LECTURERS' CHALLENGES AND CONFIDENCE IN IMPLEMENTING PROBLEM-BASED LEARNING (PBL) IN MATHEMATIC SUBJECT

Palaniappan Shamala[1], Muruga Chinniah[2*], Oswald Timothy Edward[3]

[1]*College of Computing, Informatics, and Mathematics, Universiti Teknologi MARA, UiTM Johor Segamat Campus, 85000 Segamat, Johor Malaysia*

[2,3]*Faculty of Business and Management, Universiti Teknologi MARA, UiTM Johor Segamat Campus, 85000 Segamat, Johor Malaysia*

[*] Corresponding Author

Email: murug480@uitm.edu.my

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ABSTRACT

Mathematics is categorized as one of the most poorly taught, widely hated, and very hardly understood subjects in elementary schools. Previously, students taught in traditional mathematics education environments were preoccupied with exercises, rules, and equations that need to be learned but are of limited use in unfamiliar situations such as solving real-life mathematics projects. In contrast to conventional mathematics learning environments, a Problem-Based Learning (PBL) environment provides students with opportunities to develop their abilities to adapt and change methods to fit new situations. Therefore, the qualitative part is chosen to get explanations from lecturers who are teaching mathematics at Malaysian Public University. One-to-one interview sessions using semi-structured interviews were chosen. The findings of the interview were arranged as follows: (1) lecturers' knowledge and experience of teaching maths to students; (2) students' capability to master the basic skills and knowledge of mathematics; (3) applying the PBL method to teach Math, its challenges and confidence level throughout the PBL session; and (4) lecturers' view towards the PBL challenges and usefulness applying in university level. The findings have revealed that teaching students using PBL positively affected student content knowledge and the development of skills such as collaboration, critical thinking, and problem-solving.

Keywords: Mathematics, Problem-Based Learning (PBL), Qualitative Method, Semi-structured Interview, Teaching Mathematics

1.0 INTRODUCTION

In today's interconnected world of globalization, students are required to develop problem-solving and communication skills. They should also be creative, innovative, competitive, possess a variety of skills, enterprising, confident, and adept at mastering and utilizing the latest digital technology. Additionally, they should strive to be lifelong learners (Abdullah et al., 2010; Alt, 2023). In line with this, having a strong understanding of mathematics (Rahman et al., 2021) both procedurally and conceptually, can greatly increase one's chances of success in a competitive globalized society. Mathematics plays a crucial role in enabling students to develop the necessary skills, as the mathematics curriculum within the education system aids individuals in enhancing their problem-solving abilities. This enables individuals to effectively tackle a wide range of problems, including those that are routine, non-routine, applied, non-applied, and non-routine non-applied routine problems (Syabila et.al., 2021).

Students in traditional maths classes focus on exercises, rules, and equations, which may not be useful in real-life situations. Problem-based learning (PBL) gives opportunities to develop their abilities to adapt and change methods for new situations, unlike conventional maths learning. The PBL approach is effective as it uses problems to drive learning (Mulyanto et.al., 2018).

Students acquire knowledge by tackling open-ended problems that require both subject-specific content and critical thinking skills. Problem-Based Learning (PBL) is an educational approach where students engage in facilitated problem-solving to enhance their learning. The process begins with presenting a problem that students must solve, prompting them to utilize their subject-specific reasoning abilities, identify their learning gaps, engage in self-study, apply new knowledge to the issue at hand, and summarise their learning outcomes (Ghani et.al., 2021).

It is undeniable that the Mathematics Education curriculum and system in Malaysia has undergone major reforms and has been planned to meet the demands and challenges of globalisation (Abdullah et al., 2010). However, according to (Aliyu, 2020; Ibrahim & Othman, 2010), secondary school graduates entering universities lack basic maths skills in trigonometry, algebra, and even arithmetic, and high dependence on calculators. The majority of Sijil Pelajaran Malaysia (SPM), Sijil Tinggi Persekolahan Malaysia (STPM) and Matriculation students lack mastery in basic maths skills, reasoning and proof, and are not able to make connections in other disciplines.

Therefore, the qualitative part is chosen to gain answers for the following research objectives: (1)Identify lecturers' knowledge and experience in teaching mathematics & students' ability to master maths skills; (2) Identify challenges and confidence levels of lecturers when applying the PBL method; and (3) Gather lecturers' views on the challenges and usefulness of PBL in university-level mathematics education. One-to-one interview sessions using semi-structured interviews were chosen. To accomplish this interview, the lecturers who are teaching mathematics at one of the Malaysian Public Universities were approached.

2.0 LITERATURE REVIEW

Mathematics is commonly classified as one of the subjects that is poorly taught, largely disliked, and often challenging to comprehend in elementary educational settings. Furthermore, the author has indicated that students' inadequate academic outcomes can be linked to various factors, including the prevailing perception within society that mathematics is inherently challenging, a shortage of proficient instructors, insufficiency of mathematics laboratory facilities, and a deficiency in engaging and innovative pedagogical approaches (Ali et al., 2010; Geteregechi, 2023; Doz et al., 2024). Teachers and other professionals have applied various pedagogical rules of teaching and learning to ensure the best results in students' math learning. It is undeniable that previously the most famous way of teaching math in the schooling system was the passive way which is also known as the lecturer-centered way.

Passive learning is characterized by students engaging in educational components focused solely on receiving information. Instances of this type of learning involve activities such as reading, attending lectures, viewing videos, and examining visuals like pictures or PowerPoints. Students acquire knowledge at this level through the reception of presented information. Passive individuals are inclined to passively acquire information and understanding without actively interacting with the received content or the educational process. This type of teaching is only able to produce a student who is also passive and less enthusiastic in engaging in the mathematics learning process.

However, in the problem-based learning model, students transition from being passive recipients of information to becoming active, autonomous self-learners and problem-solvers. The central focus of contemporary educational systems is student-centred learning, where the role of the teacher is primarily that of a facilitator or guide. Within all active learning processes, individuals acquire knowledge based on their specific requirements and learning speed (Tandogan&Orhan, 2007; Eqbes&Ajaja, 2023 & Zetriuslita et al., 2023). Students are afforded the opportunities to exercise agency in making decisions about various aspects of the educational process and engaging in self-regulation. When engaging in active learning, the educational experience is individualized rather than following a standardized format. Within classrooms that employ a problem-based learning approach to instruction, students assume a significantly greater level of accountability for their learning. Consequently, they develop into autonomous and lifelong learners, capable of pursuing knowledge throughout their lifespan.

Advocates of mathematical problem-solving argue that the development of students as proficient problem solvers is achieved through the heuristic acquisition of mathematical knowledge. Additionally, students' effective management of their knowledge contributes significantly to their ability to solve mathematical problems proficiently (Major & Thalia, 2018; Major & Mulvihill, 2023). Problem-based learning is an educational approach within the classroom setting that structures the teaching of mathematics around problem-solving tasks. This method provides students with increased chances to engage in critical thinking, express their original ideas, and interact with classmates through mathematical communication.

According to Padmavathy (2013), figure 1 elucidates the process of problem-based learning. By presenting students with a problem, they are allowed to engage in risk-taking, acquire new insights, apply their knowledge, operate within a specific context, and relish the excitement of exploration. The steps of PBL offer a platform for learners to engage in critical thinking, active participation, brainstorming, and learning, all of which have become prominent topics in discussions regarding classroom instruction or transferable learning, while also serving as a source of motivation. (Padmayathy&Mareesh, 2013; Dorimana et al., 2022; ALMuharragi&Toworfe, 2020; Herlambang et al. 2021).

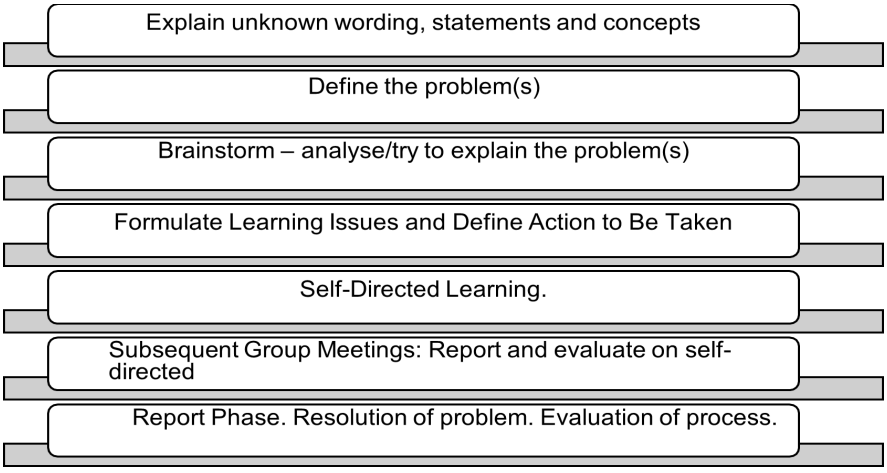

Fig. 1 *Steps of problem-based learning (Padmayathy&Mareesh, 2013)*

In problem-based learning, the primary responsibility of educators in PBL environments is to possess a profound comprehension of mathematics, which empowers them to effectively steer students in the utilization of knowledge across diverse problem scenarios. Educators lacking sufficient mathematical expertise could potentially lead to student struggles within mathematical PBL settings.

The teacher will assume the responsibility of facilitating student engagement in problem-solving and the application of knowledge to unfamiliar scenarios. The teacher's objective is to facilitate students' transition to autonomous learning. During the PBL session, the teacher facilitated the formation of groups and established a deliberate and collaborative environment. The teacher guaranteed that the students maintained authority over the discourse. In instances where direction was necessary, the teacher posed broad, open-ended questions and provided extensive room for students to concentrate on the objective. The teacher promoted the cultivation of critical thinking skills.

3.0 METHOD

This study employed a qualitative descriptive design (Creswell & Poth, 2018). This qualitative study has a description design to provide an authentic insight into one of the public university lecturers' experiences, challenges, and confidence in implementing PBL for the mathematics subject. Moreover, the descriptive design was chosen to discover and understand the phenomenon by getting information directly from the lecturers involved in implementing PBL in the mathematics subject.

In the qualitative phase, the purposive sampling technique in which the interviewees were chosen based on three characteristics: 1) lecturers who teach mathematics, 2) experience in teaching mathematics for more than 1 year, and 3) have exposure using PBL in teaching is found. Eight lecturers who taught mathematics were identified, and the researcher contacted them to seek permission to conduct the interviews. The researcher explained clearly and briefly the purpose of interviewing them. The related documents were then sent to the lecturers who agreed to participate in the interview session. However, out of the eight lecturers, only five agreed to participate by providing an appointment date. Table 1 summarises the lecturer's background.

Table 1. Lecturer's Background

ID	Qualification Degree	Teaching Math Subject	Experience applying PBL	Year of Experience
Lecturer A	Sarjana MudaSains (SainsKomputer)	Statistic, Structure discrete	Have and still learning	2 years
Lecturer B	SarjanaMudaTeknologi Maklumat	Algebra	Have and still learning	2 years
Lecturer C	SarjanaMudaKejurutera an (Bioperubatan)	Statistic, Structure discrete	Have and still learning	2 years
Lecturer D	Sarjana Muda Sains Komputer	Statistic, Structure discrete	Have and still learning	8 years
Lecturer E	SarjanaMudaTeknologi Maklumat	Algebra	Have and still learning	8 years

A semi-structured interview guide (Creswell & Poth, 2018) was used to guide the interviews. Open-ended questions were used to encourage participants to share their experiences in their own words, providing rich, qualitative data. The researcher conducted one-on-one interview sessions. Semi-structured interviews afford researchers flexibility while adhering to an interview framework. Semi-structured interviews offer a considerable amount of leeway to the researcher to probe the respondents along with maintaining a basic interview structure.

The following protocol was adhered to during the semi-structured interview process:

1. The interview guide was prepared to explore lecturers' experiences with problem-based learning. Their perceptions of its challenges, confidence and effectiveness in enhancing student engagement learning PBL for the mathematics subject.
2. A pilot test was conducted with two lecturers who provided feedback on the clarity and relevance of the interview questions. They too provided feedback on whether the questions were appropriate for capturing lecturers' experiences with problem-based learning. Minor adjustments were made based on their responses.
3. Each participant received an informed consent form detailing the study's purpose, their rights, and data confidentiality. Before the interviews, all participants signed a consent form.
4. This research was carried out at one of the public universities in Malaysia in January 2024. The interviews took from 90 to 100 minutes and they were audio-recorded with the consent of participants.
5. A content summary approach was applied, where the responses were reported directly to reflect the participants' experiences without further categorization. The data were reviewed and summarised to provide a clear description of the participants' responses.
6. After the interviews were conducted, participants were requested to review the summarized data to ensure their perspectives were accurately captured.

4.0 RESULT AND DISCUSSION

This section presents the findings concerning the three research objectives, without comparison to external studies. Minimal analysis was applied, whereby interview responses were summarized to provide a clear description of lecturers' views.

4.1 Lecturers' Knowledge and Experience In Teaching Math To Students

All the lecturers who teach mathematics, have not graduated from a mathematical background. All of them are from computer engineering bases. However, all of them have good qualification achievement in their maths subject during their Malaysian Certificate of Education and also Malaysian Higher School Certificate. Based on their passion and also qualifications, the faculty gave them the responsibility to teach maths to students. Initially, all of them struggled to understand how to deliver the teaching and learning process of maths. Studying maths as a student is different from teaching it to others. Only lecturers B and D agreed that they still do more homework to master mathematics in terms of presenting to students.

Lecturer A: *"I am good at maths. Maths is not my first degree. I was given the responsibility to teach maths because of my score during secondary. Since I love maths, I pushed myself to improve even further. I still enrol in training sessions and positively accept feedback from students.*"

Lecturer B: *"I know how to do the maths, but I struggle when I need to break the steps into simpler ones to teach them."*

Lecturer C: "I have the skills in doing maths. My passion always drives me to learn more. I always want to adapt and find ways to teach."

Lecturer D: "*I can solve complex mathematical problems easily. However, I have difficulty explaining those concepts in a way that students can grasp easily. Most of the time I find myself lost in the earlier stage, but now I'm improving."*

Lecturer E: "Training programs and peer collaborations constantly pushed me to expand my teaching techniques in PBL."

Lecturers improved their teaching practices significantly through ongoing learning and professional development. This progress was achieved regardless of their original field of study. Generally, all of them have higher confidence in teaching students maths. Muhammad Aiman et al. (2017) and Ealangov&Jamaludin (2024) affirm that the educators' competence to implement a teaching and learning approach is influenced by their preparedness in terms of knowledge, skills, attitudes, interests, and objectives of execution.
All lecturers are highly prepared to implement PBL and their knowledge, passion, and attitude toward learning have an impact on PBL implementation skills.

4.2 Students' Capability to Master The Basic Skills And Knowledge Of Mathematics

All the lecturers discussed that a higher proportion of students in Malaysia are inspired to get good scores on tests of performance. Lecturer A said that teachers at primary and secondary are very concerned with finishing the syllabus and drilling students on exam questions and answers. They are reluctant therefore to involve other approaches to the teaching and learning of mathematics as it would take up too much time and are irrelevant to passing examinations. Lecturer B mentioned that in schooling education, the chalk-and-talk method is dominant in explaining rules, and definitions and solving problems. These teaching and learning methods applied in primary and secondary schooling caused tertiary students to have difficulty manipulating information and forming mathematical statements. Students lack in information processing skill (Son & Fatimah,2020;Tambychik& Meerah, 2010)

Lecturers were facing problems in teaching maths because all of them applied a student-centred learning approach in teaching maths. Students from different levels are allocated to the class. Thus, it causes some students to have difficulty in mastering the maths skills and low capabilities to interrelate the problems and solutions. However, lecturers A, B, C and D confidently said that students' performance will surely increase if the lecturers' teaching approach is effective and tallys with the level of understanding of the students. This is supported by Thumvichit (2024), teachers with good mathematical understanding will enhance the quality of their teaching and directly or indirectly, contribute to their students' self-confidence as maths learners.

Lecturers B, C, D and E mentioned that lecturers' motivation and belief in students' success directly enhance students' mastery of mathematics. Hidayatullah&Csíkos (2024) said mathematics educators should consider how to shape students' beliefs, because these beliefs would control students' attitudes as well as motivation, in that way, their achievements will increase. Thus, concluding that lecturers play a crucial role in fostering students' interest and willingness to master maths skills.

4.3 Applying the PBL Method to Teach Math, Its Challenges, and Confidence Level Throughout the PBL Session

All the interviewed lecturers, without any doubt mentioned that they are applying problem-based learning in teaching mathematics. The syllabus for mathematical subjects that they are teaching is also requested to conduct PBL in the teaching process.

Lecturer A: *"In PBL, students must take more responsibility for their learning, teachers need to relinquish the role of imparting knowledge."*

Lecturer C: *"There's no single correct answer in PBL implementation. The lecturer's role is to guide students through the learning process by asking open-ended questions that help them express their thought process."*

Lecturer D: *"PBL isn't always easy to put into practice since it needs a lot of preparation and hard work from us. But when it's done right, it can turn students into active learners, problem solvers, and solid team players."*

Essentially, all lecturers are aware of the benefit of implementing PBL but they also agree that they encounter difficulties when conducting classes using PBL. They all acknowledge facing challenges, including feelings of insecurity, lack of confidence, difficulties in promoting student collaboration, and structural constraints. Additionally, they encounter issues such as increased workload and lack of support from their peers. Problem-based learning demands significant resources and extensive coordination, making it time-consuming. The time needed for teacher supervision and advice to individuals or groups is much greater than that required in conventional teaching (Mansor et al.2015; Suwastiniet al. 2021). Chen et al.(2021) mentioned that lecturers faced a heavier workload in PBL courses in providing professional guidance, practical experiences, and teamwork facilitation throughout the entire project.

Lecturer B: *"Honestly, PBL can take up a lot of time. I am not just teaching the material, I need to constantly check in on students and guide them to solve issues. Most importantly, I need to ensure everyone's on track. It's way more involved than traditional teaching."*

Lecturers A, B, and D mentioned that they only apply the PBL lesson plan and rubric created by previous lecturers. They strictly adhere to the steps outlined in the lesson plan. They are still in the learning process and have confidence that they will master the skills in applying PBL in their teaching process. However, all three strongly agreed that the PBL teaching approach gives more benefits than traditional methods. PBL has the potential to impact students' performance and attitude towards the subject. The student's academic progress demonstrated that PBL positively influenced the teaching of mathematics and enhanced students' comprehension and ability to apply concepts in real-life scenarios.

The rest of the lecturers also concurred that implementing PBL can be quite challenging for them. They argued that PBL necessitates extensive preparation and effort on the part of the lecturers. Initially, it might be tough for the lecturers to relinquish control and transition into a facilitator role, guiding the students to pose appropriate questions instead of providing them with answers. This shift in approach requires a fundamental change in mindset and teaching style, which can be quite demanding for educators who are accustomed to more traditional methods of instruction.

Lecturer C mentioned facing challenges when applying PBL in teaching maths. Only lecturers who see PBL practices as beneficial for their professional development are positive in managing classroom instruction for PBL. Math lecturers can better handle PBL when they grasp the changed teacher role and view preparing for PBL as an opportunity for professional growth.

4.4 Lecturers' View Towards the PBL Challenges And Usefulness Applying In The University Level

Lecturers recommend strategies to overcome challenges in implementing PBL. They posit that the incorporation of PBL in mathematics classrooms necessitates lecturers' expertise in identifying and analyzing students' needs to establish a conducive learning environment that promotes peer interaction, the application of mathematical principles to real-world scenarios, and the construction of new knowledge through the utilization of existing knowledge. Lack of readiness or motivation among teachers can hinder the successful implementation of PBL. Therefore, all of them suggested that regular training, workshops, and seminars be instituted to equip lecturers with the requisite knowledge and comprehension of problem-based learning. Lecturers must partake in more extensive training opportunities, including hands-on training sessions.

Although the majority of individuals are still in the process of learning how to apply Problem-Based Learning (PBL), they highly recommend that all mathematics lecturers utilize this method to enhance students' academic achievements. Lecturer A suggests that the government should convert mathematics textbooks into a problem-based learning format, as traditional textbooks do not align with the problem-solving approach. Furthermore, teachers in primary and secondary schools should undergo training programs, seminars, and workshops to effectively implement the problem-solving method in their classrooms. To make PBL more effective, include real-world case studies or scenarios to tackle. Students can approach local communities or organizations to work on real-world problems. This approach can create a more engaging and collaborative learning experience.

University should continuously apply PBL in teaching math because PBL helps students be better problem solvers, demonstrating effective verbal and written communication skills and being able to work collaboratively. Encourages higher-order critical thinking and deemphasizes memorization. Increases motivation to learn to arrive at a solution.

5.0 CONCLUSION

The paper aims to shed light on lecturers' challenges and confidence related to PBL implementations. Teaching students using PBL has a positive effect on student content knowledge and the development of skills such as collaboration, critical thinking, problem-solving, and providing valuable insights into enhancing learning outcomes. Students in PBL classes reported the acquisition of skills such as interaction, problem-solving, self-confidence, self-direction, critical thinking, and teamwork. In addition to skill development, PBL promotes a deeper understanding, enhances theoretical knowledge, and encourages a profound approach to learning. It is because the PBL model required students to solve the problem by themselves, so students used their creativity and gained more confidence in solving mathematics problems. It is undeniable that applying PBL in teaching is challenging for lecturers. In this context, teachers are advised to establish a conducive learning atmosphere that fosters students' active participation in PBL endeavours and augments their educational progress. On the other hand, students need support including help setting up and directing initial inquiry, organizing their time to complete tasks, and integrating technology into projects in meaningful ways. Thus, PBL requires collaboration, reflection, and discussion of concepts between teachers and students, emphasizing the importance of both parties in the learning process, Strong support from staff and faculty, and students' and teachers' readiness appear to be the very important key ingredients for successful implementation of PBL in Malaysia. As a suggestion, further research could be undertaken to extensively assess learners' before (conventional methods) and during PBL model implementation in the teaching of mathematics.

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