on the social constructivist theory of learning.

Keywords: Collaborative m-learning, computer-mediated communications, collaborative on-line tools

The scientific process is important in acquiring scientific knowledge. When communicating in science, scientific vocabulary and symbols are used. Learners of science require more practice in communicating with these new vocabulary and symbols. Computer-mediated communications enables discussions in science to continue outside the classroom. The tools for computer-mediated communications enable collaborative learning to take place. In addition, these tools enable the learner to be mobile; learning can take place anywhere. Hence, science instruction can be designed to take advantage of the affordances of computer-mediated communications tools for a blended approach of collaborative and mobile learning, or collaborative mLearning.

Communicating in Science

Science is the body of knowledge constructed from scientific processes to make discoveries about the natural world (Abruscato, 2000). Science consists of both the content or scientific knowledge; and the scientific and reasoning processes (Howe & Jones, 1993). The content is built upon using scientific reasoning processes and may be conducted individually or within "a community of peers" in collaboration with other scientists (Hogan & Fisherkeller, 2005, p. 96). The teaching of science should reflect the nature of science where science should be taught in a collaborative environment to reflect the influence of the community of peers (Hogan & Fisherkeller, 2005).

Science education is not only about teaching content or scientific knowledge but involves the scientific method which arises from scientific reasoning processes. In the process of acquiring scientific knowledge and practicing scientific methods, learners should begin to be knowledgeable enough to debate issues in society and learn science to cater for their own personal needs. In order to acquire knowledge and employ the scientific reasoning process, a person must be able to understand what is being communicated, and to communicate his feelings, doubts and give feedback as well. Communication in science involves the passing of information in the form of words or symbols among individuals or groups of individuals (Wolfinger, 2000). Thus, communication assists the construction of knowledge and the thought processes (Hoyle & Stone, 2000).

Firstly, in order to understand scientific communications, learners would need to have scientific verbal knowledge. Scientific verbal knowledge is the knowledge of communicating in the science vocabulary (Hoyle & Stone, 2000; Karpov & Haywood, 1998; Wolfinger, 2000). With scientific verbal knowledge, the learner is able to use scientific terms and construct meaningful phrases and sentences to communicate his thoughts.

Then, learners can progress in their communications and develop science concepts and principles through modeling and patterning, scaffolded by their peers and teachers (Hoyle & Stone, 2000; Karpov & Haywood, 1998; Wolfinger, 2000). As Vygotsky emphasized, scientific verbal knowledge and mastery of basic procedures are required to enable learners to understand and participate in scientific discussions and to build their understanding of concepts and principles (Karpov & Haywood, 1998).

Further, 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). This requires scientific verbal knowledge as learners contribute their ideas based on their current understandings of concepts and principles. The advantage of student-centered discussions is that critical thinking skills are developed during the discussions with other learners, and differences are resolved to reach a mutual understanding (Hoyle & Stone, 2000; Karpov & Haywood, 1998).

Designing Science Instruction to Allow for Communication

Communication is important for learning science. Several principles should be taken into account when designing science instruction. Firstly, learners must be given sufficient activities for discussion to assist them in building their vocabulary, and personal understanding of scientific concepts and principles. These would provide more opportunities for learners to show patterns of the words, symbols and models of scientific language that can be used (Hoyle & Stone, 2000).

Secondly, teachers must be more aware of the difficulties learners experience when trying to comprehend the vocabulary and language structures of science (Ellerton, 2003). More opportunities for patterning and modeling should be given to the novice learner. Individualized support and scaffolding should be provided for learners who require support (Hoyle & Stone, 2000).

Next, learners should be given opportunities to link the science knowledge that they build to their own personal experience (Ellerton, 2003). Hence, developing listening and speaking skills in scientific discussions is important for planning, sharing and developing ideas and understandings in science as well as critical thinking skills (Ellerton, 2003; Hoyle & Stone, 2000).

Finally, social interactions have motivated learners to be engaged in carrying out activities successfully to build their knowledge meaningfully in science (Brown, 2006). However, the success of the discussions would depend on the learners' understandings of the language, their motivation, beliefs, and whether they have assimilated into the culture (Brown, 2006).

In conclusion, the teaching of science should provide learners opportunities for vocabulary building and understanding science concepts; allow patterning, modeling of science concepts and principles and provide individualized scaffolding when required; provide opportunities to link the newly acquired knowledge with their existing knowledge; and have more social interactions to motivate learning.

Hence, the design for the teaching of science should include more problem tasks and more time for group discussions; more opportunities for modeling and scaffolding on tasks by teachers and peers; problem tasks that start from simple to more difficult, and are relevant and motivating; and opportunities for social interaction.

On the other hand, in the science classroom there is insufficient time to provide more problem tasks and have social interaction. There are only five periods of about 30 minutes, which means a total of about 150 minutes a week for teaching Form 2 science. With the large amount of content to be covered, there does not seem to be enough time for social interaction. Hence, an alternative has to be provided to allow opportunities for group discussions outside the classroom.

However, communication can be easily done at a low cost using a computer with Internet connections. There are many computer-mediated communication tools which can be easily made available to students.

Computer-Mediated Communication

Computer-mediated communication (CMC) is any form of two-way interaction using the computer (Inglis, Ling & Joosten, 2002). CMC has been used for delivering information and for social interaction (Romiszowski & Mason, 2004). There are two forms of CMC: synchronous communication, which is real-time communication; and asynchronous communication, which is at a delayed time (Jonassen, 2000). Synchronous communications consist of open networks using chats and other messaging systems, multi-user domains, and desktop video conferencing (Grabe & Grabe, 2004; Jonassen, 2000). Asynchronous communications are delayed communications such as electronic mail (e-mail), mailing lists, bulletin boards, conferences and forums and collaborative workspaces such as Swiki and Seedwiki (Grabe & Grabe, 2004; Jonassen, 2000; Jonassen, Howland, Moore, & Marra, 2003). Text-based asynchronous and synchronous CMC can be used to create both formal and informal environments for collaborative learning (Jonassen, Lee, Yang, & Laffey, 2005).

Definitions of Terms

Collaborative Learning

Collaborative learning arises from the process of social interaction, and does not depend on the learning materials provided (Jonassen, Lee et al., 2005) but on the learners' unplanned responses and interactions within the community of learners (Johnson & Johnson, 2004). CMC tools enhance the collaborative learning process by facilitating communication and social interactions.

mLearning

CMC has become more mobile as technology advances to wireless systems. Laptops and Personal Digital Assistants (PDA) have enabled communications to be conducted anywhere: at home, out of school, or on the move; and anytime, after school hours. CMC is now mobile. This form of learning where the learner is mobile, or devices that enable the learner to be mobile are used is considered mobile learning or mLearning (Mohamad Ally, 2004; Saedah Siraj, 2005).

Collaborative mLearning

Collaborative mLearning occurs when collaborative learning through social interactions as learners collaborate on tasks to solve a problem occurs in an environment that allows the learner to be mobile. Hence, collaborative mLearning can occur at anywhere and anytime.

Tools for Collaborative mLearning

The tools for collaborative mLearning that will be discussed in this paper are discussion forums, collaborative workspaces and text messaging, commonly known as Short Messaging System or SMS.

Discussion Forums

Online discussion forums enable members of the group to post messages, and read messages posted by other members. These messages are sometimes threaded so that the discussions can be tracked. The member has a choice to receive the messages posted through his email. This is useful as there is direct contact between the teacher and learners (Grabe & Grabe, 2004; Jonassen, 2000; Jonassen, Howland et al., 2003). The online discussion forum enables social interactions to occur through messages that are sent and allows collaborative learning as members collaborate to solve problems and work on tasks (Grabe & Grabe, 2004). The discussion forum used in this study is Yahoo groups.

Collaborative Workspace

A collaborative workspace is an open online collaborative website that enables users to write, edit and publish documents collaboratively (Jonassen et al., 2003). The user need not be a member to edit or publish on the website. However, tracking of changes can be done when the user logs in as a member. These open websites are called wikis and in this study the Seedwiki would be used.

Text Messaging

Text messaging thorough mobile devices such as handphones and PDAs uses a messaging system known as Short Messaging System or SMS. SMS allows synchronous and asynchronous communications on the mobile device. Interactions are one to one and personal.

Studies on Collaborative mLearning

Some studies which make use of CMC for collaborative mLearning are described. Some of these studies are implemented using the online tools while the learner is mobile. Other studies discussed make use of mobile devices and text messaging to complement the online tools.

Discussion forums and collaborative workspaces have been used for teaching science to encourage collaborative mLearning. One example of such an environment is The Knowledge Integration Environment (KIE) which provides social context and opportunity for collaborative work in science for learners from elementary to high school (Slotta & Linn, 2000). Tools that allow web resources to be kept allow scaffolding in the form of tips, guidance for the sequence of activities to be done and an online asynchronous discussion tool. In this research, the 8th grade participants were able to evaluate web pages effectively and ask relevant science questions with the cognitive guidance and modeling that was given. The students also found the system useful for learning science (Slotta & Linn, 2000).

Another tool which makes use of discussions forums and collaborative workspaces to support student discussions for teaching science is CaMILE. CaMILE, a web-based tool for collaborative learning, was found to be effective in encouraging learners to communicate and work together in science inquiry projects (Guzdial & Turns, 2000). From the discussions conducted on CaMILE, there was evidence that science learning was made personally relevant as learning took place at the individual level; the discussions were more sustained showing that the learners were engaged with the topics (Guzdial & Turns, 2000).

Text messaging has been combined with a collaborative workspace for collaborative mLearning in some studies. Arrigo, Gentile, Taibi, Chiappone and Tegolo (2004) used a collaborative platform for mLearning using emails and SMS to send messages to the Peer to Peer Communication module in the system. In this platform, learners stored and shared photos and videos from their mobile phones in a repository and were able to collaborate and build their understandings.

Another team of researchers incorporated text messaging in a learning management system for e-learning. Capuano, Gaeta, Miranda and Pappacena (2004) offered "SMS pills", short textual learning objects, in a course which incorporated an e-learning platform to track learners' progress and respond to answers to the quizzes. They report that the trials have shown users were more motivated to learn using SMS, as compared to browser-based interactions.

Text messaging with mobile phones has been used for language learning (Kadyte, 2004; Noessel, 2004; Sim, 2004). Lessons and information personalized to the learner can be pushed to mobile phones without the learner requesting for it (Kadyte, 2004), or sent on request (Noessel, 2004). Open-ended questions could also be sent by the learner to the system to be answered (Noessel, 2004). Learners involved in learning with text messaging were interested and motivated to learn.

A variety of content form can be delivered using mobile phones, depending on the technology of the device, as the content can be highly interactive animations to simple text messages (Smyth, 2004). In the “skoool” project, an e-learning initiative at Intel IT Innovation Centre in the United Kingdom (U.K.) and Sweden, several forms of content was developed: (a) instructional learning objects for learning and revision; (b) interactive simulations for the application of learning; and (c) text-based content for reminders or revision. The users found the content beneficial but the researcher noted that there was not enough opportunity for learners to give ideas and create knowledge in this project (Smyth, 2004).

Messages sent with push technologies have been highly effective in promoting regular study and managing learning. In the BBC BitSize program, content was provided in the form of videos and interactive games. In the European Union mLearning project, prototype products and technologies such as MMS, SMS, XHTML, WAP Java and Flash were found to engage learners (Popat & Stead, 2004). The use of text messaging engages learners (Popat & Stead, 2004; Stone, 2004). Stone (2004) found that all the students asked were interested in using SMS to support their learning even though the number of responses to the messages sent was low. He also found that students were just as likely to inform their peers of information shared with an SMS as compared to a voice call or face to face.

A comparison of the use of SMS, emails and online groups showed that the use of SMS motivated learners and that the use of online group could improve examination performance. Rau, Gau and Wu (2005) described their experimental research in Taiwan on the effects of SMS and collaboration on motivation, pressure and students' exam performance in traditional classrooms in a vocational senior high school. Although there was no difference in motivation and pressure among the groups which used SMS, e-mails and online groups, the learning performance of the SMS group compared to the control group did increase and the SMS group also felt more pressure compared to the control group, but were more motivated as they perceived that the lecture notes and reminders helped them improve. A combination of SMS and online groups was also shown to improve learning performance and motivation (Rau et al., 2005).

Rau's team showed that learners' motivation increased with the use of electronic media as instructor and learners could communicate. In addition, when a combination of mobile and Internet tools were used, concise information was relayed in a personal manner; and this increased learners' motivation to study, and contributed to improved performance.

Hence text messaging has been used to support learning. When text messaging is combined with another collaborative tool, learning may be improved. Communication technologies enable students to e-mail experts in the field of science and technology to get feedback, have authentic discussions and interact in a collaborative environment. However, there seems to be a lack of usage of online forums combined with text messaging for the teaching of in science in Malaysia.

Teaching Science in a Collaborative mLearning Environment

A collaborative mLearning environment using collaborative mLearning tools is suggested to address the need for communication in learning science. In the first section, the authors suggested that the design for the teaching of science should include more problem tasks with more time for group discussions; more opportunities for modeling, scaffolding and assistance; problem tasks should start from simple to more difficult and be relevant and motivating; and provide more opportunities for social interaction. Each of these suggestions is discussed based on tools that could be used in a collaborative mLearning environment.

1. More problem tasks and more time for more group discussions should be given. Problem tasks are given to groups of learners in the discussion forum, Yahoo groups. Learners are directed to a collaborative workspace, Seedwiki, to work and discuss the problems. While on the discussion forums, they can post comments, questions and source for assistance.

Rationale: A discussion forum and collaborative workspace allows learners to spend more time on group tasks and discussions as the learning environment is available anytime, 24 hours a day, 7 days a week (Jonassen, 2000). The learners do not have to be at the same location for learning to occur (Grabe & Grabe, 2004) as learning can occur anywhere, at school or at home as long as they have access to a computer with Internet access (Inglis et al., 2002).

In addition, learning is time-independent as learners do not have to interact immediately, but can view the messages and work in progress at their leisure and convenience (Grabe & Grabe, 2004; Inglis et al., 2002). This benefits reflective learners, who need time to reflect before responding (Grabe & Grabe, 2004; Jonassen, 2000; Jonassen, Lee et al., 2005).

2. More time for is required for modeling, scaffolding of tasks and assistance.
   As learners discuss the problem tasks on the discussion forums, they are directed to materials when required, which may assist them through links to web pages, and text messages on the mobile. On the collaborative workspace, Seedwiki, as learners discuss solutions to the problem task, they are monitored and assisted when required.

Rationale: As learners discuss their experience and share their views, modeling and patterning of the language and concepts of science from their peers and teachers occurs. Different experiences, expertise and contexts can be shared as learners interact and share different opinions and viewpoints online (Grabe & Grabe, 2004). Then the learners would be able to observe different patterns and models and construct their own understanding. In addition, a deeper level of understanding occurs when learners discuss and debate among themselves, as well as with peers, experts and teachers.

As learning occurs in the social negotiation of ideas about the content being studied, creative thinking and other complex thinking skills are scaffolded (Jonassen, 2000; Jonassen. Howland et al., 2003). Learning can be individualized with text messaging (Saedah Siraj, 2005) and is private as learners can work at their own time and place (Colley & Stead, 2004; Kadyte, 2003; Saedah Siraj, 2005). Text messages can enable synchronous or asynchronous discussions.

Scaffolding in the form of individualized feedback can be given to learners immediately in the areas they need assistance through text messaging (Attewell, 2005; Attewell & Webster, 2004; O'Nuallain & Brennan, 2005). Hence, learning is personalized to the learner in terms of knowledge, depending on the learner background and goals (Mohamad Ally, 2004). This means that the teacher or tutor can personally scaffold the learners according to their needs.

3. Problem tasks to start from simple to more difficult to allow for opportunities to link with present knowledge. A main problem task is given for each group to solve. Before the main problem is solved, several simpler problem tasks are given.

Rationale: The First Principles of Instruction are design-orientated principles that influenced learning were used to solve real-world problems in learning environments that make use of any delivery system (Merrill, 2002). Merrill's (2002) first principles are based on the fact that learning is facilitated when learners are engaged in solving real-world problems Initial problems given as tasks are relatively simple problem and progress sequentially to more complex problem-solving tasks (Merrill, 2002; Reigeluth, 1999) to ensure that learners gain expertise in problem solving.

4. Social interaction out of school hours with tasks that interest and motivate.
   Real world problems are given to motivate learners. At the same time, interactivity is encouraged through text messaging and discussion in the discussion forum. Prompting by the teacher occurs if there is a lack of response and interaction.

Rationale: Tasks and the activities should be interesting enough to motivate the learner to participate in the social interaction. In addition, fast-paced synchronous communications, like text messaging which do not allow learners to reflect on their answers has been shown to be exciting and motivating to learners (Jonassen, 2000). The learner needs to use critical thinking skills when engaged in synchronous conferencing and the messages are personalized as the learner elaborates, expands, modifies and concretizes ideas in the discussions (Jonassen, 2000).

Generally, there seems to be more interaction among learners online as compared to in a face to face environment, as learners tend to spend more time online (Jonassen et al., 2005). The forms of communication in the discussions are more complex and diverse: researchers note that e-mail messages are longer, more complex and productive compared to classroom discussions (Grabe & Grabe, 2004). As all comments are accepted in conferences, this encourages participation as there is no threat as compared to a classroom environment which may cause a learner to perceive unfavorable cues (Grabe & Grabe, 2004; Inglis et al., 2002).

In addition, collaborative mLearning engages the learners who are normally not interested in learning (Attewell & Webster, 2004). Learners tend to be more focused for a longer period (Attewell & Webster, 2004), and show interest in learning and sharing information (Colley & Stead, 2004). Collaborative mLearning has been shown to improve learners' self-confidence, especially with learners who have been disengaged with learning (Attewell, 2005; Attewell & Webster, 2004). In addition, it has also been used to cater for learners with special needs (Attewell, 2005; Saedah Siraj, 2005). Learners in the new environment are engaged when experimenting, communicating and collaborating using new techniques and tools.

Conclusion

In designing instruction to enable learners to have more time and opportunity to communicate in science, communication tools which are free or inexpensive, easy to use and do not require expensive infrastructure are used. In this paper, web-based online tools, such as discussion forums and a collaborative workspace, Seedwiki, are suggested to be used with text messaging on mobile phones. A collaborative mLearning environment can allow opportunities for communication, discussion and the construction of knowledge in science.

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