Chapter 28
A Comparative Study of Problem-Based and Traditional Teaching in Computing Subjects

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Abstract This study aimed to compare the impact of the problem-based (PBL) with the traditional teaching (TLA) approach on students' academic performance and learning attitudes of computing subjects at the Kolej Profesional MARA Seri Iskandar (KPMSI), Perak, Malaysia. The participants of this study involved 74 students in the second semester of Foundation in Business (FIB 2) and third semester of Higher National Diploma (HND 3). A total of 40 students were allocated in PBL group while 34 students were allocated in TLA group. The participants were selected using a stratified random sampling technique. In this experimental design study, a quantitative method was employed using an adapted pretest and posttest as the research instrument which consists of 30 multiple choice items. Additionally, a structured survey was administered to the students after they are being exposed to a particular teaching method. Findings of the study showed that students instructed with problem-based approach significantly outperformed than those instructed with traditionally designed instruction. This study also suggests that there was a significant relationship between teaching methods and students' academic performance. A significant relationship also found in students' learning attitudes and academic performance where the feedback from the students indicated that items "learn from others" and "peer support" have an impact on their academic performance. No statistically significant relationship was found between teaching methods employed and the students' learning attitudes. The findings from this study will provide educators with an alternative strategy for improving teaching and learning of computing subjects.

Keywords Problem-based approach · Students' academic performance · Students' learning attitudes · Traditional teaching

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28.1 Introduction

Classrooms today are dictated by standards and assessments. The goal is for students to graduate with a well-rounded education having developed the skills and knowledge to be successful in the next phase in their life. Students need to learn how to read and interpret information. Learning how to think and solve the problems is the point of education. This study is performed to compare the students' academic performance and learning attitudes between two groups of students; problem-based (PBL) and traditional teaching (TLA) approach groups. The study also explores the relationship between students' learning attitudes and their academic performance.

Learning in the classrooms cannot be confined to just the content to be taught for the day, nor the syllabus to be completed in the semester. It will be so unnatural because acquisition of knowledge comes in a package together with the acquisition of other skills. In other words, learners are not just learning but also simultaneously picking up a variety of generic skills. A curriculum requires its future professionals to be fully prepared with a variety of skills such as analytical, creative thinking, teamwork, communication, technical, self-learning, and problem solving. The skills are acquired through various effective practices. Thus, the curriculum should be more dynamic and well-developed in order to acquire the necessary skills rather than teaching information. The need for such skills is vital to prepare proficient future professional in their own field of expertise to face the challenges of increasingly complex information and communication technology (ICT) world. Unfortunately, many students struggle to develop those skills and construct new knowledge especially when the subject materials are inherently intangible, difficult to visualize, and are conceptually different than what students are usually familiar with [1]. Past research has showed an important role of PBL and students' learning attitudes to stimulate learners to learn and find solutions to the problems [2, 3].

28.2 The Context

Kolej Profesional MARA (KPM) is formerly known as the Institut Perdagangan MARA (IPM) was established in May 1977. Since its establishment until the end of July 1982, KPM was located at the Sing Hoe Motor Building, Jalan Ipoh, Kuala Lumpur. Initially, KPM had only 100 students with four lecturers. On June 1, 1998, KPM Kuala Lumpur campus has moved to Beranang, Selangor. The second campus of KPM is located at Bandar Melaka, followed by KPM Indera Mahkota, KPM Seri Iskandar, KPM Bandar Penawar, and KPM Ayer Molek. To date, there are six KPM campuses in Malaysia. A Majlis Amanah Rakyat (MARA) through the Bahagian Pendidikan Tinggi (BPT) has taken many steps to strengthen its education sector in order to support Malaysia into a leading education hub. In 2011, BPT has urged all KPM campuses to implement a PBL teaching method at their colleges (cited in BPT MARA Road Map 2011–2015).

28.3 Problem Statement

Students' academic performance problems are often highlighted in the academic literature and mass media. Therefore, it is important for teachers to be aware and know about the factors related to students' academic performance. Traditionally, the computing subjects at the Kolej Profesional MARA Seri Iskandar (KPMSI) are taught in a lecture-based environment where each computing concept was delivered via theory and practical teaching method. Several teachers used analogy technique to enhance students' understanding. But in a real situation, some computing behaviors and ideas cannot be readily shown [4]. Due to the requirement of considerable amount of resources, it is difficult to expose students to some basic concepts of computing. To overcome the limitations of this traditional teaching method, a problem-based (PBL) approach is broadly used nowadays. The approach generally seems to have a positive effect on computing learning environment. Nonetheless, there was a major issue raised by many researchers; is the approach significantly aided the learning process and led to deeper content understanding? Several studies were conducted in the early 1990s and since the year of 2000, studies had showed a remarkably difference result of PBL effectiveness toward student's academic performance [5]. Furthermore, according to [6], psychological and sociological are the two main factors that contribute to students' academic performance. Psychological factors refer to the internal elements of individual including emotional and cognitive domains, whereas sociological factors refer to the external factors such as socio-environment and peers. Agreed by Mamat and Mazelan [7] on predicting student success, they discovered that student's attitude toward learning was one of the main factors that influenced student's academic performance. In the light of this perspective, this study attempts to investigate the influences of PBL and students' learning attitudes that only focus on six categories namely collaboration with peers, learning from others, peers support, social skills, problem solving and motivation, and interest toward students' academic performance specifically in a computing subject.

28.4 Review of Literature

The PBL model has become both nationally and internationally recognized by universities, researchers, and students as an advanced and efficient learning model. The PBL is based on the information processing model, constructivist learning theories. Learners are given only guidelines as to how to approach the problems [8] where students should metacognitively aware of what information they already know and what information they are need to know in order to solve the PBL problems. In solving the problems, learners will share the information but at the same time they construct their own knowledge [5]. The shift of TLA toward PBL provide a more realistic approach to learning and create an educational

methodology which emphasizes real-world challenges, higher order thinking skills, multidisciplinary learning, independent learning, teamwork, and communication skills through a problem-based learning environment. The PBL model consists of three items; (1) the problem (2) the teachers who act as facilitators, and (3) the students who act as the problem solvers [9]. In order to transform the TLA to PBL teaching method, this study adapted the PBL model introduced by Neo and Neo [9].

In addition to teaching method as a factor that may affect the student's academic performance, students' learning attitude is another factor that was identified by numerous researchers which can influence the student's academic performance. Learning attitudes have been shown to impact the academic performance especially between students-centered and teacher-centered learning environment. Research has shown that when students have positive attitude for a certain learning task, forth more effort will be set to accomplish the task [10]. Students will work harder and persist longer with the learning task. As a result they are more likely to be successful than students with negative learning attitude [11]. Several researchers such as [2, 3, 5] illustrated that the more positive one's attitude toward an academic subject, the higher the possibility for the students to perform well academically. From the literature, some researchers developed a theory that could be used to explain the relationship between learning attitudes and academic performance. This preliminary analysis of students' attitudes will determine whether there is a statistically significant association between the teaching methods and students' learning attitudes that may influence their academic performance.

The theoretical framework provides a rationale for predictions about the relationships among variables for this study. Thus, based on the review of literature mentioned previously, the framework of this study can be conceptualized as illustrated in Fig. 28.1.

The study believed that when the PBL method is applied, the problem-driven instruction could motivate students to learn the subject due to the human nature of curiosity and taking on challenge [12]. Through the problem solving process, students are not only acquiring the domain knowledge but at the same time constructing an effective knowledge acquisition and perform better academically. Students' learning attitudes is another one factor that expected to influence the students' academic performance. The study of students' learning attitudes will determine whether it has an association with the teaching method that may influence the students' academic performance.

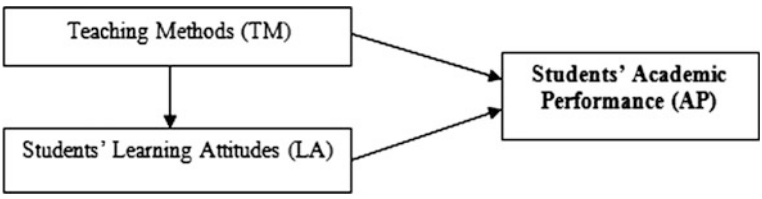

Fig. 28.1 Conceptual framework of the study

28.5 Methodology

28.5.1 Population and Sampling Technique

The population of this study involved the students of the Kolej Profesional MARA Seri Iskandar (KPMSI) enrolled in Foundation in Business (FIB 2) and Higher National Diploma (HND 3) programs. The samples or participants of this study involved 74 students in the second semester of Foundation in Business (FIB 2) and third semester of Higher National Diploma (HND 3). A total of 40 students were allocated in PBL group while 34 students were allocated in TLA group. The participants were selected using a stratified random sampling technique. This type of sampling allows the participants to be grouped according to a variable determined by the researcher. According to [13], the researchers can predetermine the stratified population, and then select the samples that best represent the population under study. The samples or participants selected in each program were randomly picked from the specified sampling frame of this study. The stratified random sampling technique was used to select samples from the selected computing subjects.

28.5.2 Instrumentations

In this experimental design study, a quantitative method was employed via three types of approaches: (1) an adapted pretest and posttest, (2) a structured survey, and (3) students' final exam grades. The following sections were the descriptions of instruments used in this study:

(1) *Pretest and Posttest*
There were two tests, namely, pretest and posttest used to evaluate the academic performance of the students before and after the completion of each teaching method. The tests were based on a 30-multiple choice items adapted [14, 15]. Pretest was administered in classes which was completed by students (on-paper) during the first week of semester before implementing the PBL or TLA teaching method. One topic from each subject's syllabus, that is, Networking Technologies (21470D) and Fundamentals of Database (CSC 1143) has been selected. Though the topics were different, it was tested previously that the level of difficulties in pretest are similar for both the subjects. The purpose of the pretest was to evaluate the academic performance of the students' basic computing skills before the experiment. The total score of test was 30 marks. During tenth week of semester, the students completed the posttest (same items in pretest) in classes. The posttest was used to test for significant learning gains (from pretest to posttest) within each group of PBL and TLA teaching method.

(2) *Structured Survey*
A structured survey was adapted from the recent study conducted by Looi and Seyal [16]. It consists of two sections: Section A provides the information about the respondents' demographic background, and Section B measures the student's attitudes toward their learning on a 5-point Likert scale (maximum score of 5 represents the highest level of agreement, and minimum score of 1 represents the strongest disagreement) of a total 21 items. A Cronbach's alpha coefficient value for each component of students' learning attitudes categorized as collaborative learning (4 items), learning from others (3 items), motivation and interest (3 items), peer support (4 items), social skills (3 items), and problem solving skills (4 items) produced an acceptable reliability level of 0.802, 0.796, 0.843, 0.879, 0.763, and 0.776, respectively.

(3) *Students' Final Exam Grades*
The grading system of computing subjects at KPMSI is based on Qualification and Credit Framework (QCF) by Pearson, the United Kingdom's largest awarding organization. It is also known as outcomes-based grading system. The student's academic performance is evaluated and documented using this grading system. Their final grade is tied to the level of performance documented according to several outcomes. For each outcome, student's performance can be graded as "Redo", "Pass", "Merit", and "Distinction". Both the subjects consist of three types of assessments with four outcomes to be achieved by students. At the end of the semester, student's grade depends on their overall performance of each criteria assessed in all assessments.

28.6 Analysis and Results

In order to perform the statistical analyses required for this study, the software called Statistical Package for Social Sciences (SPSS) Version 20.0 was used. All statistical analyses performed in this study were set to use 5 % level of significance, in other words, it will reject the null hypothesis if the given significance value (p-value) is less than 0.05. The analyses consist of four parts of statistical tests according to its purpose as described below:

(i) *Descriptive Analysis of the Participants*

The participants of this study were categorized into two groups of age range; 18–20 years old and 21–23 years old. This was possibly due to the participants from different batch, FIB 2 and HND 3. Out of 74 participants, 58 % of them aged 18–20 years old, and 42 % aged 21–23 years old. Among gender, 74 % were female and 26 % were male. About 61 % of the participants had a current CGPA between 3.00 and 3.50, 37 % were above 3.50, and others below 3.00.

According to the composition of experimental groups; out of 34 students in TLA teaching method, 19 (56 %) students enrolled in FIB 2 subject and 15 (44 %)

students enrolled in HND 3 subject. While out of 40 students in PBL teaching method, 22 (55 %) students enrolled in FIB 2 subject, and 18 (45 %) students enrolled in HND 3 subject.

(ii) *Independent t-test Analysis* (*Pretest and Posttest*) *between Groups*

An independent t-test analysis was used to compare the pretest and posttest mean scores obtained by students in PBL and TLA teaching methods. The pretest was conducted to determine whether there is a significant difference in terms of the prerequisite knowledge (basic computing skills) among students in PBL and TLA teaching methods (first week of semester). The result revealed that no significant difference was found in the mean scores ($t_{72} = 0.157$, $p = 0.876$ with equal variances assumed, $F = 0.387$, $p = 0.536$) for the pretest between the students in PBL (mean score of 11.10 marks) and TLA teaching methods (mean score of 10.97 marks). This indicated that the level of prerequisite knowledge among students in PBL and TLA teaching methods was significantly equivalent.

The posttest was conducted to determine whether there is a significant difference in terms of learning gains among students after implementing the PBL and TLA teaching methods (tenth week of semester). The result revealed that a significant difference was found in the mean scores ($t_{72} = 3.563$, $p = 0.001$ with equal variances assumed, $F = 0.371$, $p = 0.545$) for the posttest between the students in PBL and TLA teaching methods. This indicated that the performance of students in PBL teaching method (mean score of 19.35 marks) was significantly higher than in TLA teaching method (mean score of 15.82 marks) for the posttest.

(iii) *Dependent t-test Analysis* (*from Pretest to Posttest*) *within Groups*

A dependent t-test analysis was used to determine whether there is a significant improvement in the mean scores (from pretest to posttest) within each teaching methods (PBL and TLA). The findings revealed that the students in TLA teaching method demonstrated significant learning gains throughout the semester from a mean score of 10.97 marks on the pretest to a mean score of 15.82 on the posttest ($t_{33} = 8.380$, $p < 0.001$). This indicated that there was an increase in the performance of students in the posttest compared to the pretest at the average increase of 4.85 marks in TLA teaching method.

Similarly in PBL teaching methods, the students demonstrated significant learning gains throughout the semester from a mean score of 11.10 marks on the pretest to a mean score of 19.35 marks on the posttest ($t_{39} = 10.390$, $p < 0.001$). This indicated that there was an increase in the performance of students in the posttest compared to the pretest at the average increase of 8.25 marks. In comparison, the findings revealed that the students in PBL teaching method performed better than the students in TLA teaching method with a mean difference score of 3.4 marks.

(iv) *Chi-square test of Independence Between Variables*

A Chi-Square test of independence is used to examine the relationship between two categorical variables. An analysis of differences between two teaching methods on the students' final grades revealed that the percentage of students in PBL teaching method who obtained a Distinction (24.3 %) was higher than in TLA (8.1 %). The percentage of students who obtained a Merit in PBL teaching method (16.2 %) was also higher than in TLA (9.5 %). While, the percentage of students in PBL teaching method who obtained a Pass grade (13.5 %) was lower than in TLA (28.4 %). The findings revealed that there was a significant impact or association between the teaching methods (TLA and PBL) on students' academic performance (Chi-Square value of 10.804 and p-value of 0.005).

The findings also revealed that most of the learning attitude items have no significant relationship with the students' academic performance except only for the items "understand the difficult material by hearing to classmate discuss it" and "get support and encouragement from classmate to learn." These two items were significantly associated with the students' academic performance with a Chi-Square value of 17.067 with a p-value of 0.009, and a Chi-Square value of 13.461 with a p-value of 0.036, respectively. In other words, the students' attitudes toward learning do not impact their academic performance except for the two items. These findings showed that the student's attitude in learning from others and peer support are effective in helping them to learn and perform better in their academic performance.

28.7 Conclusion

Based on the findings discussed previously, it can be concluded that the PBL teaching method employed significantly impacted the students' academic performance. In comparison with the TLA teaching method, the students in PBL had better academic performance after being exposed and guided in classrooms. This evidence was in line with the studies conducted by Sangestani and Khatiban [17] and Sungur et al. [18] where the students instructed with PBL teaching method significantly outperformed than those instructed with traditionally designed instruction. A group work activity which was employed in PBL teaching method such as "peer support" and "learn from others" also proved a significant impact or relationship with the students' academic performance. Similar to the study conducted by Looi and Seyal [16], these two activities were ranked as the most important activities in the PBL learning environment. At the KPMSI, though the TLA teaching method also focus on group work activity, no significant differences were found in collaborative learning, learn from others, peer supports, and social skill components of learning attitudes. Nevertheless, this study also revealed that different teaching methods employed will not influence the students' learning attitudes. Likewise, a study by McParland et al. [19] reported that no significant differences were found in learning styles or attitudes between students in PBL and

TLA teaching methods. Specifically in this study, both groups were taught by the same instructor to ensure that equivalent motivation was given to the students in learning and solving problems and exercises.

In order to improve the representativeness of future study, it is suggested that the researcher involves the computing students from all KPMs in Malaysia. Therefore, the results generated from the study can be generalized to represent a larger group of population. Further study is recommended to use a variety of pre- and posttest instruments so as to evaluate students' knowledge acquisitions instead of multiple choice questions.

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