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Students' Perceptions on the Suitability of Implementing an Online Problem-Based Learning in a Physics Course

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Abstract

This paper reports on the suitability of implementing an instructional design method known as problem-based learning (PBL) online in a physics course based on students' perceptions. There were 50 students involved in this study which consists of 30 students from the School of Science and Technology (science student) and 20 students from the School of Education and Social Development (pre-service science teachers), University Malaysia Sabah. Ten collaborative groups were formed (4-5 students in each group). The students then followed all the PBL learning activities. Online learning environment (i.e., Learning Management System, LMS) was used as the main medium to carry the full learning process throughout the second semester of 2008/2009 academic year. Data were gathered from an open-ended questionnaire and a semi-structured focus group interviews after completed with the learning activities by the end of the semester. Generally, students said that: it is easy to understand modern physics theory; learning becomes more interesting, enjoyable and fun and also; they need more different method of learning which can make them understand better. Science students stressed that PBL online exposed them to the preparation for responsibility in the workforce, while majority of the pre-service teachers concurred that the instructional designed trained them to be more students-centered.

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Introduction

Problem-based learning (PBL) is a pedagogical approach to science education that focuses on helping students develop self-directed learning skills (Barrows & Tamblyn, 1980; Boud & Felleti, 1991). It was originally developed in a medical school in 1969 at McMaster University (Rideout & Carpio, 2001), but has since spread to other subjects. There is now substantial literature on how PBL and online learning might be merged (see e.g., Candela et al, 2009; Cheaney & Ingebritsen, 2005; Jennings, 2006; Lee, 2006; Lim, 2005; Savin-Baden & Gibbon, 2006; Savin-Baden & Wilkie, 2006), a combination that is sometimes called PBL online. The argument in favour of this combination is that PBL online is capable of promoting both the development of problem-solving, and student ability to use information technology; emphasising the advantages of PBL as a promoter of process, as opposed to content, objectives (Watson, 2002). At first, technology was only used by teachers for administrative purposes, or for information dissemination (Lim, 2005), but as teachers became more familiar with such technologies, they sought to explore the potential of ICT in delivering collaborative inquiry through online forums (Lim, 2005). Some authors report integrating constructivist-based education of practical work such as PBL with online learning (Lim, 2005).

Integrating PBL with online learning basically means merging the pedagogy (which in this case is PBL) and delivering the content partly, or entirely, online via the Web. A key feature of PBL online is the online collaboration that occurs as part of the learning activities (Savin-Baden & Wilkie, 2006), and this focuses on team-oriented knowledge-building discourse, and reduced teacher-centred learning (Savin-Baden, 2006). Savin-Baden also noted that PBL online involves students working collaboratively in real time, or asynchronously, and collaboration tools such as shared whiteboards, video conferencing, group browsing, e-mail, and forum rooms are vital for the effective use of PBL online. Students can learn through the use of Web-based materials such as text, simulations, videos, demonstrations and related resources (Savin-Baden & Gibbon, 2006). In some cases, no print materials are provided, and students only can access materials directly from the course website (see e.g., Yong, Jen, & Liang, 2003). In other cases (e.g., Savin-Baden & Gibbon, 2006) there is a focus around a particular site, through which students are guided by the use of strategy problems, online material and specific links to core material, rather than wholly online delivery of PBL. In both cases, use of web sites is mostly student led, and the materials provided support the learning they undertake in face-to-face PBL groups. An example of such a site is that for the SONIC

(student online of nursing integrated curricula) project (Savin-Baden & Gibbon, 2006), which implemented PBL in an interactive environment using Flash Player-based physiology resources in order to improve students expertise in nursing. Savin-Baden and Gibbon in an investigation of the interrelationship of PBL and interactive media, report that the assessment of combined PBL and interactive media to date have not extrapolated the difficulties of combining these two approaches.

Issues and Reported Advantages of PBL Online

Savin-Baden and Wilkie (2006) describe how PBL can be implemented successfully in an online learning environment, noting that it must be integrated with the right pedagogy, and must be handled by an experienced practitioner, especially when it comes to tutoring or facilitating learning (see also Barrows, 2002). Hong (2002) reported that PBL implemented in a Web-course in Malaysia at the university level led to enhanced student attitude and academic performance, mostly as a result of implementing a conversation discussion room online, so that students could engage in online discussion asynchronously. Lim (2005) likewise supported the benefits of asynchronous online forums to support discussion within learner groups to improve the current use of online forums in the PBL approach, and Sulaiman (2004) integrated PBL with online learning, using simulation, pictures, chat rooms and other learning aids. In a variation of PBL online, Lim (2005) incorporated an online forum and PBL in Law so learners could discuss facts and interview their clients electronically. Gosmann et al (2007) summed up much research about PBL online, saying PBL can be integrated into a Web-course delivery and that such PBL online is at least as effective as a traditional PBL curriculum version, and that students enjoy learning via such a PBL approach.

It was reported that PBL online has many of the trademarks of traditional PBL models developed in 1960s by McMaster University, Canada, and delivered through face-to-face pedagogy. PBL online, like traditional PBL, is more than a linear approach to problem solving, where problem scenarios are used as key learning or key issues in online learning environments. However, Savin-Baden and Wilkie (2006) say that many practitioners, educators and researchers held concerns about whether PBL online might adversely affect the existence of face-to-face PBL, because PBL online may be seen as being more cost effective. One concern here is practitioner anxiety that PBL online may conflict with intentions of PBL generally, since some forms of PBL online tend to put more emphasis on solving closely defined or outlined problems, meaning PBL online may be less successful in encouraging students to become independent inquirers who own their learning. A second concern was that learning in groups online may inhibit students' capacity to work through team difficulties and conflicts in the way face-to-face PBL occurs (Savin-Baden & Wilkie, 2006). Nevertheless, PBL online is an approach that stresses complementing, constructing and improving what is already in existence, rather than trying to replace face-to-face learning pedagogy activities (Gossman et al, 2007; Savin-Baden & Wilkie, 2006), and it is reported that PBL online promotes good cognitive engagement among students (Gossman et al, 2007).

PBL online also aims to enhance students' ability to form structured approaches to deal with PBL exercises. When undertaking a PBL exercise, students are required to analyse and assess the given situation, make choices as to how they might tackle it, and provide recommendations for future action. They can, for example, make observations, seek further information from various sources and undertake common diagnostic tests. The use of PBL online to deliver PBL can, therefore, integrate the theory and the practice of the topic being studied. A PBL online approach allows students to be presented with a previously unseen problem (Gossman et al, 2007), and the literature suggests that it also can support student learning by reducing cognitive load because of the supportive learning environment (Gossman et al, 2007). What is important is that students have access to the objectives of the module, and the ability to negotiate their own learning needs in the context of the given outcomes (Savin-Baden & Wilkie, 2006). Facilitation of learning in PBL online requires teachers or tutors to have access to the ongoing discussions without necessarily participating fully, giving the groups minimal guidance, and ensuring the group discussion is maintained (Boud & Felleti, 1991; Camp, 1996; Savery & Duffy, 1995). It is important to realise, however, that different forms of environments utilized, whether created specifically for PBL, or adapted to be used with it, all seem to have a strong management genre in terms of the forms of authorship used. In other words, the design and management of the digital space is always strongly influenced by the teacher/tutor and their pedagogical inclinations or philosophies (Savery & Wilkie, 2003). The design of such digital spaces could be seen as being authored; both in the sense of authorial design behind the Web and the authors of the written text who make up components of the web site(s). While the authoring of text (whether traditional or virtual) and the authoring of design can be seen as very

different functions, it seems that both have the capacity to "impede the free circulation, the free manipulation, the free composition, decomposition, and free composition of fiction" (Foucault, 1988, p. 209). This would seem to introduce questions about the extent to which, for example, constructivist-based approaches to learning can be authored and managed in PBL online. Hence, as Ravenscroft (2004, p. 139) argues, "We need to investigate, examine and where possible, design appropriate learning communities if we want to support effective e-learning discourse."

The literature thus suggests that group learning is the norm in PBL whether face-to-face or online, and group characteristics must be taken into account when establishing an effective collaborative learning group. To compose a small effective group, whether cooperative, collaborative, or mixed, a number of factors must be taken into account: students' academic ability, gender and ethnicity (Aronson, 1978; DeVaries & Slavin, 1978; Slavin, 1978a; Slavin, 1978b; Springer, Stanne, & Donovan, 1999). Slavin (1980) says we must also include mutual concern among students. Some authors suggest we should maximize heterogeneity of ability levels (Aronson, 1978; DeVaries & Slavin, 1978; Slavin, 1978a; Slavin, 1978b). There are some outcomes that have also been measured or seen in cooperative learning; such as liking school, self-esteem, time on-task, ability to take the perspective of another person, and various measures of cooperativeness and competitiveness (Slavin, 1980). From a Malaysian perspective, work by Neo and Neo (2009) suggests that to compose a positive, effectively collaborative group, students should be randomly assigned, come from different backgrounds or faculties, and work with someone they do not know.

Though the literature showed that the use of PBL online in several context and other disciplines is engaging, and enabling students to develop a number of cognitive skills (e.g., Albanese & Mitchell, 1993) until now, little research has been done about to seek the students' perception on how the suitability on implementing this particular instructional method specifically in science education course like physics. With respect to development of education in higher education especially the science students and pre-service science teachers and the enhancement of the students engagement it is important to know how good PBL online classroom practices can be enhanced and what are the views of students about how effective PBL online discussion and working together. Hence the purpose of this paper was to explore the students' perceptions about the suitability and appropriateness on implementing the problem-based learning instruction through online in a physics course to better know what the real deal between PBL online and students is.

Method

The intervention done in this study was administered in Semester II during the 2008/2009 academic year at the School of Science and Technology (SST) and at the School of Education and Social Development (SESD) University Malaysia Sabah (UMS), Malaysia. The sample consisted of students from the Bachelor of Physics and Electronic Programme (science physics students) and also from the Bachelor of Education with Science Programme (pre-service science teachers) student who were taking Modern Physics course during the semester. There were 50 students who took part in the study. The students were separated into two main groups, one group formed the PBL group for SST (N= 30) and the rest formed the PBL group for SESD (N=20). The students learned in collaborative groups of 4-6 students, and there were total of 10 groups involved (6 group from SST and 4 groups from SESD).
Table **1** shows the group sample for the study.

Table 1 Group sample for the study

Group	Science Physics Students (SST)	Pre-Service Science Teachers (SESD)
N	30 students (6 groups)	20 Students (4 groups)

The intervention was conducted over 16 weeks. During the intervention the entire learning activities delivered by using Learning Management System (LMS) provided from the Educational Technology and Multimedia Unit (ETMU) from the Universiti Malaysia Sabah. The researcher prepared and organised the LMS followed the PBL learning activities (including the problem's design) approach to fulfilled the learning and teaching activities via online learning. Thereupon students can access the LMS anywhere and at anytime they prefer suite to their own period and space. The university's library also provides student

with five hundreds computers that have the Internet connection at a computer lab known as The Mega Lab. Thus, those who did not have their own computer can use the computer at the lab.

There were five problems need to be solved by each group. Students were engaged in variety of synchronous and asynchronous PBL learning activities, such as chat rooms; forum; sending and receiving e-mail from group members and facilitator; uploading their own materials to be used by other friends; downloading materials from the Internet; sending assignments and also get feed-back from facilitator. Since there were no fix times during the learning process, they can choose their own flexible time to carry out all the activities by online. A facilitator guided the PBL groups cognitively in collaborative atmosphere all the way throughout the semester, in a very minimum direction.

Data were collected through an open-ended questionnaire they completed, and a semi-structured focus group interview after the intervention finished. The survey consisted of questions about the PBL online approach used during the intervention. In addition a focus group interview was conducted a week after the intervention completed. One of the main objectives of this survey and interview was to seek students' opinions about the suitability of implementing problem-based learning online (PBL online) in a physics course.

Findings and Discussion

The data finding suggests that students reacted positively on implementing PBL online in a physics course. Feedback for the physics science students and pre-service science teachers is first presented combined and any differences between the cohorts then discussed.

Table 2 shows the themes that been categorised upon the open ended questionnaire and focus group interview of students' perception on the suitability of implementing problem-based learning online in a physics course. The themes been formed by a question which was: *Do you think the PBL approach is a suitable way for you to learn modern physics? Explain why, or why not?*

Table 2 Themes of Students' Perception on the Suitability of Implementing Problem-Based Learning Online in a Physics Course

Generally
i. Easy to understand modern physics theory;
ii. Learning becomes more interesting, enjoyable and fun;
iii. Need method of learning which can make them understand better
SST
i. Can expose them to the preparation for responsibility in the workforce
SESD
i. Student-centred approach
Other Perspective (Neutral)
i. Not enough time to study using PBL approach;
ii. Depends on individual
Other Perspective (Negative)
i. Need plenty of time and energy to be cope with learning;
ii. Tutorial taught us how to answer exam questions

Obviously the students could simply answer yes or no this question. But what is of more interest is how they presented their answers and their justifications. In their responses to the open-ended questionnaire, their reactions were first split into those who answered the above question in the affirmative, and in the negative. For those who answered in the affirmative, the reasons they felt attracted to this learning approach were categorized into three themes: *i. Easy to understand modern physics theory*; ii. *Learning becomes more interesting, enjoyable and fun*; and iii. *Need method of learning which can make them understand better*.

i. Easy to understand modern physic theory

The nature of the PBL features that give problems at the beginning of the learning activity and the problem itself is can be encounter in their daily-life situation was able to give opportunity for students to understand learning content easily, making it easier for them to connect it to the learning content, as observed by a participant:

> *I think, the PBL approach is a suitable way for you to learn modern physics. It because the PBL approach made easily to student to understand the concept of physics with giving the problem that occurs surrounding. (R1, SESD, Female, questionnaire)*

ii. Learning become more interesting, enjoyable and fun

A participant remarked that the free style of learning that was not forcing them to get the right answer has opened their opportunity to learn in an enjoyable and interesting atmosphere:

> *Yes. Student will find out that modern physics is an interesting subject to learn. Attract student to learn more about them. (R18, SST, Female, questionnaire)*

Some participants linked their enjoyment of learning via PBL online to contrast it with previous, more traditional learning experiences. In particular, they talked of being able to participate actively in their learning, compared with the traditional learning where they were treated passively:

> *Yes, this is because if I just study in classroom I really do not understand what the lecturer is teaching and feel very boring even sometime really do not listen what he or she is talking about. While if using PBL I can find more information and I can get what I want or what I do not understand straight away from the Internet. It is more interesting to use PBL to learn if compares to just sit in the class. It brings more fun to me and I do not feel boring to it. Besides, I can discuss with friends straight away but in class can not talk. (R2, SESD, Female, questionnaire)*

iii. Need method of learning which can make them understand better

A participant brought up a key point here the need to change the presents learning process and activities (e.g., rote learning, lecture-based learning and well-structured syllabus) to a new, challenging one. Students require an instructional method and learning process that helps them to absorb and to understand the physics contents meaningfully:

> *Yes indeed because modern physics is not just about reading and to memorize all things and also just doing homework that are related to it but modern physics is far beyond all of this. We need a method of learning that helps us to absorb and to understand all about physics. Physics learners need to be very highly imaginative thinkers so that they know what really in the physics world. Being one of this, I am confident in some ways that this problem based learning will accelerate the minds of each student and they will surely get what they should obtain as stated in the learning outcomes. (R15, SST, Female, questionnaire).*

One student pointed out that she felt her self-esteem was much improved, and felt that this approach is suitable for other science subjects:

> *Compare to the tutorial, I think tutorial is just involve the theories, that's why PBL able to build up our self-esteem on how to be confident to approach something new. I think this PBL kind of more suitable for science subject, because science subject we need more research, observation and all the application that we apply from the theory. Compare to the tutorial, we just memorizing and apply the equation, so it's not really help us in the future. Because from the tutorial it's just reflect on how good your memorization. (R1, Female, SST, interview)*

In addition to these common themes, there were some differences between the SESD and SST student cohorts. As an example, some SST students felt that the intervention *i. Can expose them to preparation for responsibility in the workforce* and SESD students said that this learning approach is suitable for university students since it is a *ii. Student-centred approach*.

i. Can expose them to the preparation for responsibility in the workforce

A participant mentioned that it is vital for a physics student to make a connection between what they have learnt in lecture room and the outside world. It will help them much in order to get ready and be more responsible for what will they face in their jobs in the future:

> *Because modern physics has more connections to the real life situation. By using PBL approach, we can try to relate both of theoretical and real life. And think of what we will face and see the early picture during the real jobs that needs the applications of modern physics. (R20, SST, Female, questionnaire)*

ii. Student-centered approach

A key feature of PBL is to train students to be more student-centered in their learning activities. Thus a participant remarked that it is very useful, especially to adult students, for them to take charge of their own learning and be more efficient, particularly when arranging their own study timing and what they need to find in order to fulfil their learning content:

> *PBL is a student-centered approach. This is a very convenient approach for a university student whom was consider as an adult that should be able to arrange their time in learning. When the time comes to be free, it is always a habit to use the time in learning the modern physics. Other than that, the wide range of view expands our knowledge on certain theory and concept. (R10, SESD, Male, questionnaire)*

However, from a different perspective, some of the students also were more neutral in their feedback regarding the suitability of using PBL Online:

i. Not enough time to study using PBL approach

A participant mentioned that, a disadvantage of PBL is the long process that they need to follow in order to solve a problem, thus they do not have enough time to cover all the learning contents within the period given. However, she also remarked that the key features in PBL learning activities that need them to think actively do help them to become more creative and think like a scientist:

> *I think if we want to learn modern physics, it is not enough if we just learn it via PBL. But PBL approach give a bigger impact for me personally, it is because during solve one problem in PBL question; we need to imagine, try to think creative and try to solve it using our way as a physicist. But this PBL approach more interesting if we can see the problem in front of our eyes, it can increase our thinking skill to solve it. (R2, SST, Female, questionnaire)*

ii. Depends on individual

A participant strongly suggested that if one student learns well using PBL, it is not necessarily so that another student will be equally successful and comfortable with the method. It all depends on the acceptance by each individual and the needs of each student:

> *In my opinion of this PBL, since the name itself is PBL, at first it will give us the problems, and we have to solve it by ourself in a group. So in my opinion it depends on individual. For those who really love to read, loves to surf the Internet, I think these kinds of activity suit them. But for those who likes to only wait for lecturer to give them notes, questions and resources, maybe they didn't feel comfortable with this kind of learning. (R30, SST, Male, interview)*

There was one participant who was quite negative in his feedback and he responded that this approach *i. Needs plenty of time and energy to be cope with learning* and *ii. Tutorial taught us how to answer exam questions.*

i. Needs plenty of time and energy to be cope with learning

An unsatisfied participant claimed that there was time limitation while experiencing the PBL online since they need to do many learning activities in their mission to find a solution for each problem:

> *No, because needs a lot of time and energy for identifying, reflecting, creating, etc. Problems and solutions even for a little bit of progress. Didn't have adequate knowledge and proper understanding of modern physics to be able actually gain anything substantial from the problems presented. (R23, SST, Male, questionnaire)*

ii. Tutorial taught us how to answer exam questions

The response here reflected that the education system at the university is still driven by the tutorial and exam-oriented system. Thus, some students found it hard to study in a situation like the one presented in PBL. As remarked by a participant:

> *In my opinion this PBL is really different than the tutorial. I am not quite happy with it. Because tutorial we use what we have learn through out in this university, like we use equations to answer questions. But in PBL we only use more on our general knowledge. So for my point of view general knowledge can be read from books and from any resources. (R26, SST, Male, interview)*

Conclusion

The main objective of this paper was to get descriptions from the students' point of view of what is the real agreement on implementing an instructional design that is problem-based learning which been delivered through online (PBL online) in a physics course. In conclusion it is clear that students gained positive engagement through PBL online where the findings came up with several themes focused on their: easy to understand modern physics theory; learning becomes more interesting, enjoyable and fun; and need method of learning which can make them understand better. In different perspective majority of the science student noted that can expose them to the preparation for responsibility in the workforce whilst many of the pre-service science teacher remarked that the instructional design recruited them to become more student-centred learner. Nevertheless, minor feedback also stressed that they need more time to study using PBL online instruction design and it really depends on the need of each individual. They also mentioned that PBL online really need lots of effort, time and energy besides old traditional method thought them on how to answer the exam questions better. This is similar to work reported by Norman and Schmidt (2000), who described PBL was a more challenging environment of learning, yet one that is a motivating and enjoyable approach. Atan et al (2005) also stressed that PBL that been delivered through Web-based learning approach also been indicated, such as learning through social interaction, acquisition of skills in meta-cognitive reasoning and proficiency in problem solving in the workplace context. Thus, basically this finding should be able to give a few clear descriptions and ideas to educators, researchers and lectures on what is the real deal happen between students and PBL online especially when it comes to its suitability at tertiary level.

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