

## Problem-Based Learning Online in Thermodynamics Course (SF20503): A Preliminary Study at the Universiti Malaysia Sabah

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### Abstract

The research attempts to investigate the students' performance in a new constructive approach known as problem-based learning online (PBLonline). PBLonline was fully intervened in a second year physics' course known as Thermodynamics encoded as SF20503 in Semester I Session 2011/2012. The intervention took place at the School of Science and Technology, Universiti Malaysia Sabah (UMS) located eleven kilometer from Kota Kinabalu, Sabah. Forty-one physics students under the Physics with Electronic program took part in the intervention and they were divided into seven small groups consist of five to seven people each group. Under the approach, each group were undergone a fully constructivist learning process such as, collaborative learning, active learning, independent learning and work in group in order to solve their main daily issue that they choose at the beginning of the semester. 16 weeks were given for them to undertake all the learning process such as construct their own learning, come up with hypothesis, synthesizing and analyzing the potential way of solution, find information in many angles and perspective and last but not least they need to come up with a possible better solution of all. There were seven big problems and each group need to solve only one of them. In additional the Learning Management System (LMS) provided by the university and also the Facebook had been used as the main medium for the groups to get connected to each other and with the facilitator. They need to discuss to their issue every once in a week with the facilitator via online (e.g., group chatting, forum, uploading, downloading, e-mail). Besides they also need to present their progress report and final report findings by group separately: one in the middle of the semester; and second during the fifteenth week, as to show they did their assessment continuously. Each group also sent their reports on their final findings and solution. The data were gathered from the final exam's grade as the outcome knowledge from the PBLonline and then been compared to the previous three session before the PBLonline for the same course (Session 2008/2009; 2009/2010; and 2010/2011). As the result, the grade's analysis reveals that the percentage of students who's got grade C and below dropped around 32 percent. Thus leads to the results that those who got grade C and above increased significantly from 64 percent to 95 percent. Therefore this may give some positive description that PBLonline have its potential in improving students' grade in overall. However a holistic research needs to be done in order to really identify the real deal between the PBLonline and the students' outcome based learning in various perspectives.

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### Introduction

Problem-based learning strategies are becoming well established as a method and an area of study within the field of instructional design (see e.g., Driscoll, 1994; Duffy & Cunningham, 1996; Jonassen, 1991; Wilson, 1996). Knowledge in this millennium is increasingly characterized by creative integration of information and learning from diverse disciplines. For these disciplines, PBL is probably the most extensively used tool (Ward & Lee, 2002) and many educational institutions worldwide have used PBL in educational reform and curricular innovation (Tan, 2004). Various studies using PBL in many disciplines, including in science, chemistry, biology, marine, and management suggest that PBL works especially well for complex, multi-disciplinary subjects like medicine. Koh et al (2008), for example, reported that trainee doctors who learnt via PBL in a medical school showed enhanced social and cognitive competencies, such as coping with uncertainty and enhanced communication skills (Koh et al, 2008); Colliver (1993) likewise reported gains in clinical skills ( see also Blake et al (2000), for more work on medical).

Besides constructivist and PBL, the online learning is also highly considered in Malaysia. One reason why the Malaysian government seeks to drive the development of learning via online learning in higher

education is that international literature suggests it may enhance students' knowledge and academic performance (Beadle & Santy, 2008). It is also considered to be effective in developing higher-order thinking skills, including defining problems, judging information, solving problems, and drawing appropriate conclusions and solutions (Rice & Wilson, 1999). Thus this study integrated PBL and online learning and see what its impact to students' engagement of creative thinking.

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 notes 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 et al, 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 FlashPlayer-based physiology resources in order to improve students expertise in nursing. Savin-Baden and Gibbon (2006) 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.

Although research indicated that the use of PBL online in several context and other disciplines is engaging, and enabling students to develop a number of cognitive skills (see e.g., Albanese & Mitchell, 1993) until now, little research has been done about to seek the students' perception on how their engage their creative thinking specifically in science education course like physics. With respect to improvement 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 effective PBL online discussion and working together. Hence the purpose of this study is to explore the students' perceptions about their engagement of creative thinking that been implemented in a physics course to better know what is the real engagement deal between PBL online and students. Two groups of students been participated in this study which is science physics students and also pre-service science teachers.

### **Problem-Based Learning (PBL)**

PBL is then a student-centred instructional approach in which students collaboratively solve problems, and reflect on their experience and practical knowledge. It was pioneered and used extensively at McMaster University in Canada. Characteristics of PBL are that learning is driven by challenging, open-ended problems. Students work in small collaborative groups, and lecturers or teachers take on the role as 'facilitators' of learning. Accordingly, students are encouraged to take responsibility for their group and organize and direct the learning process with support from a tutor or instructor (Albanese & Mitchell, 1993; Colliver, 1993; Finucane et al, 1998; Gallagher, 1997; Lim, 2005). PBL approaches involve confronting situations where students are uncertain about information and solutions, and mastering the art of the instinctive leap in the process of resolving these situations (Boud & Felletti, 1991). Learning thus occurs through the application of knowledge and skills to the solution of authentic problems, often in the context of real practice (Bligh, 1995). PBL is a form of situated learning, and learning occurs through goal-directed activity situated in circumstances that are authentic in terms of intended application of the learnt knowledge. Advocates of PBL claim it can be used to enhance content knowledge and foster the development of communication, problem-solving, and self-directed learning skills. It is also an instructional method of hands-on, active, learning-centred education involving the investigation and resolution of messy, ill, loosely-structured problems, that one can find in real-world situations (Ahlfeldt et al, 2005; Paget, 2004).

In this study, the researcher employed a model based on a combination of three models: that used by McMaster University (Barrows & Tamblyn, 1980); the Torp and Sage Model (Illinois Mathematics and Science Academy (IMSA), 1998); and the model used by Pastirik (2006). The main purpose of choosing a hybrid model was to ensure students explore their own learning, especially in terms sharpening their analytical skills, improving their critical justification in making decision, being a creative observer, and practicing their communication skills. All of these characteristics can be sharpened through these established learning models. Thus these PBL models were modified to suit undergraduate students. There are five main stages that consist in this PBL which are:

- i. problem presented; defined the problems which is ill-structure and complex situation;
- ii. student recognizes learning issues and potential sources of knowledge and information;
- iii. engage in independent study by gathering and analyzing essential scenario information;
- iv. student then meet with the small group, they critically discuss the practical application of the information to the scenario; and
- v. student then critically reflect on both the content learned and the process.

These theories are important in this study to maintain the key features of PBL and which, at the same time, can be applied to undergraduate level physics students in Malaysia. This is because the learning process that is embraced in these PBL models also needs to be acceptable in Malaysia, and to promote the soft skills that are deemed important in Malaysian institutes of higher education. Hence, the researcher integrated these models in order to create new PBL online model to address the research questions for this study.

### **PBL Online and Its Potential in Science Courses**

There is now a substantial literature on how PBL and online learning might be merged (see e.g., Candela et al, 2009; Cheaney & Ingebritsen, 2005), a combination that is sometimes called PBL online (see below, where this notion is expanded). 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; emphasizing 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, 2006b). Savin-Baden also notes 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 FlashPlayer-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.

In physics there were evidence that PBLonline can improved students' creativity and critical thinking (see e.g., Fauziah, 2004; Fauziah, 2011) . Some of the features that blended between PBL approach and the of online learning such as, chat room activities and sharing files synchronously did contribute to the students need of learning thus motivate them to be more active in their learning (Fauziah, 2011). Thus the advantages of PBLonline approach can be seen as the latest learning methodology that can contribute something to the education system evolution particularly in higher learning (see e.g., Neo & Neo, 2008; Sern, 2011).

### Methodology

The intervention was done in Semester I during the 2011/2012 academic year at the School of Science and Technology (SST), Universiti Malaysia Sabah. The sample consisted of students from the Bachelor of Science in Physics with Electronic Programme who registered for Thermodynamics course encoded as SF20503. The course is one of the second's year core-course in the program. There were 41 students who took part in the study. Among the sample, eleven students repeated the paper for the second time. The rest of the student registered the course for the first time.

**Table 1** Group Sample For The Study

Group		
PBL Group of Student	First Timer	Second Timer
	30	11

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. Besides, the researcher also used the FaceBook (FB) as one of the main medium for the learning activities (e.g, weekly discussions, asynchronous forum, uploading, downloading, sharing informations, etc). The researcher prepared and organised the LMS by using the PBL approach to fulfilled the learning and teaching activities via online learning. Thereupon students can access the LMS anywhere and at any time they prefer suited to their own period and space. The learning process can be seen in the flow chart shown in Figure 1.

There were seven groups in this study (consists of 5-7 students per group). Each group choose their own member as it will make them works more easily since they had been known to each other. In Week 1, the facilitator briefed the students about PBL, and how it will be implemented on the course. The course was Physics Thermodynamics (SF20503), offered in Semester I, during the 2011/2012 learning session. After formed their groups, their first task was to come up with a daily basis real time issue that they encountered. The critical point here was the issue or problem must be genuine and authentic enough for the students to solve and to estimate whether they really come up with an appropriate problem for the semester. This is vital so that they can solve the problem within the time given (15 weeks or so).

During the learning process, students were engaged in variety of synchronous and asynchronous PBL online 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 groups cognitively in a collaborative atmosphere all the way throughout the semester. The guidance was in a very minimum direction, thus the facilitator only ask the questions that only will arose more questions to the students, they need to find their own answer by themselves and not answered by the facilitator.

Data were gathered from the final grade examination and compared to the previous three semester's (session 2008/2009; 2009/2010; and 2010/2011) grade for the same course. The main objective of this analysis is to recognise the pattern of the students' results before and after the PBL online implementation.

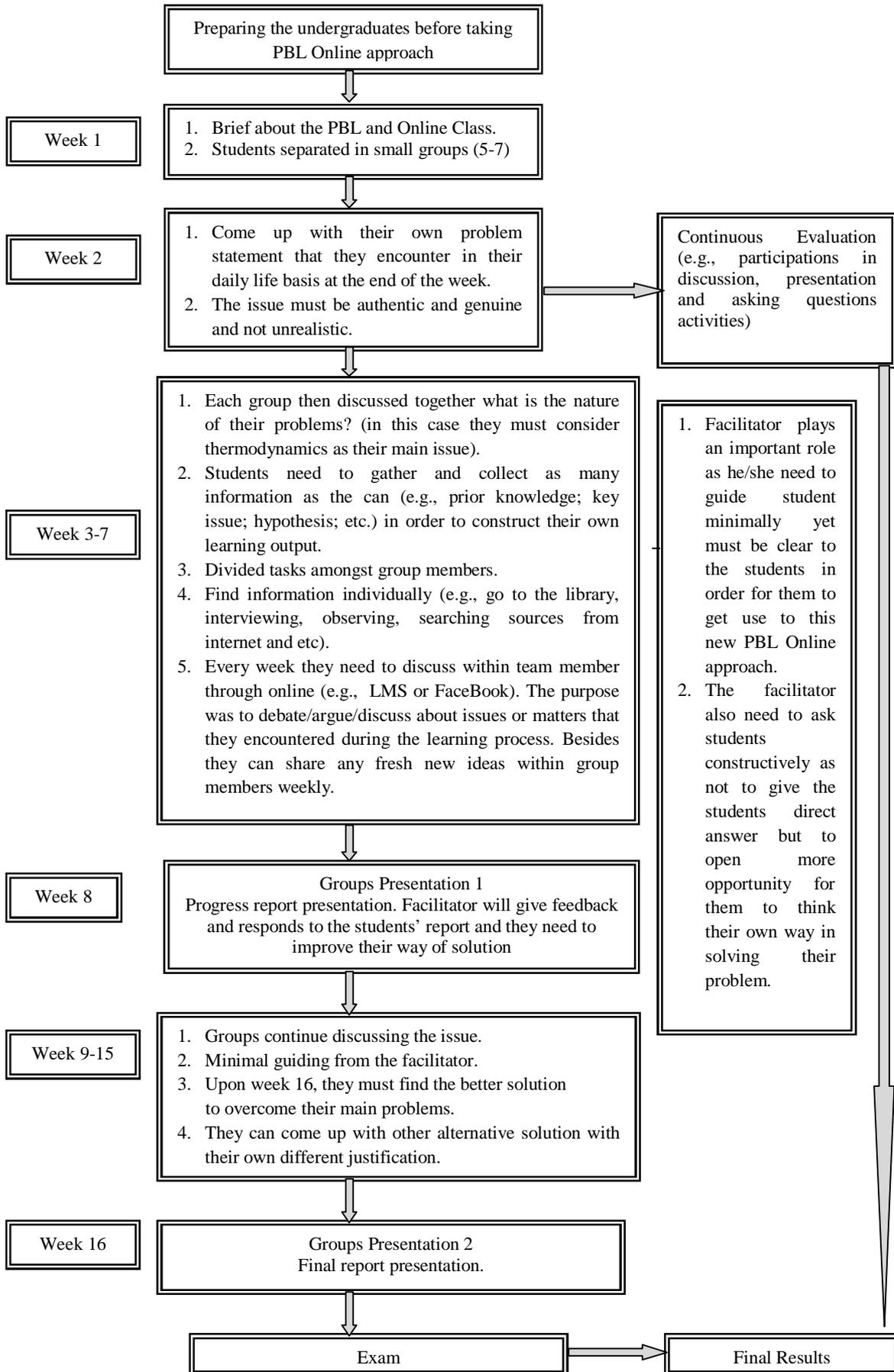


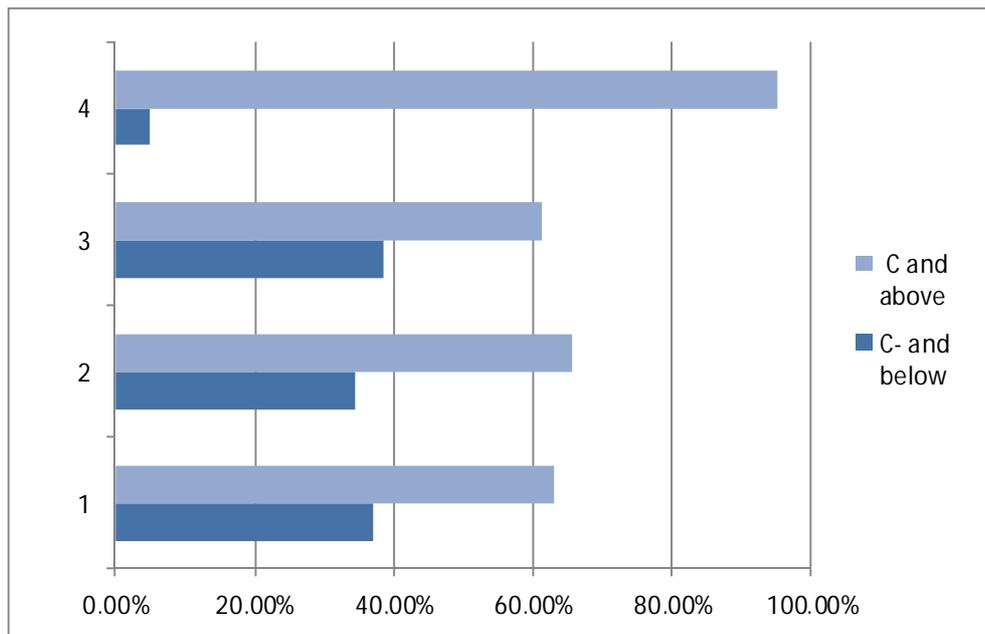
Figure 1 Flowchart of the PBL Online Implementation

### Findings and Discussions

The data finding suggests that as far as the PBL online approach is concerned the students' result were improved compare to the three previous sessions. Table 1 and Graph 1 shows the paten changing between before and after the PBLOnline implementation.

**Table 1** Grade Analysis for the Thermodynamics Course (SF20503) within Four Years.

Grade	Conventional Learning			PBL Online Learning
	Session 2008/2009	Session 2009/2010	Session 2010/2011	Session 2011/2012
<b>Number of Students</b>	46	61	70	41
<b>C- ≥</b>	17 (36.9%)	21 (34.4%)	24 (38.6%)	2 (4.9%)
<b>C ≤</b>	29 (63.1%)	40 (65.6%)	46 (61.4%)	39 (95.1%)



**Graph 1** Students' grade from: Session 1-2008/2009; Session 2-2009/2010; Session 3-2010/2011; and Session 4-2011/2012.

As shown in Table 1, the grade's analysis for the Thermodynamics course encoded with SF20503 reveals that the percentage of students whose got grade C and below dropped around 32 percent. Thus leads to the results that those who got grade C and above increased significantly from 64 percent (average percentage for previous three years) to 95 percent. This findings are similar to the work reported by Nasr and Ramadan (2008) who say that students that been treated with PBL-instructed in a science course were performed well in the final exam's question compare those who have been treated in a conventional way. In addition, the facebook medium that used as the main medium for the learning process takes place also contributed to the achievement in indirect way. This is in line with the work by Zaidatun et al (2011) works that reported the social networks has its own significant potential to be the main medium in teaching and learning process.

## Conclusions

This paper reports the preliminary findings of the PBLonline approach that been newly implemented in a physics course known as Thermodynamics encoded as SF20503 during the Semester I Session 2011/2012 in Universiti Malaysia Sabah. Data were gathered from the final exams paper as the reflection of the 16 weeks of fully PBL online implementation. Based on the data and analysis, it seems that this group of sample did records a significant achievement where fewer students recorded C and lower compared to the previous three sessions. In addition students also found learning in a small group really helps them engaging in their learning process in order to solve their problem. Thus, the researcher had planned to pursue the project to ensure the same achievement can be achieved in other physics courses thus can improve the students' grade in overall. Besides, possibly in the next project the researcher will look more into some potential variable that perhaps affect the students' output in overall such as affective factors (i.e., motivation, self-efficacy, and self-confidence) and cognitive factors (i.e., prior knowledge, metacognition, epistemological belief and cognitive control) and other factors such as students' perceptions, students' satisfaction, learning effectiveness, cost effectiveness and access before, during and after the PBL online. (Zaidatun et al, 2011)

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