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Problem Based Learning in Engineering Course in Malaysia

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ABSTRACT: Problem-based learning (PBL) is an effective educational approach that promotes critical thinking, collaboration, and creativity. The study aimed to review an implementation of PBL in engineering course in Malaysia. PBL has been shown to be effective in engaging students in the learning process by presenting them with complex, open-ended problems that require critical thinking and creativity to solve. Through this process, students develop their critical thinking skills, including their ability to analyze information, evaluate arguments, and make sound judgments. PBL also helps students to develop their problem-solving skills, which are essential in the real world. Despite its benefits, implementing PBL in the classroom can also have some challenges and limitations. It can be time-consuming, difficult to assess, challenging to implement in large classes, and may not be suitable for all students. Thus, careful planning and preparation are required before implementing PBL in a university setting. In an engineering course, PBL provides students with opportunities to develop their critical thinking and problem-solving skills, as well as to enhance their collaboration and communication abilities. It also allows students to see the relevance of the knowledge and skills they are learning and to take ownership of their learning. Therefore, implementing PBL in a university requires identifying appropriate learning objectives and designing a problem or scenario that aligns with those objectives. The problem or scenario should be complex and open-ended, requiring students to draw on knowledge and skills from multiple subject areas. The implementation of PBL should also involve ongoing evaluation and refinement to ensure its effectiveness.

KEYWORDS: Educational approach; critical thinking; earning process; engineering course; engaging students

1. Introduction

Problem-based learning (PBL) is an educational approach that has gained popularity in recent years due to its effectiveness in engaging students and promoting critical thinking. PBL focuses on real-world problems, where students work collaboratively to find solutions using their knowledge and skills from multiple subject areas. PBL involves presenting students with a real-world problem or scenario that requires them to apply their knowledge and skills to develop a solution. The problem is open-ended, which means that there may be more than one possible solution and that the solution may not be obvious [1, 2]. Students work in small groups to research the problem and develop a solution, with guidance and support from their teacher. The teacher acts as a facilitator, rather than a lecturer, and provides feedback and guidance to

students throughout the process. PBL has many benefits for students. Firstly, it promotes critical thinking skills, as students are required to analyze and evaluate information to develop a solution to the problem. Secondly, it enhances collaboration skills, as students work in groups to find a solution, which requires communication and teamwork. PBL encourages creativity and innovation, as students are free to develop their own solutions to the problem. Fourthly, it provides students with a real-world context for learning, which helps to increase their motivation and engagement with the subject matter [3, 4]. However, PBL also has some challenges and limitations. Firstly, it can be time-consuming, as students need to spend time researching and developing their solution to the problem. Secondly, it can be difficult to assess students' learning, as the focus is on the process of learning, rather than the final product. Thirdly, it can be challenging to implement in large classes, as it requires a high level of teacher support and guidance. Fourthly, it may not be suitable for all students, as some students may struggle with the open-ended nature of the problem or may prefer a more structured learning environment [4, 5]. Figure 1. Shows the differences traditional learning and problem-based learning

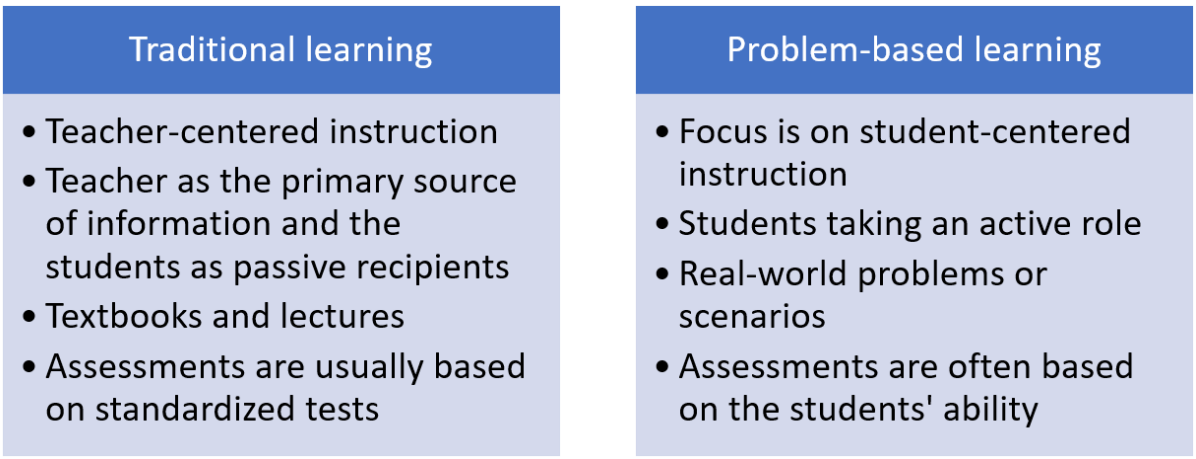

Figure 1. Differences traditional learning and problem-based learning.

2. Effectiveness of Problem Based Learning

PBL has been shown to be effective in engaging students in the learning process. This is because PBL presents students with complex, open-ended problems that require critical thinking and creativity to solve. Students are motivated to find solutions to the problem, as they are invested in solving the problem and are able to see the relevance of the knowledge and skills they are learning. Additionally, PBL allows students to take ownership of their learning, as they are responsible for their own research and analysis, which enhances their sense of autonomy and self-direction. PBL also effective in promoting critical thinking skills [1, 3]. PBL requires students to think deeply about the problem and to consider multiple perspectives and solutions. Through this process, students develop their critical thinking skills, including their ability to analyze information, evaluate arguments, and make sound judgments [2]. PBL also helps students to develop their problem-solving skills, which are essential in the real world, as they face complex and unpredictable problems [1]. Thirdly, PBL has been shown to be

effective in enhancing collaboration skills [5]. PBL involves group work, where students work together to find solutions to the problem. This promotes communication and collaboration skills, as students learn how to work effectively in a team and how to communicate their ideas and perspectives clearly. Additionally, PBL encourages students to share their knowledge and skills, which creates a supportive learning environment that benefits everyone [6].

3. Implementation of Problem Based Learning in University

Problem-based learning (PBL) is a teaching approach that can be effectively implemented in universities to enhance students' learning outcomes and prepare them for the real world. Implementing PBL in a university setting requires careful planning and preparation, as well as ongoing evaluation and refinement [1, 7]. In the PBL cycle, students are initially presented with a problem or case study that requires analysis and solution. Next, they brainstorm potential solutions, considering multiple perspectives and possible outcomes. In order to identify what they need to learn to solve the problem, students then identify the learning objectives. They conduct research and self-directed learning activities to acquire the knowledge and skills necessary to address the problem. Through group discussion, students share their research findings and potential solutions to the problem. Reflection is an integral part of the PBL process as it helps students to evaluate their learning experiences and the effectiveness of their problem-solving strategies. Students then evaluate their solutions and make adjustments based on feedback and new information. Finally, students present their final solutions to the class or to an external audience, showcasing their critical thinking, problem-solving, and communication skills. The PBL approach fosters student-centered learning, encourages collaboration and communication, and provides students with opportunities to apply their learning to real-world problems [7, 9]. The cycle of PBL step is summarized in Figure 2.

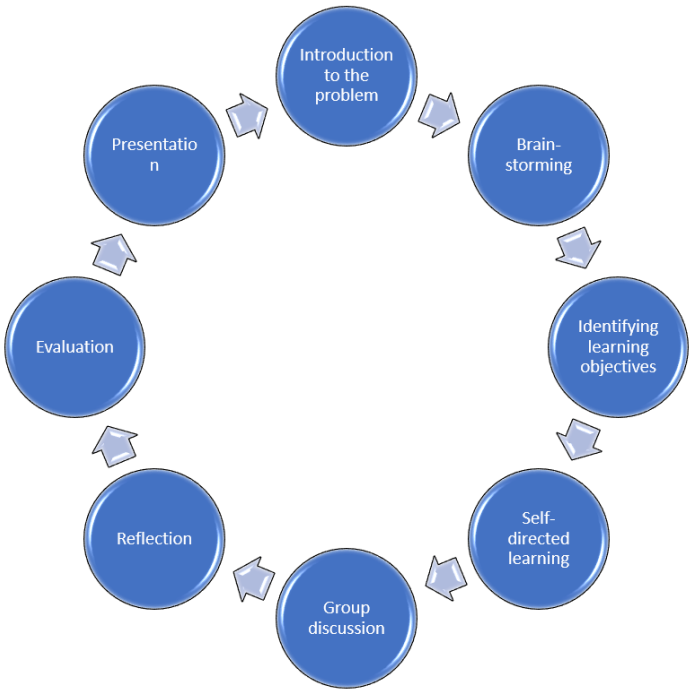

Figure 2. The cycle of PBL step.

4. Impact Problem Based Learning in Engineering Course

Problem-based learning (PBL) has a significant impact on engineering courses. PBL provides engineering students with opportunities to develop their critical thinking and problem-solving skills, as well as to enhance their collaboration and communication abilities. By working on real-world problems, students can apply the theoretical concepts they have learned to solve complex, multifaceted problems [10]. This approach to learning also prepares engineering students for the challenges they will face in their future careers, as they will be required to apply their knowledge to real-world problems in a team-based setting. Overall, PBL has a positive impact on the learning outcomes of engineering students and is a valuable addition to engineering education [11]. The application of PBL in engineering courses involves students working in small groups to solve complex, real-world problems. These problems are typically open-ended and multidisciplinary, requiring students to draw upon their knowledge of various engineering disciplines to develop innovative solutions. The teacher's role in PBL is that of a facilitator, guiding and supporting students throughout the problem-solving process rather than providing direct instruction [1].

One of the main benefits of PBL in engineering courses is the promotion of critical thinking skills. PBL challenges students to analyze and evaluate information from various sources, identify and define problems, and develop and evaluate potential solutions. This approach to learning encourages students to engage in higher-order thinking, enabling them to apply their theoretical knowledge to real-world problems [9, 12]. Another benefit of PBL in engineering courses is the development of problem-solving skills. Through PBL, students are exposed to a variety of complex problems that require them to work collaboratively and creatively to develop solutions. PBL helps students to develop the ability to identify problems, formulate and evaluate potential solutions, and make evidence-based decisions. PBL also has a positive impact on collaboration and communication skills [9]. In PBL, students work in small groups, fostering communication, teamwork, and collaboration. This approach to learning provides students with opportunities to develop effective communication skills and learn to work collaboratively with others [13, 14].

The real-world context of PBL in engineering courses provides students with a better understanding of the applications of engineering concepts and how they relate to real-world problems. This approach to learning enhances students' motivation and engagement, helping them to see the relevance of what they are learning to their future careers. However, there are some limitations to PBL in engineering courses. One of the major limitations is the amount of time and effort required to design and implement PBL activities. PBL requires extensive planning and preparation, as well as ongoing support and evaluation, which can be challenging for educators with limited time and resources. Additionally, PBL may not be suitable for all learners, as some students may prefer a more structured learning environment [3, 4]. Problem-based learning involves presenting students with a real-world problem or scenario that is open-ended and multidisciplinary, requiring them to apply their knowledge from different areas to solve it. The problem-solving process involves several steps, such as problem identification, research, analysis, solution development, and evaluation, which are guided by a facilitator or instructor who provides support and feedback to the students. The outcomes of problem-based learning include the development of critical thinking, problem-solving, collaboration, and

communication skills, as well as a better understanding of the practical applications of theoretical knowledge [12, 15]. Students are also able to demonstrate their ability to apply their knowledge to real-world problems and develop innovative solutions (Fig. 3).

Figure 3 The main component for problem-based learning.

5. Impact of PBL for Lecturer and Student

5.1. Impact on lecturers.

Implementing PBL in the classroom requires a significant amount of time and effort from lecturers. However, the benefits of PBL for lecturers are numerous. PBL encourages lecturers to adopt a facilitative teaching style, where they act as a guide and mentor rather than an instructor. This approach allows lecturers to take a step back and let students take control of their learning, which can be empowering for both lecturers and students [16, 17]. PBL also encourages lecturers to collaborate with colleagues from different disciplines, facilitating interdisciplinary teaching and learning. This interdisciplinary approach enables lecturers to broaden their own knowledge and understanding of other disciplines, which can help them to develop more comprehensive and diverse curriculum offerings. Another benefit of PBL for lecturers is the opportunity to engage in ongoing professional development. PBL requires lecturers to be flexible, adaptable, and responsive to students' needs and feedback. This ongoing engagement can help lecturers to improve their teaching skills and keep up-to-date with the latest teaching methods and trends [1, 5, 18].

5.2. Impact on students.

PBL has a significant impact on students' learning outcomes, including the development of problem-solving, critical thinking, collaboration, and communication skills. PBL challenges students to take responsibility for their own learning, encouraging them to become self-directed learners who can work effectively in teams. One of the key benefits of PBL for students is the opportunity to apply their knowledge to real-world problems. PBL provides students with a learning environment that simulates real-world situations, which can enhance their motivation and engagement in the learning process. This approach to learning also helps students to develop a deeper understanding of the practical applications of theoretical knowledge, which can be useful in their future careers [2, 19]. PBL also promotes the development of communication and collaboration skills. Working in teams on complex problems requires students to engage in effective communication and collaboration, helping them to develop interpersonal skills that are essential for success in the workplace. However, PBL can also present challenges for some students. Students who are not used to self-directed learning may

find it difficult to adapt to this approach, and students who are not comfortable working in teams may struggle with collaboration. It is essential that lecturers provide the necessary support and guidance to help all students to succeed in a PBL environment [30, 31].

5.2.1. Impact on critical thinking.

Critical thinking is the ability to analyze, evaluate, and synthesize information to solve problems and make decisions. PBL is an effective way to promote critical thinking because it requires students to actively engage in the learning process and apply their knowledge to real-world problems. In a PBL environment, students are presented with a complex problem or scenario that requires them to identify and analyze relevant information. This process requires students to think critically about the problem, question assumptions, and evaluate the credibility of sources [5, 20]. PBL also encourages students to develop metacognitive skills, which involves monitoring and regulating their own thinking processes. Students are required to reflect on their problem-solving strategies, assess their progress, and adjust their approach as needed. This metacognitive approach to learning promotes the development of self-directed learners who are able to think critically and solve problems independently [21].

5.2.2. Impact on communication skills.

Effective communication is an essential skill for success in any profession. PBL provides an ideal environment for students to develop their communication skills because it requires them to work collaboratively in teams and communicate their ideas effectively to their peers. In a PBL environment, students are required to present their findings and solutions to the problem to their peers and instructors. This process requires students to communicate their ideas clearly and effectively, using a range of communication modalities such as written reports, oral presentations, and visual aids [17]. PBL also promotes the development of interpersonal communication skills, which are essential for success in the workplace. Working collaboratively in teams requires students to engage in effective communication, which includes active listening, giving and receiving feedback, and resolving conflicts [22].

5.3.3. Impact on learning experience.

Problem-based learning (PBL) has been found to have a positive impact on student satisfaction with the learning experience. PBL is an educational approach that presents students with complex, real-world problems and encourages them to work collaboratively to develop solutions. The focus is on developing critical thinking and problem-solving skills, as well as promoting teamwork and communication [8]. Several studies have reported increased satisfaction with the learning experience among students who have participated in PBL. A study by Schmidt et al. found that medical students who participated in a PBL curriculum reported higher levels of satisfaction with the learning experience compared to those in a traditional curriculum. The study also reported that PBL students had a better understanding of the relevance of what they were learning to real-world scenarios [23, 24]. Similarly, previous studies found that engineering students who participated in PBL reported higher levels of satisfaction with the learning experience compared to those in a traditional curriculum. The study also reported that PBL students had better problem-solving skills and were better able to

apply their knowledge to real-world situations [4, 25]. One reason for the increased satisfaction with PBL is that it provides students with a sense of autonomy and ownership over their learning. PBL requires students to take responsibility for their own learning, which can lead to increased motivation and engagement with the subject matter [3]. PBL also encourages collaboration and teamwork, which can help students develop important social and communication skills [4, 5, 17]. PBL can lead to a deeper understanding of the subject matter. By presenting students with complex, real-world problems, PBL encourages students to think critically and consider multiple perspectives. This can lead to a more comprehensive understanding of the subject matter and a greater ability to apply knowledge to new situations [26].

6. Implementation and Challenge of Problem Based Learning in Malaysia

In Malaysia, PBL has been implemented in various levels of education, including primary, secondary, and tertiary education. However, the adoption of PBL in Malaysia faces several challenges, such as lack of resources, inadequate training of educators, and the need for a significant shift in the traditional education system's paradigm. One of the significant challenges in implementing PBL in Malaysia is the lack of resources, particularly in rural areas. Rural schools often lack adequate infrastructure and teaching resources, which can make it difficult to implement PBL effectively [10, 27]. Moreover, the cost of implementing PBL can be high, making it challenging for schools with limited budgets to adopt this approach. Another significant challenge is the inadequate training of educators in PBL. Most educators in Malaysia have been trained in traditional teaching methods, and there is a need for extensive training to adopt PBL effectively. Lack of training can lead to improper implementation of PBL, resulting in limited student engagement and inadequate learning outcomes [28–30].

The shift in the traditional education system's paradigm is also a significant challenge in implementing PBL in Malaysia. The traditional education system in Malaysia is primarily teacher-centered, where students are passive learners. PBL, on the other hand, requires students to be active participants in their learning, which can be challenging to implement in a system that prioritizes rote learning. Despite these challenges, there have been successful implementations of PBL in Malaysia. For instance, the University of Malaya has been implementing PBL in their electrical engineering program and successful in improving student learning outcomes and has been well received by both students and educators [31].

One of the challenges of implementing PBL in Malaysian universities is the lack of awareness and understanding of the PBL approach among educators. Many educators in Malaysia are not familiar with PBL and may not be aware of its benefits. As a result, there is a lack of commitment and support for the implementation of PBL in the curriculum. To address this challenge, universities need to provide training and development programs to equip educators with the necessary knowledge and skills to implement PBL effectively. Another challenge is the lack of resources, particularly in terms of facilities and technology. PBL requires a supportive learning environment that encourages collaboration and teamwork among students [10, 29]. However, many Malaysian universities may not have the necessary resources to support PBL, such as classrooms with flexible seating arrangements and multimedia equipment. Without these resources, it may be challenging to implement PBL effectively. The

language barrier is another challenge that may hinder the implementation of PBL in Malaysian universities. English is the language of instruction in many universities in Malaysia, and some students may have difficulty understanding the language. This language barrier may affect the ability of students to collaborate and communicate effectively in a PBL setting. To overcome this challenge, universities may need to provide language support services to students, such as language courses and translation services [32].

The assessment of PBL is another challenge that needs to be addressed. Traditional assessment methods, such as exams and quizzes, may not be suitable for PBL as they do not reflect the process of problem-solving and collaboration among students. Therefore, universities need to develop appropriate assessment methods that reflect the learning outcomes of PBL, such as group presentations and portfolios [27]. Finally, the implementation of PBL in Malaysian universities may face resistance from students who are used to traditional teaching methods. Some students may find PBL challenging and may prefer to be taught through lectures and exams. Therefore, universities need to provide support and guidance to students to help them adapt to PBL and understand its benefits [30, 32, 33].

7. Conclusion

In conclusion, Problem-based learning (PBL) is an effective educational approach that promotes critical thinking, collaboration, and creativity. It provides students with a real-world context for learning and helps to increase their motivation and engagement with the subject matter. However, it also has some challenges and limitations that need to be considered when implementing it in the classroom. PBL has been shown to be effective in engaging students in the learning process by presenting them with complex, open-ended problems that require critical thinking and creativity to solve. Additionally, PBL allows students to take ownership of their learning, as they are responsible for their own research and analysis, which enhances their sense of autonomy and self-direction. PBL has also been shown to be effective in promoting critical thinking skills. PBL requires students to think deeply about the problem and to consider multiple perspectives and solutions. Through this process, students develop their critical thinking skills, including their ability to analyze information, evaluate arguments, and make sound judgments. PBL also helps students to develop their problem-solving skills, which are essential in the real world, as they face complex and unpredictable problems. PBL is a valuable approach to education that can benefit students in many different ways. However, it also has some challenges and limitations that need to be considered when implementing it in the classroom. For example, it can be time-consuming, difficult to assess, challenging to implement in large classes, and may not be suitable for all students. Implementing PBL in a university setting requires careful planning and preparation, as well as ongoing evaluation and refinement. The first step in implementing PBL in a university is to identify appropriate learning objectives and design a problem or scenario that aligns with those objectives. The problem or scenario should be complex and open-ended, requiring students to draw on knowledge and skills from multiple subject areas. In an engineering course, PBL provides engineering students with opportunities to develop their critical thinking and problem-solving skills, as well as to enhance their collaboration and communication abilities. PBL also allows students to see the relevance of the knowledge and skills they are learning and to take ownership of their learning, which enhances their sense of autonomy and self-direction.

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Competing Interest

All authors declare no competing interest.

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