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A Qualitative Study on How Health Professional Students and Their PBL Facilitators Perceive the Use of Mobile Devices During PBL

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Mobile devices are increasingly being used by undergraduate students to access online information in the problem-based learning (PBL) process, initially in the self-directed phase, and more recently within face-to-face tutorials. This qualitative study across three undergraduate health professional programs used semi-structured interviews to investigate facilitators' and students' perceptions of mobile device usage in PBL tutorials. Transcribed interviews were analyzed thematically, drawing on the principles of grounded theory. Implications for future practice were identified. Students perceived that mobile devices are useful and convenient for instant access to various sources of information, for note taking, and for visually sharing their research and ideas. Despite some facilitator concerns that mobile devices are potentially distracting in face-to-face PBL tutorials, students prioritized collaboration through brainstorming and sharing ideas with group members in face-to-face tutorials over searching online. Facilitators and students suggested practical guidelines for mobile device usage in tutorials to enhance critical thinking in PBL.

Keywords: problem-based learning, PBL, self-directed learning, mobile devices, educational technology, learning technology, Internet, qualitative research

Introduction

Problem-Based Learning

Problem-based learning (PBL) is widely adopted by health professional programs as an inquiry-based, constructivist educational philosophy, as a model for curriculum design, and as a pedagogical approach (Lu, Bridges, & Hmelo-Silver, 2014). While overarching PBL curriculum designs may vary from hybrid to full implementation, the PBL tutorial process remains a central pedagogical feature of these programs (Whitehill, Bridges, & Chan, 2014). In PBL tutorials, students actively construct knowledge by working as a team and dealing with complex clinical cases or ill-defined, real-world problems that do not have a single correct answer (Dochy et al., 2005; Hmelo-Silver & Barrows, 2006). Student groups need to collectively: clarify terms or concepts; identify the key facts in the problems statement; and, based on these facts and their prior knowledge, generate a list of hypotheses (differential diagnoses in most problems) that can potentially explain the

clinical situation or broaden their level of understanding of the complexly interwoven issues presented (see Figure 1).

During the PBL process, healthcare profession students also realize that there are gaps in their knowledge that prevent them from further reasoning through and understanding the broad biopsychosocial dimensions of clinical problems. The identified gaps form learning objectives that are the starting point for students to engage in self-directed learning (SDL), which traditionally takes place outside of the classroom. At the beginning of the next PBL session, under the guidance of a facilitator, students share what they have learned from their SDL with the group. More importantly, the group works to evaluate and synthesize new information and apply what they have learned to the problems at hand. At this point, they will realize whether their knowledge is now sufficient for understanding or solving the problem, or whether further knowledge building is necessary (Das, Mpofu, Hasan, & Stewart, 2002). The above sequence has not only been reported in the PBL literature as a "cycle" (Hmelo-Silver & Eberbach, 2012), but also as a series of "steps" (Schmidt, 1983) (Figure 2).
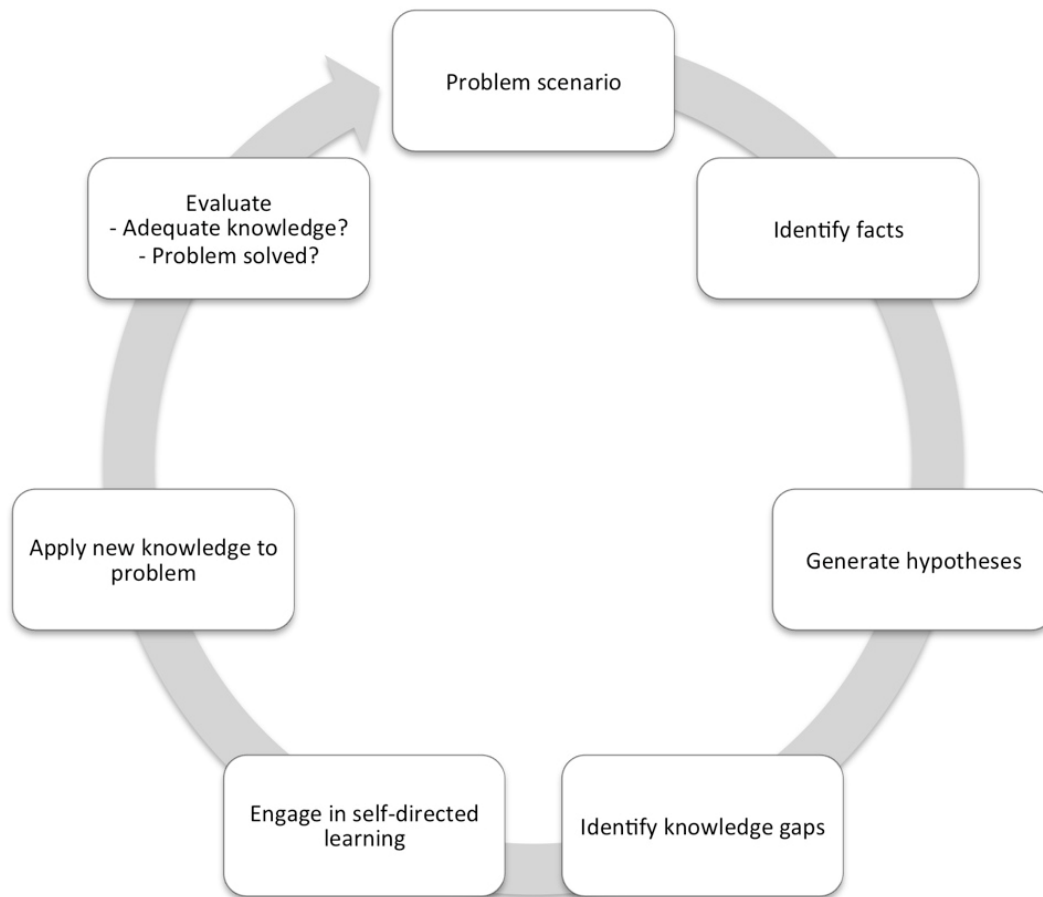
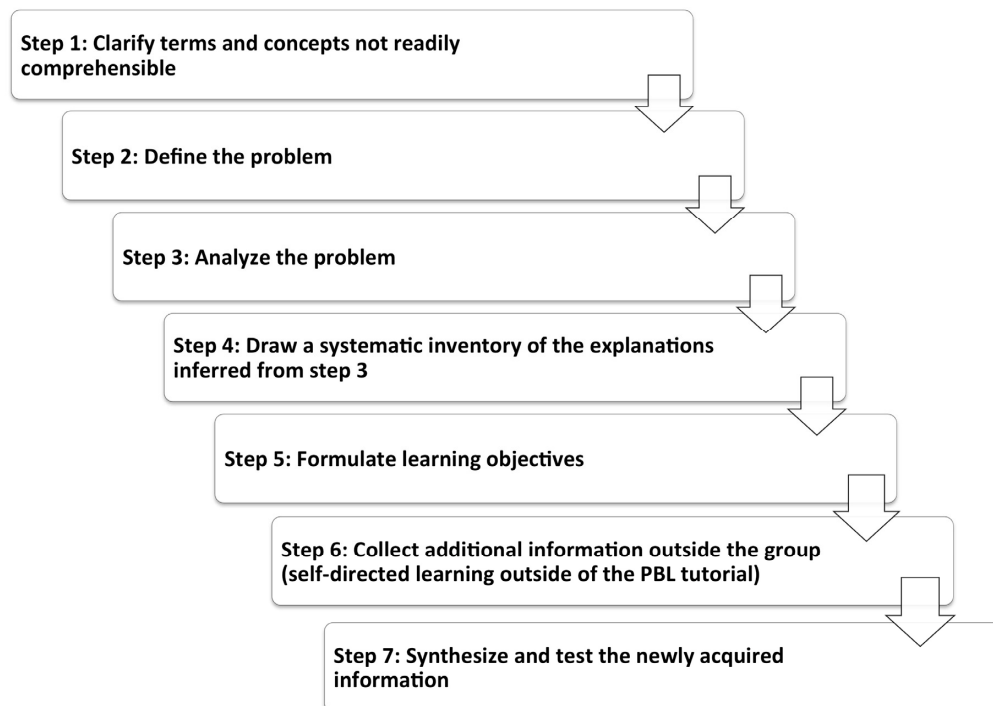*Figure 1.* The PBL cycle (adapted from Hmelo-Silver & Eberbach, 2012).

Figure 2. Steps involved in PBL (adapted from Schmidt, 1983).

Learning with Technology in PBL

The gradual infusion of digital media and technologies into PBL in health professional programs has been well noted (Bridges, Botelho, & Tsang, 2010; Bridges, Botelho, Green, & Chau, 2012; Chan, Lu, Ip, & Yip, 2012; Lu, Lajoie, & Wiseman, 2010). Certainly, the appropriate use of technology in different educational settings in higher education has been shown to promote: student-centered learning beyond traditional classrooms (Corbeil & Valdes-Corbeil, 2007); active learning and SDL among Millennial learners (Wilson & Bollinger, 2013); and problem-solving skills and academic achievement by using wireless laptops in lecture halls (Barak, Lipson, & Lerman, 2006). A recent study in dental education has found that interactive whiteboards support student learning in PBL through accessing in-house and open-access digital materials (Bridges et al., 2010). Another study in the same discipline also indicated that the application of CMap-Tools™ (for creating group concept maps) in PBL tutorials enhanced students' thinking processes and consolidated their learning (Bridges, Dyson, & Corbet, 2009). The results of a pilot study (Ng et al., 2013) regarding designing and implementing a synchronous online PBL environment for undergraduate students of a program in speech and hearing sciences has shown a student preference for synchronous online PBL via *Adobe Connect*. While the learning outcome of online PBL was not different from that of traditional tutorial room PBL, synchronous online PBL indicated positive uptake by this pilot group.

However, one aspect of the use of technology in PBL remains under-researched: the use of mobile devices in PBL tutorials. Anecdotally, mobile devices (laptop computers, smart phones, tablets, electronic book readers, etc.) have increasingly been used by students during PBL tutorials in recent years, probably due to their decreasing cost and the widespread availability of Wi-Fi connectivity anytime and anywhere on campuses. This is certainly the case for Hong Kong, with a recent study by Ang et al. (2012) indicating that students in Hong Kong were mobile enabled and interested in learning opportunities provided by mobile devices. In face-to-face PBL tutorials, the use of mobile devices may, however, pose new and particular challenges to facilitators, curriculum designers, and even students. In considering the rising use of mobile technologies within the problem cycle, while it once may have been the case that online information seeking only took place during the period of SDL outside PBL tutorials (see Figure 2, step 6), thanks to the increasingly ubiquitous nature of mobile devices and increased connectivity, students can achieve instant access to vast amounts of information within face-to-face PBL tutorials. However, there is little literature on the effects of the use of mobile devices on student learning during PBL and how they can be harnessed to provide better learning experiences for health profession students in PBL.

As a simple observation among this team of PBL practitioners and researchers, it seems that students react differently. Some embrace mobile devices and cannot part with them during PBL tutorials, while others refuse to use them. Similarly, facilitators also react differently. Some welcome the opportunity to access and critique new sources of information in new formats directly in the first tutorial; others think that the use of these devices can distract students from communicating with their peers during the PBL knowledge building process. Some facilitators even explicitly ban the use of mobile devices in PBL tutorials, as they want students to be focused on the PBL discussion rather than engage in surface approaches to learning by surfing topics and relaying information read from their devices, without understanding what they are reading. Other facilitators think that these devices may have some use in PBL due to the fact that they allow students to search for information in real time, thereby promoting more informed discussion and extending students' understanding. Given this perceived divide, the project team sought to evaluate students' use of mobile devices in PBL, and to identify and categorize students' and facilitators' concerns by interviewing them. Our goal is to identify pertinent issues in order to arrive at a tenable position for making worthwhile use of mobile devices in PBL.

The wider literature on the general use of mobile devices in teaching and learning is of use to this study in providing frameworks and guidelines for implementing and evaluating mobile learning (Nestel et al., 2010; Taxler & Kukulska-Hulme, 2005; Teall, Wang, & Callaghan, 2011). These studies are important as we move forward after 50 years of PBL in higher education, particularly in providing guidelines on successfully implementing mobile learning strategies to this new, connected generation of PBL learners. The overall aim of this study is to uncover these emerging new digital practices in problem-based learning in health professional programs, and to understand facilitators' and students' perceptions of the use of mobile devices in PBL. A key outcome of this study is to propose some useful guidelines for health profession students and facilitators on the use of mobile devices within face-to-face PBL tutorials.

Materials and Methods

Context

While the PBL process was broadly described in Figures 1 and 2 above, specific implementation differed across the three undergraduate health profession programs at The University of Hong Kong, where this study took place (see Figure 3). The

three programs were Bachelor of Medicine and Bachelor of Surgery (MBBS), Bachelor of Dental Surgery (BDS), and Bachelor of Science in Speech and Hearing Sciences (BSC(SPEECH)). The BDS and BSC(SPEECH) students received problem information (such as a problem statement and related content materials) only in the first tutorial (T1), and then continued to discuss the problem and identify areas of further research and exploration before moving into SDL. In the second tutorial (T2), they shared, evaluated, and synthesized the information they had gathered during SDL to apply to the problem posed during T1. In the MBBS program, additional problem information would be distributed during the ensuing tutorial (T2) with some problems including and presenting new information during a third tutorial (T3). In addition, reading materials relevant to the problem were distributed to BSC(SPEECH) students in T1, but BDS students were not given set readings. MBBS students were given a list of references at the end of the problem cycle. At the end of T2, BDS students were required to reflect orally on their own performances as well as on those of their classmates, whereas BSC(SPEECH) students were asked to submit a reflective journal at the end of each problem. BDS students completed a consolidation task in the form of a group assignment or 'product' after their final tutorial. In the BSC(SPEECH), apart from the reflective journal, students also submitted a structured reading form after T2, in which they summarized and critiqued the set reading materials.

Interviews

Ethical approval for this study was obtained from the Institutional Review Board of The University of Hong Kong/Hospital Authority Hong Kong West Cluster, and written informed consent was obtained from all participants. Fifty participants, including six PBL facilitators and their students, voluntarily took part in the study. Facilitators responded to individual interviews while students were interviewed in discipline-based focus groups. The interviews were semi-structured with open-ended questions in order to maintain control of the direction of the interview while giving scope for more personalized responses about the use of mobile devices in PBL (Denzin & Lincoln, 2000).
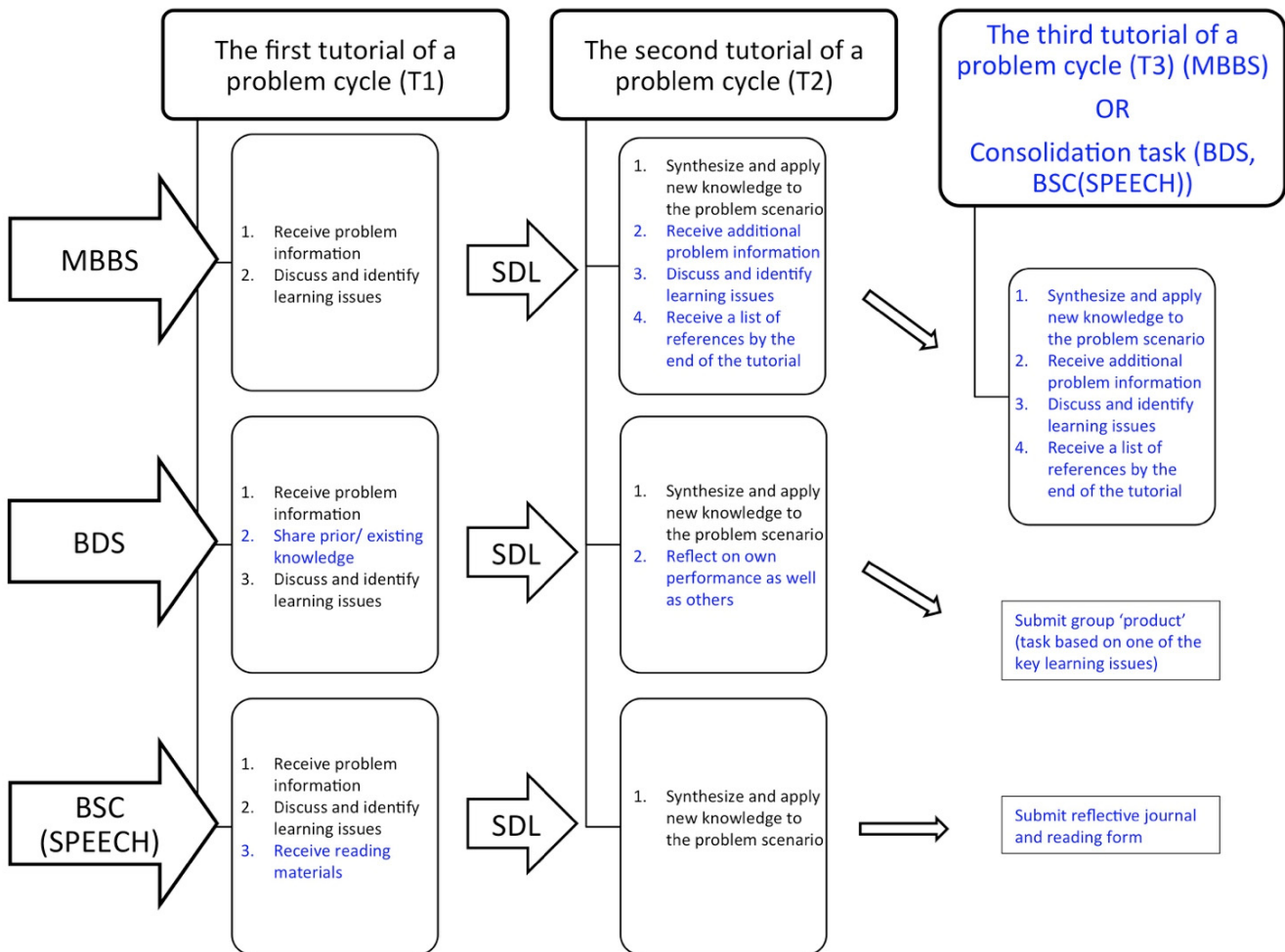

Figure 3. Variations of the PBL process among the three programs.

Facilitator Interviews

PBL facilitators (*n* = 6) from the three health profession programs at The University of Hong Kong (two from each program) were selected using convenience sampling, with no reference to their PBL facilitation style or performance. Individual semi-structured interviews were conducted, with each lasting for a maximum of 30 minutes. The interviews were audio-recorded and transcribed. Facilitators were asked to:

a. describe how PBL was delivered in their program,

b. indicate whether they had given guidelines to students regarding when and how to use their mobile devices in PBL,

c. explain their concerns about the use of mobile devices in PBL, and

d. suggest guidelines regarding the use of mobile devices in PBL.

Additional probing questions sought clarification or exemplifications of the core issues above.

Student Interviews

The students (*n* = 44) tutored by the six participating facilitators were invited to take part in this study (MBBS:10; BDS:19; BSC(SPEECH):15). Semi-structured focus group interviews were conducted. Each focus group had between three to eight students from the same program. Each interview lasted for a maximum of 30 minutes. The interviews were also audio-recorded and transcribed. Students were asked about:

a. how they used their mobile devices during PBL,

b. factors motivating them to use mobile devices in PBL,

c. factors preventing them from using mobile devices in PBL,

d. practical tips that could improve the effectiveness of the use of mobile devices in PBL, and

e. suggestions on appropriate use of mobile devices in PBL.

As with the facilitator interviews, additional probing questions sought clarification or exemplifications of the core issues above.

Data Analysis

Transcripts of all fourteen interviews were coded, drawing on the principles of grounded theory, a systematic procedure often used in qualitative studies (Creswell, 2008; Sbaraini et al., 2011). The two sets of transcripts were initially coded separately with codes grouped under the core questions (NOTE: facilitators' responses to (a) regarding the program description are reported in "context" above). Within each of the themes, coding from the responses to the questions and the ensuing probes was inductively developed by one researcher (HL) and agreed upon in discussion with the research team. For example, from a facilitator question on student usage of devices in tutorials, arising themes included deep approaches to learning and self-regulation (see below). Finally, in considering the implications for practice, the two sets of data (facilitator and student) were drawn together to provide a coherent set of suggestions and potential guidelines for the application of mobile technologies in PBL tutorials.

Results and Discussion

The results of facilitator interviews and student interviews will be reported in two separate sections. The guidelines recommended by both facilitators and students will be reported in another section.

Facilitators' Perspectives

Seven themes emerged regarding the existing guidelines on the usage of mobile devices in PBL and facilitators' concerns about the use (parts b and c of the facilitator interview guide).

Existing Guidelines on the Usage of Mobile Devices in PBL

Facilitators were asked whether they had given guidelines to students regarding when and how to use their mobile devices in PBL. They had the impression that students used their mobile devices mainly for searching for PBL-related information, as well as definitions of novel terms from the Internet, and that the online searching had never disrupted the discussion. Therefore, five of the six facilitators did not provide explicit guidelines regarding the use of mobile devices in PBL to their students.

Theme: Conceptual Clarifications

One of these five facilitators encouraged her students to utilize mobile apps to help explain concepts and ideas without giving specific guidelines on how to use them.

> *Actually I would encourage, [use] if the mobile devices are used for learning purposes. Sometimes, I recommend my students to use apps with animation and pictures which are good for explaining health problems to their patients in their future career . . . I usually suggest them to download some free animation apps as they are useful and also free of charge.* (BSC(SPEECH) Facilitator 1)

One facilitator perceived there was a need to support his students with regard to when and how to use their mobile devices in PBL, and was thus the only facilitator who had set up guidelines for his students regarding the use of such devices. Before starting a discussion, he allowed students to use their mobile devices to search for the definitions of some unknown terms that appeared in the problem statement. In addition, he also alerted students when to avoid using mobile devices in T1, such as when students needed to brainstorm ideas after they had received the problem statement or after they had already searched for the definitions of novel terms.

Facilitators' Concerns About the Use of Mobile Devices in PBL

Facilitators were also asked to explain their concerns about the use of mobile devices in PBL. Their concerns are subdivided into six themes.

Theme: Self-regulation

In general, facilitators in this study believed that their students were self-disciplined and did not use their mobile devices for non-learning activities during PBL.

> *It is obvious that students cannot play mobile games and participate in the discussion at the same time . . .* (BSC(SPEECH) Facilitator 2)

Facilitators in this study would not stop students from using their mobile devices during PBL as long as the group discussion was not interrupted by their use. A facilitator in MBBS found the use of mobile devices in PBL to be unproblematic.

> *My students would take pictures of the complicated diagrams on the whiteboard…I don't mind if they use their mobile devices . . . the use of mobile devices never disrupts the discussion.* (MBBS Facilitator 1)

Theme: Enriching the discussion

In addition, the two BDS facilitators were positive regarding the appropriate use of mobile devices, proposing that the discussion would be enriched by bringing along more problem-related information gathered from the Internet.

> *The use of mobile devices is actually good for the discussion by bringing along more information . . . there is more information available on the Internet than in a single textbook.* (BDS Facilitator 1)

> *Say if you know nothing about the topic, you don't know where to start the discussion . . . however, if you have all the information [you need], you don't need to think… Appropriate use [of mobile devices] would be good . . . but it is no good to rely too much on it.* (BDS Facilitator 2)

Theme: Distraction from important tasks

The interview results showed that, though students were self-disciplined with their mobile device usage and were able to focus on the discussion, facilitators were still concerned that students would be distracted by the use of mobile devices. The distraction was seen as potentially negatively affecting students' individual performance as well as peer interactions.

> *In T1, facilitators do not want students to use their mobile devices individually. Otherwise, students will be distracted from the discussion.* (BDS Facilitator 1)

> *Maybe they would play with their phones or talk on the phone. There are not many cons of using mobile devices in PBL, except it could be a kind of distraction, like they may want to pick up the phone when somebody calls or read the text messages that they receive. They also use their phones frequently just for checking the time.* (BSC(SPEECH) Facilitator 1)

Theme: Reduction of face-to-face interaction

While the adaption of social network sites such as Facebook was seen as enhancing collaborative knowledge building among MBBS students, one facilitator was also concerned as to the possible reduction of face-to-face interaction.

> *They [students] have a Facebook group, sometimes they use Facebook to review documents they have uploaded. That's why I am worried . . . the only concern is the reduction in interaction [among students] . . .* (MBBS Facilitator 2)

Theme: Critiquing retrieved information

Additionally, with regard to the quality of information yielded from online searching, facilitators worried that some students might fail to critically review information.

> *They [students] usually search on Wikipedia for additional information. That's why the information found may not be 100% accurate . . .* (BDS Facilitator 2)

However, the MBBS facilitators considered that there is no harm in students using such information since it opened a space for critique. They noted that some students were able to self-correct their mistakes once they realized the information was wrong, or else facilitators can challenge the credibility of the data or website as part of the facilitation process.

> *I personally think that this [getting wrong information from Wikipedia] is not a big deal…as facilitators may correct students' mistakes . . . I would challenge [them] with questions . . .* (MBBS Facilitator 1)

Students are smart . . . they are able to self-correct their mistakes . . . or facilitators may also point out their mistakes . . . (MBBS Facilitator 2)

One facilitator in BDS raised the concern that screening out unreliable information found on the Internet was very time-consuming. Moreover, students might read out directly from the online resources and may not use their critical thinking skills to process what they are reading.

I think there is an enormous amount of information on the Internet, but it is very time consuming to screen all the information . . . They may say something correct but not involve critical thinking because they do not process the information, do not think about the logic between concepts . . . (BDS Facilitator 2)

Theme: Deep approaches to learning

A facilitator in the MBBS program also noted a possible link between deep and surface approaches to learning with regard to the application of mobile devices. He noted that some students who chose not to use mobile devices had prepared adequately in their SDL and were able to productively take part in the discussion, whereas other students may still be searching rather than analyzing and evaluating.

I believe the reason for some students not to use mobile devices in PBL is they have done good preparation . . . the materials they found during research [self-directed study] have been absorbed…they understand what other group members are talking about and are able to complement right away . . . like the student who uses his own words to elaborate his ideas . . . I believe his preparation work is way better than the others' . . . (MBBS Facilitator 1)

Students' Perspectives

Six themes emerged regarding how students used their mobile devices during PBL, factors motivating them to use mobile devices in PBL, and factors preventing them from using mobile devices in PBL (parts a, b, and c of the student interview guide).

The Uses of Mobile Devices in PBL

All students who participated in this study reported that they brought their mobile devices (mostly laptops/notebooks, smart phones, and tablets) to PBL tutorials. However, not all of them used their mobile devices during PBL. For those who did, Table 1 shows how their reported usages can be matched to the steps in traditional PBL processes (Schmidt, 1983). In step 1, when the students first received the problem scenario or case, they might use their mobile devices to initially search for the definitions of key terms and concepts. In steps 2 and 3, accessing problem-related inquiry materials, such as videos, pictures, and clinical data, helped students to better understand the dimensions of the problem, and thereby supported analysis. In steps 4 and 5, students reported using their mobile devices to make their own notes on the discussion or to collectively construct the group's notes on shared, cloud-computing documents such as "*Google Docs*" or via the scribe's laptop linked to large display screens such as plasma screens (MBBS) or interactive whiteboards (BDS, BSC(SPEECH)). In step 6, during the period of SDL, students used their mobile devices at home to retrieve supporting problem materials posted by their faculty on the University's Learning Management System (LMS) or to search for additional open-access learning materials. In the last step of the PBL problem cycle, when students shared and worked to synthesize what they had learned during SDL, they reviewed on-screen the materials they had prepared for the discussion. Some students used educational mobile apps, videos, and PowerPoint during tutorials to help others to understand difficult concepts.

Factors Motivating Students to Use their Mobile Devices in PBL

Factors that motivate students to use mobile devices in PBL are grouped under three themes, namely: collaborative knowledge building, social responsibility, and cognitive prompts.

Theme: Collaborative knowledge building

Students in all three programs perceived mobile devices as useful for gaining instant access to various sources of information and for note taking. Students perceived that the instant access to a vast amount of information helped them to better follow the progress of group discussion (e.g., if a new and unfamiliar term was used in the group discussion, a student could instantly search for its meaning, which then allowed the student to follow the discussion). It also helped the group discussion to gain in breadth and depth, so that eventually the group could set learning objectives appropriately.

Sometimes when we don't really understand the definition of a term, we would search on the Web . . . because it is very important for us to understand the definition before we can start the discussion . . . if we don't even know the term, we may then move towards the wrong direction . . . (BSC(SPEECH) Year 3 student)

Theme: Social responsibility

In addition, students thought that it was environmentally friendly and convenient to review problem-related materials on-screen because printing out many pages of notes would be a waste.

Table 1. The uses of mobile devices in the PBL process

The problem process (Schmidt, 1983)	Mobile technology applications
Step 1: Clarify terms and concepts not readily comprehensible	- Search for the definitions of key terms and concepts from the Internet
Step 2 and 3: Define and analyze the problem	- Access problem/ case materials on the in-house LMS
	- Search for problem-related materials,(e.g. videos, pictures, and clinical data from the Internet)
Step 4 and 5: Draw a systematic inventory of the explanations inferred from step 3 and formulate learning objectives	- Make notes on the discussion by using laptops and smart phones
	- Use visualization tools/software for brainstorming and retrieving prior knowledge
Step 6: Collect additional information outside the group (SDL)	- Retrieve supporting problem materials (e.g., case history, photos, videos) from the in-house LMS
	- Search for additional open-access learning materials relevant to the problem
Step 7: Synthesize and test the newly acquired information	- Share and review on-screen materials (e.g., notes, photos, 3-D animations, videos, etc.)
	- Use educational mobile apps and software, and PowerPoint to help understand difficult and abstract concepts

Advantages include . . . environmentally friendly. It reduces the consumption of ink and papers . . . (MBBS Year 2 student)

There are many learning issues for each PBL tutorial. Therefore, it will waste ink and papers if we print all the notes out. And I also need plenty of space to store them up. (BDS Year 1 student)

Theme: Cognitive prompts

During the SDL period between PBL tutorials, students might have gathered a large amount of information that they would share with their group members in PBL tutorials. Students found it very difficult to absorb all the information in just a few days. Some BDS and MBBS students preferred to use mobile devices as a prompter for sharing their SDL results in T2 and T3 (see Table 1, step 7). They made notes based on resources such as books, journal papers, and videos they had accessed out of class. It was not uncommon for students to show pictures and videos to the group when they were trying to explain complex concepts and clinical techniques.

In T2, I use my laptop because I can hardly memorize all the information [found during SDL]. So it is convenient to store the information up on my laptop. (BDS Year 1 student)

In T2, I bring my tablet for reviewing my notes. (BDS Year 1 student)

Sometimes, I gather information from different books. I don't think it is good to bring all of the books to PBL. So bringing along my laptop to PBL is more convenient. (BDS Year 1 student)

For example, some photos of the brain can show where the lesion may happen and also can show some brain features. (BSC(SPEECH) Year 3 student)

Factors Preventing Students from Using Mobile Devices in PBL

Three themes emerged regarding factors that prevented students from using mobile devices in PBL. They included impaired interactivity, surface approaches to learning, and time and timing.

Theme: Impaired interactivity

Though students on the whole saw many benefits in using mobile devices, some students in this study did raise a few issues about their use. A MBBS year 1 student, for example, thought that students might make less eye contact when they were busy searching or reading on their mobile devices, thus

reducing the interaction with their peers. Students might also compete in "Googling" instead of trying to fully understand the information found.

It's like when you can find something from the Web immediately . . . so amazing . . . but you are just stating the facts without deep understanding . . . (MBBS Year 2 student)

Theme: Surface approaches to learning

Some students in this study perceived that online information was useful, yet the immediate access to such information could lead to surface approaches to learning. Fast and instant access could prevent them from brainstorming ideas and using their prior knowledge and critical reasoning to understand the problem.

Sometimes students share online information to the group without deep understanding . . . they do not digest what they have found before sharing . . . they may be challenged by other group members. (MBBS Year 2 student)

Maybe it is too convenient. If there is something that we are not so sure about, we would skip the thinking process and go directly to Wikipedia to get the information. With mobile devices, we obtain knowledge without much thinking and deep learning. (BSC(SPEECH) Year 3 student)

Theme: Time and timing

Others reported that it was almost impossible for students to digest a large amount of online information while paying attention to the discussion at the same time. Furthermore, it took a lot of time and effort for students to critically assess the information generated from online searches and then select the relevant information that might contribute to the discussion. Therefore, even though facilitators did not ban the use of mobile devices in PBL, some students chose not to use their mobile devices and preferred to think critically on their own and focus on the problem-solving process.

Because time is very limited . . . you have to process what others say, you also need to express your opinion . . . (BSC(SPEECH) Year 2 student)

In addition, some online information is not valid. You have to process it and see if it is reliable. (BSC(SPEECH) Year 2 student)

Guidelines Recommended by Facilitators and Students

Both facilitators and students were asked to suggest some guidelines regarding the appropriate use of mobile devices in PBL. Some of the senior students thought that they had already developed the skills and knowledge to use mobile devices appropriately in PBL, and that they did not need facilitators to give any guidelines regarding their use of mobile devices in PBL. Therefore, these students were asked to give some practical tips for junior students to improve the effectiveness of the use of mobile devices in PBL.

Students and facilitators in this study made constructive suggestions with a view toward improving the effectiveness of the use of mobile devices both in face-to-face PBL tutorials and during SDL (Figure 4). The facilitators' major concern about mobile usage in PBL was that students may need to screen a large amount of information obtained by searching on mobile devices and could thus be distracted from engaging in problem solving, interacting with their peers, and the co-construction of knowledge. Excessive use of mobile devices in face-to-face PBL tutorials may shift the focus of PBL to information transmission, much like what happens in a traditional didactic lecture, only that this time the mobile devices, instead of the lecturer, are providing the information. In order for students to adopt a deep approach in their learning, focusing on long-term understanding of materials, the facilitators participating in this study recommended a few practical tips (Figure 4). The main aim of these recommendations is to make use of the instant access to a vast amount of information through these mobile devices, without jeopardizing the deep approach to learning. When the facilitators aim to change students' conceptions, instead of to merely transmit information, the students are more likely to achieve higher quality learning outcomes (Trigwell et al., 1999). One of the six facilitators participating in this study has explicitly adopted such an approach in facilitating his PBL tutorials.

It seems that at least some of the students in this study have a similar understanding of how best to use their mobile devices in promoting learning in face-to-face PBL tutorials. Not only were they self-disciplined in not using their mobile devices for non-learning activities, they also did not rely overly on the use of mobile devices. They considered that overreliance on mobile devices for accessing online information during the PBL discussion could not only distract students, but also prevent them from thinking critically and engaging in the collaborative learning process. Students also agreed to common ground rules for the effective use of mobile devices in PBL. These included muting devices before joining the PBL sessions and not using mobile devices for communication, such as Facebook or other social media.

Some BDS students suggested that the scribe/secretary/clerk (i.e., the designated student who takes notes of the discussion) should focus on note taking only and let other group members view the problem materials on their mobile devices. Some MBBS students also suggested using

collaborative technologies such as *Google Docs* via their mobile devices as a way to share their ideas with the group. Each group member could directly insert what they found on their personal mobile devices into the shared *Google Docs* file for immediate sharing and editing among all the group members, both during tutorials and in SDL.

> *The clerk needs to record the group discussion. Meanwhile, we have some radiographs and clinical photos to see. The clerk cannot do these tasks [using the interactive whiteboard] at the same time. If we have [our own] iPads, we can view radiographs with iPads, and the clerk can focus on note taking.* (BDS Year 4 student)

> *I think it is time consuming for the scribe to check the spelling of some terms. If you can put your notes to Google Docs where all other students can access, and then we can give some ideas about each learning issue in PBL tutorials, rather than giving a lot of factual information and making the scribe very busy in the tutorials. It is kind of boring.* (MBBS Year 1 student)

> *The scribe just records our opinion instead of facts and terms. Not only it can facilitate the flow of discussion, but also reduce the workload of the scribe.* (MBBS Year 1 student)

Limitations of the Study

Although ranging across three health profession programs, this study recognizes its small sample size to be a limitation as well as the scope being confined to a single university in Asia. A larger sample size with more diversity in students' years of exposure to PBL and the actual usage of mobile devices would enable us to gain better understanding of the functions of mobile devices in the PBL teaching and learning process. Although the findings from the three programs showed that there is a common pattern among students in their usage of mobile devices, generalization of the conclusions to other health profession programs requires caution. Future research on students' use of mobile devices in PBL may take the form of a large-scale questionnaire survey to include more students who are representative of the undergraduate health profession programs.
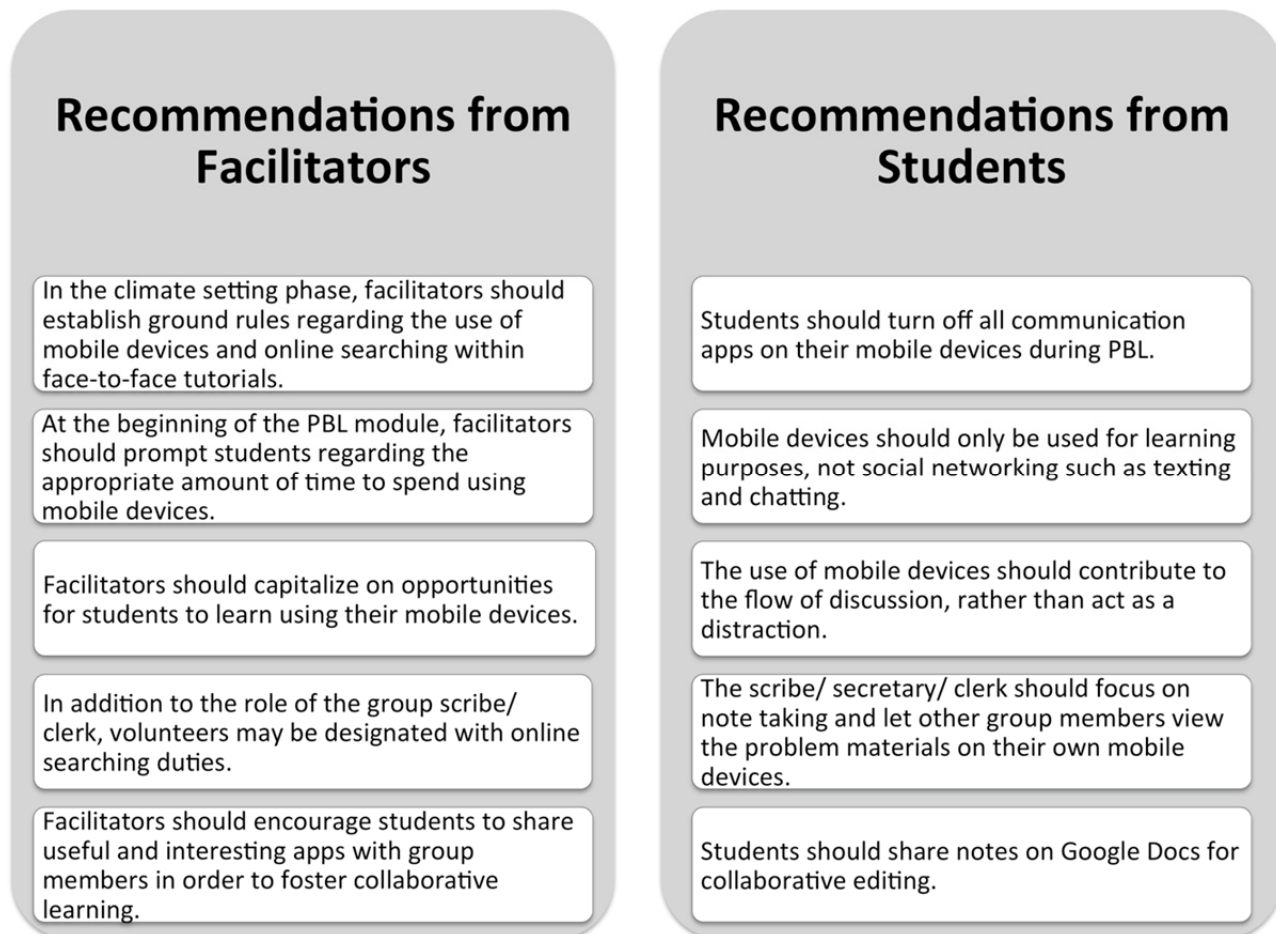
Recommendations from Facilitators

- In the climate setting phase, facilitators should establish ground rules regarding the use of mobile devices and online searching within face-to-face tutorials.
- At the beginning of the PBL module, facilitators should prompt students regarding the appropriate amount of time to spend using mobile devices.
- Facilitators should capitalize on opportunities for students to learn using their mobile devices.
- In addition to the role of the group scribe/ clerk, volunteers may be designated with online searching duties.
- Facilitators should encourage students to share useful and interesting apps with group members in order to foster collaborative learning.

Recommendations from Students

- Students should turn off all communication apps on their mobile devices during PBL.
- Mobile devices should only be used for learning purposes, not social networking such as texting and chatting.
- The use of mobile devices should contribute to the flow of discussion, rather than act as a distraction.
- The scribe/ secretary/ clerk should focus on note taking and let other group members view the problem materials on their own mobile devices.
- Students should share notes on Google Docs for collaborative editing.

Figure 4. Recommendations from facilitators and students regarding the use of mobile devices in PBL.

Conclusions

This study aimed to identify facilitators' and students' perceptions on the use of mobile devices in PBL in health profession programs, and to propose some useful guidelines for their appropriate use in face-to-face PBL tutorials. The results indicated that the differences in PBL approaches among three programs seemed to have little impact on the mobile usage among students in different programs. Students in all three programs perceived mobile devices to be useful and convenient for getting instant access to various sources of information, note taking, and visually presenting their findings. Although students and facilitators agreed that mobile devices are a powerful tool that can support various aspects of the problem process and thus facilitate collaborative knowledge building, students in all three programs articulated that focusing on the PBL group's discussion was their first priority. Instead of searching for and reading PBL-related information on their mobile devices, students were focused on spending more time brainstorming ideas and discussing the problem with other group members. Students in all three programs seemed to have developed this as a tacit consensus on the use of mobile devices, even though there were no formal guidelines given by the facilitators. Results from this study also revealed that facilitators were aware that inappropriate use of mobile devices would distract students from peer discussions.

In general, it can be concluded that both facilitators and students found mobile devices to be useful learning tools in PBL, yet they were aware of the potential distractions for students and negative effects on students' learning in face-to-face, collaborative contexts. Therefore, it would be useful to include ground rules on mobile device usage and online searching as part of the initial climate setting when forming a new PBL group. At the beginning of the PBL module, facilitators should discuss and negotiate with students the appropriate use of mobile devices. As part of the facilitation process, they can then guide students to use mobile devices to search for definitions of unknown terms and to return to the discussion quickly. Students should be encouraged to self-regulate their online and on-screen behaviors in finding the optimum balance in sustaining a productive group dynamic. Facilitators may also encourage students to explore and download different educational apps and decide which ones work best for them (Robeledo, 2012).

There is minimal literature on the effects of the use of mobile devices on student learning during PBL tutorials and how they can be harnessed to provide better learning experiences for students. Through this qualitative investigation of students' and facilitators' perceptions on the use of mobile devices across three undergraduate health profession programs, we have gained a better understanding of current practices and perceptions regarding the use of mobile technologies in teaching and learning in PBL.

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