DEVELOPING A MOBILE PROBLEM-BASED LEARNING SYSTEM: A PRELIMINARY STUDY

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ABSTRACT

Most of the teaching methods used in problem-based learning utilize text and pictures to illustrate problems. The majority of the feedback and evaluation is based on the traditional pen-and-paper observations of teachers/tutors. These methods may not generate the best possible results in assisting and evaluating learning. Problem-based learning combined with mobile technology allows students to learn and problem solving in a more organized, conceptualized, interactive, and prompted manner. Mobile problem based learning is a new technology with great application potential across many educational faculties; this system focuses on nursing education. Nursing education and training is a great expense to both student and institution. With the advent of the latest technology it is possible to reduce the cost while improving the learning outcome. For self-motivated learners, the opportunity to improve and enhance practical skills, critical thinking, and problem solving, becomes accessible anywhere and anytime. The design process and participants feedbacks are examined in this study. System modifications will be based on the current feedback for future mobile problem-based system updates.

Keywords: problem-based learning; critical thinking; problem solving; assisted learning system; mobile technology

1. INTRODUCTION

The purpose of nursing education is to cultivate nursing staff who are capable of independent thinking. They must be competent in the collection, integration, and analysis of data to correctly determine the health conditions of an individual to provide an instantaneous, safe, effective, and cost-effective nursing care, as well as be able to conform to the changing health care environment.  

Traditional teacher centered face-to-face teaching methods can rapidly introduce new ideas, impart knowledge, and resolve doubts. However, due to time limitations, this teaching method can easily become a “cramming” style of education, with insufficient training in critical thinking. As a result, students may become incapable of exerting professional judgment and autonomous thinking when facing variable clinical working conditions after graduation.  

In recent years, the Objective Structured Clinical Examination (OSCE) have been introduced into teaching and evaluation in medical and nursing education programs. The Objective Structured Clinical Examination (OSCE) is a performance-based evaluation. The main objective of the OSCE is to assess students’ capability of transferring classroom and laboratory learning experiences into simulated clinical practice.  

The words spoken and the responses of standardized patients in OSCE can affect the performance of the students, which may determine whether or not the students pass or fail the evaluation. Therefore, the standardized patients to be more effective should be professional in the field of medical and nursing. Standardized patients provide students with a safe channel for learning, evaluation, feedback and allow for repeated practice. Training a standardized patient who conforms to the OSCE is costly, and requires large amounts of time and effort. In addition, a standardized patient can be used repeatedly, but because of geographical constraints, a standardized patient cannot be used concurrently or in large numbers. In addition to standardized patients, computer-simulated instruction is also used to train
students’ clinical practice. Based on their functionalities, computer-assisted teaching is classified into low fidelity (i.e., simulated dialogues), moderate fidelity (i.e., simulated training for intubation skills) with incorporated sound effects, and high fidelity (i.e., using SimMan and HPS dummies that provide personified expressions, sensations, and responses).5,6 Human patient simulators provides an innovative teaching method for nursing students, they are quite costly. To investigate the value and need of this expenditure, a comparative study was done to examine two educational interventions: human patient simulators and interactive case studies. Students in the human patient simulation group scored significantly higher than those in the interactive case study group. However, no significant difference was found in student scores between two teaching methods.7 Simulated instruction is not widely applied because of its time-consuming nature, expensive, equipment and location constraints, and the lack of technical support.6 Due to the limitations of conventional teaching, standardized patients and simulation, mobile problem-based learning system (mPBL) was developed to offer a lower cost but timely, context-oriented, interactive training and learning tool.

PBL was proposed by Dewey, it emphasizes the importance of initiative, observation, and imagination for knowledge construction. PBL was first applied in medical education at McMaster University, Canada, and subsequently applied to education in other professions.5 PBL is a student-centered teaching model which stresses the significance of motivation and personal responsibility for learning. PBL allows students to participate in active learning, to improve their communication ability, critical thinking, analytical thinking, creative thinking and problem-solving skills in diverse learning environments.9

Numerous studies have indicated that traditional school education systems are narrow and dissociated from real life. Most knowledge learned from school has become “inert knowledge.” This so-called inert knowledge is knowledge that one has clearly memorized but is unable to apply.10 In the past, the design and application of computer-assisted instructional software lacked situational context. Consequently, learners were unable to effectively apply the knowledge and skills acquired to real life situations. Situational learning stresses the authenticity of learning activities to cultivate thinking and problem-solving abilities of students. Jonassen (1998) proposed the concept of “mindtools”, which emphasizes the incorporation of computer environments and software developed with the intention to stimulate critical thinking and creativity in learners while reinforcing extended retention and applicability of knowledge.11

With the development of mobile communication systems and wireless networks, people can obtain information from any virtually location. They can communicate with their teachers, peers, or others who have similar interests through wireless mobile communication systems (i.e., Bluetooth, and wireless local area networks) and mobile learning devices (i.e., smart phones and tablet PCs).12,13 The invention of mobile learning devices allows for more convenient information searching, rapid integration and application of information. The critical thinking and problem-solving skills of student have improved correspondingly. The rapid technological development in computers, the Internet, and mobile learning devices has revolutionized traditional teaching and learning methods. Combining the aforementioned properties with PBL offers great opportunity in the application of innovative instruction in nursing education. The application intends to: 1) enhance mobile learning option, 2) improve access to nursing education materials, 3) reduce cost of OSCE and simulation in professional training, 4) encourage the use of current technology in the educational setting, and 5) enhance human-computer interface while improving student clinical skills.

2. PURPOSE:

The aim of this study is to examine the design and use of a mobile problem-based learning (mPBL) system. Results of this preliminary finding will be used for system refine and references used in other relevant research and designs.

3. LITERATURE REVIEW:

3.1 Problem-Based Learning

In 1968, McMaster University Medical School in Canada became the first to use the PBL teaching philosophy to educate its medical students. Since then, PBL has been widely applied across various professions.1 PBL is based on 1) real life context problem, 2) the learning content is structured around the problem, 3) cooperative, 4) students assume responsibility for learning, and 5) teachers act to guide and facilitate learning.1,14
Similarly, Ekhami (2001) & Dochy, Segers, Bossche, & Gijbel (2003) mentioned that PBL involves the following actions: 1) the group identifies the topics of study, 2) time is allotted for information collection, 3) information is discussed, deliberated, and applied to solve the problem in a practical manner, 4) reflection and consensus takes place within the working group, and 5) group evaluation of their own performance. In PBL, ill-structured and true-to-life problems are used as the starting points. Students work as a team to solve the problems through collecting and analyzing pertinent information applying the knowledge learned, and integrating newfound knowledge. PBL is self-directed learning (SDL) with learners in charge of the process. Learners choose the topics they wish to study, the channels of information search, and the methods of solving problems. Therefore, the roles of the students are as thinkers, knowledge creators, and evaluators of their learning outcomes. The roles of teachers are those of facilitators, experts and community enthusiasts; they do not teach but guide and help. The ‘problem’ in PBL can be used to denote any situation that stimulates thinking in the learner, in contrast to the passive transmission of knowledge in the conventional lecture. PBL facilitates the integration of theory and practice. It improves learner attitudes with respect to their responsibility for learning on their own and trains them in problem-solving skills. The students who participated in PBL had better learning attitudes and increased knowledge as compared to students of traditional teaching styles. Applying PBL in nursing administration courses has improved the cognitive integration of students and their capacities for team coordination. Additionally, students who participated in PBL programs performed significantly better at critical thinking and comprehension abilities, than students who were taught using conventional teaching styles. Their attitudes for true exploration and self-confidence in critical thinking were also increased.

### 3.2 Mobile Technology in Learning

The Industrial Development Bureau, Ministry of Economic Affairs (2010) in Taiwan has suggested that the era of mobile learning has arrived. Two major technologies have had an impact on future learning environments: wireless and broadband technologies and mobile devices. With the development of wireless networks and broadband, students are able to acquire learning materials and instruction, and to share content with their peers. Popular mobile devices, such as smartphones, PDAs, and tablet PCs, make learning more convenient, efficient, and interactive. With the rich development in information technology, real life situations can be easily incorporated into teaching materials available to students by integrating computers, multimedia, and mobile devices. The cognitive ability of learners has become more flexible and comprehensive due to the abundance of audiovisual programs, and the up to date information. A growing trend in online knowledge synthesis, where students, domain experts and community enthusiasts meet to discuss issues and share experiences expedites knowledge generation. Computer situational learning creates a safe environment for students to make technical and nontechnical professional preparations before entering clinical practicum without risking patients' life.

Mobile devices are being used in medical and nursing care and clinical education at an increasing rate. They are rarely used in school education. Mobile computing increases the degree of work freedom for community nurses. It acts to facilitate connections with colleagues or supervisors, and to provide a more efficient and patient-centered health care model. The impact of the mobile technologies on barriers to research utilization, perceived quality of care, and on nurses’ satisfaction was examine. Results indicated that mobile information technologies increase the access to resources, reduced the barriers to research utilization, therefore increase quality of care.

### 4. METHODOLOGY

#### 4.1 Materials and System Design

A gastroesophageal reflux disease (GERD) case was used in this system because it requires critical judgment to determine the problem and care. GERD is common but easy to misdiagnose in adults because its symptoms are similar to gastritis. GERD is hard to detect in children, since children cannot describe what they feel and indicators must be observed. GERD requires medical treatment, lifestyle change, or surgical treatment. Without appropriate diagnosis and treatment, GERD may lead to Barrett's esophagus, a precursor condition for carcinoma.

The six principles of instructional design proposed by Jih & Chang (2001) were incorporated...
into the system, to enhance learners’ motivation and to improve practical application. The six principles include: 1) encourage participation, 2) simplify segmentation, 3) highlight approaches, 4) use key features, 5) control setbacks, and 6) provide demonstrations.\textsuperscript{34} Using virtual clinical cases, multimedia and animation etc. was used to motivate participation. The case context was segmented into 4 scenes, a method to simplify segmentation, which was sequentially displayed to focus learners’ attention. Highlight principles was incorporated into the system by providing the rules (e.g. external website resources, objective of each scene) of the system before practicing. Various key features were applied to enhance learning, including, key information selection, website resources, tutors, leaders, concept maps, and texts for reflection. Given the consideration of control setbacks, questions were presented in each scene for the learners to reflect upon. If learners could not complete the questions, the system leader initiated the discussion, and the system tutor encouraged the learners to rethink, and guided them through their difficulties. Additionally, learners were encouraged to write down their strengths and weaknesses and that which they have learned in the final feedback section. In terms of providing demonstrations, the system tutor provided positive feedback, tips, and corrections where appropriate, based on the responses of the learners. The system was developed with Client/Server architecture to establish the website interface. The teaching materials were developed using Photoshop and Illustrator. Animated teaching materials were created with Adobe Flash CS4 and Adobe Captivate 4. Written interactive teaching materials were developed with Action Script 2 and integrated using the ASPX.net website program language with SQL database. Figure 1 shows the algorithm of the system, Figure 2-4 are the snapshots of the program.

4.2 Procedures and Instruments

Twelve participants who previously had completed face-to-face PBL were recruited to test the program. They were divided into three groups (4 people / group), with one Tablet PC per group. They used Tablet PC to test the system in different study rooms at the same time. Each participant completed open-ended questions as follows:
1. What is your opinion of the hardware and software (monitor size, touch panel, and weight), feasibility, flexibility of use, and the Internet connection of this mobile learning system?
2. What is your opinion on the interface design, function, and ease of use of this mobile learning system?
3. What is your opinion on the data search option, critical thinking and problem-solving abilities training, group interaction, and learning objectives in line with the PBL curriculum of this mobile learning system?
4. To what degree are you willing to use this mobile learning system in the future?

5. RESULT

5.1 Demographics

In regard to the age of the twelve participants, 1 was 20 years old (8.3 %), 10 were 21 years old (83.4 %), and 1 was 22 years old (8.3 %) As for the computer usage experience, 1 student (8.3 %) had been using the Internet for 3.1 to 6 years; 6 (50.0 %) had been going online for 6.1 to 9 years; 1 (8.3 %) had been using the web for 9.1 to 12 years; and 4 (33.4 %) had over 12 years of experience using the Internet. Eight students (66.7 %) owned mobile devices, and 4 (33.3 %) did not. Eleven students (91.7 %) had used mobile devices to go online and 1 (8.3 %) had not. Seven students (58.3 %) had used mobile devices for learning whereas 5 (41.7 %) had not.

5.2 Feedback

In response to the opinions on hardware and software, and network connectivity, etc., most participants agreed that tablets PCs were convenient due to portability. However, the monitors were too small, touch panels were insensitive, unable to zoom in or out, the keyboards were too small for typing, and the network was unstable. Further the speed of the system tutors and leaders narration were too slow. By contrast the narration of the contextual videos was too fast. Finally the font size was too small. As for the perceived ease of use, the participants thought well of the interface design and its ease of use, but the font and clicking boxes were too small. The participants felt that the content was exceptional; consequently, the time for discussion and reflection lead to greater knowledge acquisition. Regarding perceived usefulness of the system, the participants indicated that the system hyperlinks linked to empirical and evidence-based websites which provided useful data. However, most of the information provided was written in English, and they had a hard time to read the information due to language barrier. In addition to using the system in group practice, it can also be used for self
motivated learning. They mentioned that the system was helpful for learning; however, it would better conform with the spirit of PBL if the system tutor and the leader were able to respond corresponding to the questions proposed by the participants. In addition, selecting crucial factors by checking options from a list may restrict critical thinking. This is a weakness in the system design, however, text frames are provided for reflection prior to the determination of care management. The participants were neutral in terms of using the system. Participants who were willing to use the system gave the following reasons for their favorable evaluation: 1) portability, 2) interactive multimedia platform increased interest and concentration, 3) improved knowledge recall, and 4) the system could provide self directed practice for enhancing problem-solving abilities. Participants who were unwilling to use the system stated their concerns over the insensitivity of the touch panels, which resulted in excess time spent on drawing the concept map. Many students were unable to afford the new technology required to access the mPBL system.

6. DISCUSSION

The participants felt that the Tablet PCs made learning more flexible. However, some hardware issues made them impractical for group exercises. Providing each person with their own mobile device could overcome the difficulties inherently involved in the sharing of one small monitor among many people. Additionally, a weak network signal reduced the speed of page loading on the Tablet PCs. This study used ASUS Eee PCs with a 10-inch 1280 x 800 WXGA LCD touch screen. The AUSU Eee PC weighed only 680 g, but the touch panel was not as sensitive as that of an iPad, and it did not have a zoom function for images or text. Furthermore, the wireless network coverage area at the study site was small and unstable. The findings of this study from the aspects of the monitor size, font, and network connection speed were consistent with those of previous studies. Mobile learning is a growing trend; the adequacy and functionality of the hardware and software is crucial to the successful implementation of mobile learning applications. In addition, the establishment of wireless campuses, communities, and cities are an urgent matter.

For perceived ease of use, the interface design is intuitive. The interface also provides functions for real-time data search and group discussion. However, the limited selection of symptomatic options limits the level of critical thinking. The participants responded that too much text was required in the group discussion and reflection portion of the learning module. Due to the insensitivity of the touch panels and the small monitor size this use of the reflection portion in the module was found to be excessively time consuming.

Regarding perceived usefulness, the participants found that the system increased their motivation to learn at all times, and was a helpful a learning tool. The learning effect can be maximized if the interaction and the depth and scope of the database can be extended. The mPBL system utilizes tutors, leaders, text input for reflection, concept maps, and student module feedback. The mPBL is significantly different from ePBL, which focuses on choosing a single correct answer and clicking accordingly. The interactivity of current mPBL system was unlike conventional PBL. To overcome this problem, a more intelligent system with a more complex decision tree database needs to be compiled. Although the mPBL algorithm did not have a complex decision-making tree, it remains extremely useful as it can save student work, upload, and print the responses with concept maps. Teachers can the nurse this information to better understand students’ decision making process, and to discuss related issues with them.

Participants with a self directed learning motivation found that the mPBL system provides opportunities for group interaction, self-directed learning, and training for critical thinking. This finding is in accordance with the study of Shi (2005) and Yang, Kuo, Yang, Yu & Chen (2009). Using an ePBL approach not only prepared users to think critically, but also gave them the opportunity to work collaboratively in dealing with real world situations.

7. CONCLUSION

Nursing educators especially value practical clinical care training as it allows students to apply theoretical knowledge to real-life situations. This type of learning is effective; however, the balance between the learning needs of the students and the safety of the patients must be addressed. Therefore, nursing educators are challenged with providing practical and effective instructional methods and learning opportunities for students. Problem-based learning is the bridge to connect learners with real life situations and enhance learners’ critical
thinking skills. Mobile technology can support PBL in various ways.

This design paper is an exploration into the development of a mPBL system. Initial feedback suggests that students will benefit from mPBL if the system is accessible, convenient, low cost, easy to operate, real life context and, highly interactive. Appropriate modifications to the system will be based on the suggestions of the participants. The modified system will be used as an intervention tool to compare students’ self-directed, critical thinking, problem-solving and group interaction learning outcomes with traditional face-to-face PBL. It will be further tested using different mobile devices for user acceptance level.

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Log in

Select tutor
1 of 3

Select leader
1 of 8

Read user guideline:

Scene 1
(Case introduction)
Learning objective:
Discussing the problem that the case may have

Scene 2
(Patient’s data presentation)
Learning objective:
Collect all data to identify the problem

Scene 3
(More patient’s data presentation)
Learning objective:
Provide appropriate nursing care

Scene 4
(Time for MBD)
Learning objective:
Provide health education and discharge plan

Team collaboration by:
1. Discussion
2. Select content key information
3. Reflective response based on selecting key information
4. Information searching
5. Tutor and leader prompting
6. Reflective thinking response
7. Drawing and uploading concept map.

Printable
Learning path and concept map for more reflection and discussion

Figure 1: Algorithm of the mPBL system
Scene 1: Case introduction

Figure 2: Case introduction
System tutor: After an initial physical assessment with his physician and a nurse, he is sent for blood testing and other examinations.

Physical assessment, Chest X-Ray, EKG, GI test, Lab data

Figure 3: Physical assessment and lab data
Figure 4: Select content information and reflection

System tutor: Please select key information and write down your thoughts in the blanks
Figure 5: Upload concept map

System leader: Let’s integrate the information we have collected and uploaded in the concept map.

Review group work for scene 2
Tutor: We now know more about Mr. Wang’s condition. Let’s reflect on the following issues:

- What is the relationship between ulcers and GERD?
- What is the relationship between Barrett’s esophagus and GERD?
- What are the differences between GERD and NERD?

Figure 6: Group discussion and reflection.