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Research paper

Using problem-based learning as an instructional approach in enhancing problem solving skills between engineering and business

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Abstract

Problem-based Learning (PBL) is one of an emerging student-centered approach in Malaysia. PBL has been proven to be one of the best approaches in helping students improve their soft skills. Complaints received from industry stating that many graduates are lacking of problem solving skills. Therefore, the objective of this study is to identify whether students' problem solving skills could be improved using PBL as an instructional tool. A quasi-experimental interrupted time series design was used involving fifty students from business and engineering faculties in a premier Technical University in Malaysia. Students were given four treatments or problems and were assessed based on accuracy and quality of solutions of the problem given. Results show that business students enhanced their problem solving skills better than engineering students. The findings support previous findings on the effectiveness of PBL on problem solving skills. This finding substantiates the use of PBL as an effective instructional tool to improve students' problem solving abilities.

Keywords: *Problem solving Skills; Problem-based Learning; Instructional Approach*

1. Introduction

Ministry of Higher Education (1) have highlighted the importance of soft skills to be embedded in Malaysian graduates. This is due to the graduates' incompetency in working world where employers complain that the graduates are ill-equipped with soft skills (2). According to Wyman (3), over 5 million jobs are unfilled in U.S due to lack of generic skills, including problem solving skills, among the applicants. Some companies would hire fresh graduates, unfortunately only one in five employers believe that the higher institutions are preparing the students with the requirements need by the employers (Career Builder, 2015). This is considered as a global issue and possible roots of problem have been identified, including the instructional approach used in class when delivering the knowledge. Therefore, the Ministry of Higher Education has move forward to amend the syllabus in education system by incorporating soft skills in the current higher education curriculum (1).

Student-centered learning is identified as the emerging trend in addressing the issue of incompetency of Malaysian graduates. Student-centered approach is seen to bring benefits to the process of learning and teaching as students are active in the class (4). Students work by their own with less supervision from the instructor (5). This leads to the development of skills which are very essential especially in the working world.

Problem-based learning (PBL) is a student-centered approach and it is becoming popular in Malaysia (6). Canada was the first country exposed to the implementation of PBL (7). Malaysia has been implementing PBL in various fields such as business administration (8), Mathematics (9), Medical (10), Social Sciences (11), architecture (12), engineering (13), law (14) and language (15). Even the goal of PBL implementation is same, there are various ways in implementing it; such as by having FILA table (16) or 5 Ladders (17).

The process of learning in PBL is similar to the work of Piaget, Dewey, and Burner (18) where this approach opens up opportunity for the students to develop their own learning goal. In addition, PBL also allows students to develop the content knowledge as well as soft skills (19).

Tasks or problems or even some might name them as assignments, are one of important aspects in PBL implementation (16). Tasks or problems are the stimulus for learning (20, 21) and are usually ill-defined ones. Barrows and Principles (22) point out several characteristics of an ill-defined problem or task. Task should have insufficient information when students try to solve the problem at the first encounter. In addition, added information is gained through inquiry as information available maybe incomplete, ambiguous, vague, and confusing, and students need to seek information as the information needed is not available in the problem. Furthermore, there are alternatives in solving the problem; which means, the solution of the problem is not only one. Students use their available knowledge and apply it in the process of problem solving. They integrate the knowledge from various disciplines in order to get the solutions. Finally, with careful reasoning, the solutions obtained may be best solutions for available problem.

Conversely, well-defined problems are problems which are well-documented in textbooks (22). In addition, the answers or solutions of the problems can be obtained with the problem in the book. As the solutions are presented together with the problem, the answers given have no alternative. There is only one correct answer accepted. Problem solvers do identify if their answers are

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wrong or right in working with the solution. This is against with what being defined as ill-defined problems and are not appropriate for enhancing individual problem solving skills (22).

2. Literature Review

As for this section, the implementation of PBL will be explained from global perspective and it also discusses the relevant literatures on problem-based learning; which include the characteristics of PBL, process and implementation of PBL and issues related to PBL.

2.1. Characteristics of PBL

Students work in small group (23). They are being active as they interact Tan (24), and responsible in their learning. Groups were formed by eight students (18), and they work with various resources. Teachers are guiding the students and this helps the students to become active in class (13, 16, 18).
Task or assignment is a real-world problem and it appears unstructured (24). Students integrate information from many resources in solving the problem (25), thus challenges their existing knowledge, attitudes, and competencies (24).

2.2. Process and Implementation of PBL

There are many ways of executing PBL. It depends on how the particular institution would like to practice. In Republic Polytechnic, Singapore, PBL is implemented based on "One-Day, One-Problem" (26) where students receive task in the morning and do their presentation at the afternoon.
Southern Illinois University, USA, practicing PBL by proposing the action plan, preparing the most probable answer, identifying resources, conducting self-direct learning, critique resource, reassess problem based on acquisition of new knowledge, solve the task and provide peer and self-assessment (20).
In the case of diploma students at Stanage University, UK, they are executing a simpler process where they are presented with a real-world problem, followed the steps analyzing the problem, identifying the learning issues, conducting self-directed learning, and conducting meeting to discuss and solve the trigger (27).
Although PBL has variety ways of its implementation (28, 29), they have common similarities such as implementing flexible knowledge and promoting self-directed learning (16, 30) and it has various features different from traditional method, that is very much teacher-centered, with less student involvement and chalk and talk approach (31).

2.3. Issues of PBL

Several issues highlighted in implementing PBL. First, is regarding on how students learn (16). It is believed that PBL can help students develop flexible knowledge, self-directed learning, effective problem solving skills, effective collaboration skills, and intrinsic motivation (16). Secondly is regarding students' motivation. Students' motivation was discussed by (16, 18, 30). In general, students are intrinsically motivated when they work on a task which suits their own interests, challenges, or sense of satisfaction. Self-directed learning is the other issue which is discussed widely in the implementation of PBL. (16, 32, 33) are among the researchers whose research are on students' self-directed learning in PBL classes. They studied the role of self-directed learning, how self-directed learning works with PBL, and what kind of self-directed learners the students become. (18, 34) point out the issue of perception. Getting the students' perception is important in ensuring effective and successful learning. PBL is not always bring positive perception, especially for those who are familiarized with talk and chalk approach of learning (35). There are many aspects of perception that can be investigated regarding PBL. Among them are about the learning environment itself, the problem or task or trigger given to students, and even perceptions towards the idea of self-directed learning process in PBL (32). Finally, the issue whether the students are becoming better problem-solvers or not has been discussed (16, 18). One of the objectives of implementing PBL is that it is understood that PBL is able at honing the problem solving skills in learners (22). Studies by Hmelo-Silver (16) found that the students become better problem- solvers after attending PBL treatments. However, Berkson (36) found that there was no significant difference between students attending PBL treatments and those who were in conventional classes.
There are mixed results on the implementation of PBL in enhancing students' ability to solve problems. Many significant results were reported by researchers regarding the efficacy of PBL in many aspects in its implementation. Therefore, it is imperative to know whether the results could appear to be similar when it is this approach of learning is implemented among business and entrepreneurship students. Literature provides many studies were done among medical students. Therefore, certain considerations should be put in implementing PBL among the business and entrepreneurship students.

3. Methodology

3.1. Design

This study was a quasi-experimental study. The purpose of this study is to see the effectiveness of PBL in improving problem solving skills between civil engineering and management students. Students were given four tasks during one semester or 14 weeks. Each task took about one to three weeks to be completed. Two facilitators were appointed to assess the students' work based on the scheme provided by the researcher. They played their role as inter-raters in the study.

3.2. Sample

The samples of this study were first year civil engineering and management students in one of MTUN (Malaysian Technical University Network) universities. There were enrolling Effective Communication class. There were 25 students in each class. In the present study, for the PBL class, the researcher divided the students into smaller groups which consisted of five students. Based on the number of students in the PBL class, which was 25, five small groups were formed and the researcher categorized the students based on their CGPA, gender, and race.

3.3. Instruments

The assignments were prepared by the researchers. These assignments or tasks were verified by experts in content area, teaching and learning and PBL. The experts evaluated the content of the tasks based on literature on crafting a good trigger, especially characteristics highlighted by (37).

3.4. Data Collection and Procedure

Students work on the tasks given and their work were evaluated by two inter-raters based on the accuracy and quality of the solutions. The inter-raters used the MUET (Malaysian University English Test) modified rubric, which was prepared by the researchers. The marks were recorded and the data were analyzed using a non-parametric test (Wilcoxon Test) and were processed using Statistical Package for Social Science (SPSS).

4. Results and Findings

The objective of this study is to determine the students' problem solving skills in Problem-based learning environment. There were four tasks given to the students and they were assessed based on the completion of the tasks. To determine if there are any im-

provements in accuracy and quality of the tasks given, the mean of each task was compared. Each task was given 35 to 50 marks, where, 35 marks were allocated for task 1 and task 2, 50 marks for task 3, and 45 marks for task 4. However, all marks were converted to 100 percent, which was equal to 10 marks, in order to standardize scores for comparison purpose. The means of the scores for all groups are presented in Table 1.

Table 1: Means on the Tasks Scores among Students in PBL Group [N=50(civil engineering: 25, management: 25)]

Task	Mean	
	KAAS	FPTP
Task 1: Accuracy	6.48	6.57
Quality	5.82	5.96
Task 2: Accuracy	6.92	7.01
Quality	6.42	6.5
Task 3: Accuracy	7.34	7.42
Quality	7.52	7.61
Task 4: Accuracy	7.8	7.94
Quality	7.16	7.62

For the civil engineering students, the mean on accuracy from first task to the following tasks are increased gradually from 6.48, 6.92, 7.34, and 7.8, accordingly. With the increment of the mean, it showed that the students' ability to solve the tasks in terms of accuracy was enhanced throughout the four tasks. For the quality, the mean of the tasks improved for the first three tasks (5.82, 6.42, and 7.52, accordingly) but declined slightly at Task 4 (7.16).

For the management students, the mean of accuracy from first task to the following tasks are higher than civil engineering students with 6.57, 7.01, 7.42, and 7.94, accordingly. In terms of quality, the mean of the tasks is increasing from 5.96, 6.5, 7.61, and 7.62.

Based on the results above, it can be concluded that management students have better problem solving skills compared to civil engineering students.

In summary, even though the result shows that the quality of solution was slightly declined on the Task 4, it can be concluded that there were improvements in students' ability in solving problem, compared to the beginning of the semester. Thus, there was a significant difference on students' problem solving skills at the beginning of the semester and after they finished the course. There are few factors observed that contribute to the declination of task 4 quality, such as completing other assignments and extra classes at the end of semester. Therefore, it can be concluded that the hypothesis of this study is accepted.

5. Conclusion

Literature proves that students are better in their problem solving skills after attending PBL classes. In the present study, the results revealed that students' problem solving skills developed well after the students attended the PBL treatments. Therefore, it can be said that PBL opens up possibilities for the students to improve their problem solving skills using the systematic technique in the process of problem solving.

In the present study, the students' problem solving skills were measured from two aspects, which are accuracy and quality. Scores on the four tests showed that the students had better problem solving skills as the trend was increasing from task 1 to task 4. The scores on the accuracy of the solutions were developing; however, the score on the quality of the solutions was slightly decreased on Task 4 compared to Task 3. Thus, it can be summarized that PBL provided the students with the ability to solve the problem accurately, and attention needed to be given to them in polishing their skills to produce better quality solutions.

It is recommended that for the future research, the implementation of PBL can be done at different levels of students, a larger sample, and longer period. Several limitations of this study including the generalization of the findings and the dimensions of problem solving studied

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