

Navigating the Shift: Educator's Experiences in Implementing Problem-Based Learning in Inclusive Science Education

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ABSTRACT:

Problem-Based Learning (PBL) is an educational approach wherein real-world problems are used to promote student achievement and motivation. It sought to describe the experiences of science educators in designing and implementation of PBL, strategies employed in fostering collaboration, measurement of student progress and understanding in PBL contexts, the different professional development employed by science educators in enhancing PBL and impact of PBL on student motivation, engagement, and learning outcomes in science. Qualitative descriptive approach, was utilized in the study. Ten (10) science educators chosen through purposive sampling were interviewed. Clarke-Braun Reflexive Thematic Analysis was used in the treatment of the interview results. The research revealed that successful design and implementation require multifaceted approach, science educators connect learning objectives to real-world problems and utilized variation of teaching strategies to meet students' diverse need and to foster collaboration. Collaboration is achieved through group work and clearly defined goals. Assessment of student outcomes and problem-solving skills should be comprehensive, using formative, summative and authentic assessment. Furthermore, ongoing professional development is crucial for teachers to stay updated on effective PBL strategies, ultimately benefiting students' learning and growth. This continuous learning, in turn, directly impacts student outcomes, fostering holistic development, enhancing higher-order thinking skills, and increasing student engagement through the real-world relevance of PBL activities

Keywords: Problem-Based Learning, Inclusive Science Education; Science Educators

1. Introduction

Problem-Based Learning (PBL) is becoming more popular in inclusive science education as an effective teaching method that gets students involved in solving real-world problems. The goal of this method is to improve student's critical thinking, problem-solving, and teamwork skills,

helping learners' more involved in their learning. According to Gorghiu et al., (2015), improvement of the learner's understanding of science, motivation and engagement with materials leading to better learning outcomes. Using real-world examples and problems creates exciting and engaging experiences on the part o

the teachers, this in turn encourages students to imaginative and resourceful, equipping them to handle future challenges.

More and more science teachers considered the shift from traditional methods into student-centered approach like PBL in their teaching practices. In recent years, educators have found that Problem-based Learning enhances both the student's cognitive, psychomotor and affective learning domains. (Ajai et al., 2013; Funa & Prudente, 2021). Technology plays a significant contribution within the PBL frameworks, makes it more useful, letting learners discover science in more engaging and collaborative ways. With the changing landscape of inclusive science education, the focus on real-world relevance and student participation within PBL will likely transforms inclusive science education landscape. (Demirel & Dagyar, 2016; Yew & Goh, 2016).

Although Problem-based Learning (PBL) offers numerous benefits in inclusive science education, several issues remain, that can prevent PBL implementation effectively. The different level of preparedness of implementation of PBL is one of the major challenges encountered by science educators. Lack the necessary teachers' training in PBL methodologies, the inconsistency affects how the methods are used in the classroom (Allen, Donham, & Bernhardt, 2011). Furthermore, shifting to problem-based learning (PBL) requires substantial changes in how the classroom works in which educators and learners that are used to traditional practices will resist to the change. The transition can be confusing, resulting to unclear roles and expectation that may have a big impact on the students' learning experiences. (Gorghiu et al., 2015).

Students' varying levels of readiness and self-directed learning skills is also one of the pressing issues on the implementation of problem-based learning (PBL). While PBL aims to promote student independence and critical thinking skills, not all learners can thrive to the learning situation because they do not have the necessary skills to do it. Yew and Go (2016) discussed that students find it difficult to adjust to the open-ended problems and they feel worried on the

collaborative set ups that can negatively impact their engagement and achievement of learning outcomes. Additionally, Demirel and Dagyar pointed that assessment of student learning in the context of problem-based learning is also an issue, they even reiterated that traditional assessment cannot capture the depth and understanding and collaborative skills of the students that were developed in using the approach. Finding solutions to the challenges is very important in promoting effectiveness of the PBL in inclusive science education and ensures that students and teachers will benefit from PBL.

Designing and implementing PBL in science teaching is an important element that influence the teachers' experiences and the attainment of learning outcomes among students. Many teachers experienced difficulties in conceptualizing real-world problems that contextually related and aligned to the curriculum standard (Akay & Akay, 2015). Pepper (2010) mentioned that in order to achieve effectiveness in the implementation of PBL, teachers need to plan and adapt strategies and methods that are expected to foster critical thinking, problem-solving skills and collaboration among students. Moreover, the transition from traditional instruction to PBL necessitates the change of roles of the teachers from providing instructions to facilitation. This requires proper know how on the different techniques of designing and implementing problem-based activities (Demirel & Dagyar, 2016). Reynolds and Hancock (2010) added that attaining successful implementation of PBL requires supportive workplace and access to resources. By examining the design and implementation of the method, teachers will gain important insights in finding effective solutions as well as enhancement of their pedagogical strategies and achieve student engagement in science learning.

The transition from traditional teaching to Problem-based learning requires meticulous and comprehensive assessment of the varying strategies of educators in designing and implementing PBL activities. Some of the strategies that needs to be revisited are the specific approaches used by science educators in

fostering collaborative learning environments that are expected to produce positive interaction among students and peer-to-peer learning. Through evaluation of the impact of PBL strategies on student motivation, engagement and overall learning outcomes, teachers will be provided with vital insights into the proper techniques and methods in improving inclusive science education. Harun et al., (2012) revealed that the level students' motivation can be increased encouraging them to achieve deep learning through systematic motivation towards learning process in PBL. The study of Nemakhavhani (2024), revealed that student engagement was increased and the students' critical thinking and problem-solving skills. Additionally, PBL strategies was found to be effective and produce positive learning outcomes as revealed in the study of Loyens et al., (2015) that students engaged in PBL strategies manifested high level of motivations and improved their learning outcomes compared to those engaged in traditional settings.

The need for professional development among teachers is vital in ensuring proper implementation of the PBL strategies. Educators need to be updated on the current trends and issues regarding the implementation of PBL in science teaching. As educators engaged themselves into challenging task of being a facilitator, their pedagogical skills should be appropriate to achieve enhancement of the learning styles (Nilson, 2010). Professional development of teachers provides opportunities to collaborate, share strategies and reflect on the practices that may results to stronger commitment to the current and functional instructional practices.

According to Nemakhavhani (2024), PBL is considered to be the most popular strategies used in Higher education, Dolmans et al., (2016) agreed that this PBL strategies is one of the most prominent, in fact, he mentioned that PBL has been adopted across various courses and believed to effective in promoting student motivation and positive learning outcomes. However, despite the numerous studies proving the effectiveness of PBL strategies there is a need to conduct a further

study that focus on the lack of comprehensive understanding of educator's experiences during the transition from traditional method to PBL in higher education. Further studies related educators' resistance to change, the need for professional development to enhance their PBL strategies, necessity of developing appropriate assessment strategies for PBL. Moreover, most of the studies are applied to the medical education, the researcher thought that there is still limited studies related to its application of PBL strategies in Inclusive science education in the university context.

The study expected to provide best practices on the implementation of PBL in inclusive science education. Also, the researcher sought to provide insights into educators' concerns and motivation regarding PBL. Through this study it is hoped to bridge the gap between theory and practice and provide possible recommendations on the types of training that are beneficial for science educators. By researching the assessing experiences of teachers on the assessment student outcomes, engagement and motivation, educators will be informed on the best practices in PBL.

Therefore, this qualitative study aimed to explore how science educators describe their experiences in Problem-Based Learning in Science Teaching. Specifically, it seeks to find answers to the following research questions: (1) How do science educators design and implement problem-based learning activities? (2) What strategies do science educators employ to cultivate collaborative learning environments in PBL settings? (3) How do science educators measure student progress and understanding in problem-based learning contexts? (4) What professional development opportunities do inclusive science education use to enhance the PBL strategies? And (5) How do problem-based learning strategies impact student motivation, engagement, and learning outcomes in science courses?

2. Research Methodology

2.1. Research Design.

The research design employed in this research is qualitative descriptive methods. Qualitative

descriptive methods are well-suited for this study because they allow researchers to gather rich, in-depth insights into educators' experiences and perceptions regarding the implementation of Problem-Based Learning (PBL) in science teaching. This approach enables the exploration of diverse contexts and individual narratives, facilitating a comprehensive understanding of the complexities and nuances involved in navigating the shift toward more innovative teaching practices.

2.2. Participants

The participants of the study were chosen through purposive sampling technique. Sharma (2017) defined purposive sampling as judgmental, selective, or subjective sampling, reflects a group of sampling techniques that rely on the judgment of the researcher when it comes to selecting the units that are to be studied. The participants were chosen using the following inclusion criteria, the researcher selected the participants who are science educators employed in the university. Another criterion was used in choosing the participants was that the educators must integrates Problem-Based Learning in their lessons. A sample of ten (10) participants were utilized in the study because the saturation of responses of the participants was reached. Moreover, according to Saunders et al (2017), saturation of responses seems to follow a narrower, more individual-oriented viewpoint on data saturation, whereby saturation operates not at the level of the dataset as a whole, but in relation to the data generated by a single participant; i.e., it is accomplished at a specific point within an interview.

2.3. Data Collection Method

The researcher made use of semi-structured interview using interview guide. The data gathering procedure involved a meticulous approach to collecting information directly from educators. Through in-depth interviews, the researcher engaged science educators in structured conversations to explore their experiences in Problem-Based Learning in Science Teaching. The researcher interviewed the science teachers who engage PBL strategies in

one of the state universities in Pampanga. The researchers sought the permission of the dean of the College of Arts and Sciences in conducting the study. Following the consent from the authorities, the researchers requested permission from the participants provided the data privacy letter to affirm their consent to use their data in the study. The interview was done virtually following the availability of the participants, the interview lasted 10-15 minutes per participants, and the interview guide was also sent via google for the participants that were not available in the virtual interview. Further, there are participants who were interviewed personally on their convenient time.

2.4. Data Analysis

The researcher used reflexive thematic analysis to further examine the gathered data. As defined by Clarke and Braun, (2013), reflexive thematic analysis (RTA), was theoretically flexible method, moreover, the researcher used codes and themes in determining the findings of the data, as well as subjective interpretative method firmly within the collected data, at the context to properly determine the collected results. Verbatim transcription was used to capture the authenticity of responses. The interviews were conducted in English. Some responses are in Filipino language which was translated in English by the researcher.

3. Findings

Following the sequence of objectives the following findings are presented

3.1. Design and Implementation of PBL Activities

In this research, four (4) themes emerged on the designing and implementing PBL activities, namely: Focus on learning objectives and real-life scenarios, diverse approaches to meet student needs, inquiry-based process, collaboration and assessment strategies.

Theme 1. Focus on Learning Objectives and Real-Life Scenarios

One of the considerations of science educators in designing and implementing PBL activities is the focus of the activities on the learning outcomes

and its relevance to the real-life situations. Science educators highlight the importance of clearly defining learning objectives before creating realistic, context-driven scenarios.

Science educators indicate,

"I am starting to design by defining the objectives of the activities. Then, stating real-life scenarios can help in these activities" - PBL3.

"It is really important that you consider the alignment of the objectives to your activities so that students will be give clear ideas on what they are learning"- PBL 5

Theme 2. Diverse Approaches to Meet Student Needs

Different students possess different strategies in achieving learning. Students learn in different situation depending on what they need, want and expectations. In the light of considering individual differences among learners, the participants of the study emphasized that in designing and implementing PBL activities, they consider the varying needs, wants and expectations of the student, thus they adjust their approaches and strategies based on the varying characteristics of the students. As they shared:

"I usually use different approaches that cater to the needs of the students, utilizing research-based questions and giving scientific situational problems" -PBL2.

"There are students who would like to do the activity outside, some would like to do it inside. Other student would like to do oral activities; some student prefers to do it written" – PBL4

"I make sure I involve the students in designing my activities that is why it is important to ask the student first on their expectations so that when you plan your lessons or activities, their needs and wants are emphasized. –PBL6.

Theme 3. Collaboration

One of the competencies of the 21st century learners is collaboration. The teachers require to design and create an activity that are expected to foster collaborations among learners. Students need to perform activities in group so that they

will be able to learn the value of sharing and teamwork. The importance of collaborative work is consistently noted, as teachers design activities that require students to work together. The science teachers explain,

"I assign the students in groups so that they can work, collaborate and share ideas. They can also share information within their grouping. –PBL4

"I create relevant and challenging problems to be solved by the learners, then provide learning resources and let the learners work together" - PBL9.

Theme 4. Assessment Strategies

In designing PBL activities, assessment strategies are also important consideration, different teachers' uses different assessment strategies in assessing students. Assessment plays a significant role in the PBL framework. Science educators in the study commonly use peer assessments and reflective practices. Some participants use formative and summative assessments to evaluate student progress to ensure that learning objectives are met. The participants stated,

"I adopt varied assessment methods, including peer assessments and reflective practices"- PBL 3

"Providing continuous feedback and helping students develop self-directed learning capabilities is important in designing PBL activities." –PBL5

3.2. Strategies employed to foster collaboration in Problem-Based Learning (PBL)

Science educators employed varied strategies to promote collaborative learning environments in PBL settings. Three (3) themes emerged on the strategies they employed to foster collaboration in PBL, namely, creating diverse teams, assigning specific roles and responsibilities, and utilizing collaborative planning strategies.

Theme 1. Creating Diverse Teams

To foster collaboration in Problem-based learning, it is important to the educators to designate create a group that mix of perspective and abilities. Such grouping considers academic

strength, learning styles and gender. This is very crucial in ensuring that each member of the group understand what they can offer to the PBL activities, this will result to better collaboration and productivity.

The participants shared:

"I randomly assign students to groups. I make sure that the students will be distributed accordingly that way I can create a group with variations of talents and abilities"- PBL 2

"The students share what they know when they are grouped in a diverse team. I also give them activities that make sure they can share their unique skills"- PBL9

Theme 2. Assigning Specific Roles and Responsibilities

Collaboration is achieved when you assign specific roles among the members of the groups. In that way, students assigned to a specific role pays attention to the task assigned to them and this emphasize clear and distinct roles resulting to better collaboration. The participants in this study emphasize the importance of assigning clear roles to the students in a group. According to them when a student's role is specific, they are very willing to share what they think what they can offer to the group. Science educators shared:

"Students when grouped accordingly can share what they know if their roles is clear to them" – PBL2

"I group students and make sure that all of them can contribute to the project. I am instructing the group to designate leaders, secretary and other so that they will have responsibilities."-PBL4

. Theme 3. Utilizing Collaborative Planning Strategies

Collaborative planning strategies is an important technique that are used by the participants in fostering collaboration in problem-based strategies. The techniques involve involving both the teachers and students in identifying analyzing and developing complex problems that will lead the learning process. According to the participants, brainstorming and specifying roles and responsibilities is necessary to foster

collaborative set ups in the problem-based learning. The participants shared:

"I usually involve students in the defining the problem. I let them observe and let them feel the relevance of what they are doing"-PL3

"I let them do brainstorming and talk among themselves of the possible solutions to the problem"-PBL5

"I just give the instructions and serve as facilitator of the lesson. I let them plan on their own learning."-PBL9

3.3. Assessing student learning and problem-solving skills in Problem-Based Learning (PBL)

In this research the participants shared three (3) themes on how they assess student learning and problem-solving skills in Problem-Based Learning. The themes emerged are: Combination of assessment type, direct observation and formative assessments, and uses of rubrics for clarity and consistency.

Theme 1. Combination of Assessment Types

One of the assessment practices of the participants is the combination of assessment types. A comprehensive approach to assessment is crucial, as articulated by science educators:

"Assess student learning and problem-solving skills by using a combination of formative and summative assessments. Employ rubrics to evaluate the quality of their solutions, process, collaboration, and presentation, and incorporate self-assessments and peer feedback" -PBL3.

"I am using varied assessment methods, including peer evaluations and self-assessments." –PBL 7

Theme 2. Direct Observation and Formative Assessments

Direct observation and formative assessments are the most commonly used type of assessment used by the participants. Science educators emphasized the role of direct observation and formative assessments in assessing critical thinking:

"I usually observe the students on how they think critically. Also, by using formative assessments and authentic assessments with a set of criteria" - PBL2.

"Through direct observation, it is ensured that valuable insights into students' critical thinking and self-directed learning capabilities are provided." –PBL 4

Theme 3. Use of Rubrics for Clarity and Consistency

Science educators reiterated that the use of rubrics is really needed in order to assess performance-based assessment. The use of rubrics is consistently identified as a tool to ensure clear and consistent evaluation criteria. Science educators noted,

"When I Implement detailed rubrics, I know it can help us provide specific feedback aligned with performance standards and promotes mastery of science concepts." –PBL2

"In evaluating the groups' products and performances, the use of rubrics to determine whether the students have clearly communicated the problem, background, research methods, solutions, and resources" -PBL6.

3.4. Professional development opportunities that enhance skills in implementing Problem-Based Learning (PBL)

Through the different opportunities of professional development, science educators can assure that their knowledge and skills are enhanced. In the implementation of Problem-Based Learning (PBL), knowledge, tools and process of implementation are improved. The current study highlighted the significance of professional development opportunities in enhancing the science educator's implementation of PBL. Three (3) themes emerged on professional development opportunities such as: Diverse training and courses, seminars and collaborative learning and online learning and advanced degrees.

Theme 1. Diverse Training and Courses

To enhance the knowledge of the participants about Problem-based learning strategies, diverse

training and professional development courses are needed. Science educators expressed the importance of varied training in their growth:

"Different trainings and seminars can help in this matter. Personally, attending extra 18-unit methods of teaching courses boosts my development in different matters, including PBL" -PBL3.

"I know professional development programs not only enhance my understanding of PBL methodologies but also build my confidence in facilitating collaborative learning environments." PBL6

Theme 2. Seminars and Collaborative Learning

Science educators narrated that their knowledge about Problem-based learning is enhanced through seminars and collaborative learning in professional development opportunities.

The educators highlighted attending seminars and collaborative opportunities:

"Through collaborative discussions and practical workshops, I am sure that my knowledge about PBL will be improved." – PBL 3

"I have participated in various professional development opportunities such as workshops and conferences focused on PBL methodologies and best practices" -PBL10.

Theme 3. Online Learning and Advanced Degrees

Some participants shared that online learning offers them flexible and accessible professional development opportunities that provides enhancement of the teachers' skills in implementing problem-based learning (PBL) approaches. Some of the responses reflects a commitment to continuous education:

"Through advanced degree programs that incorporate PBL methodologies equip us with a deep understanding of constructivist learning principles. "–PBL2

"I have taken courses/trainings that will enhance my science teaching skills. I also enrolled in my doctorate degree" -PBL6.

3.5. Impact of Problem-Based Learning (PBL) on student motivation, engagement, and learning outcomes

Problem-based learning (PBL) significantly enhances student motivation, engagement, and learning outcomes by fostering active learning, critical thinking, and collaboration. There were three (3) themes emerged on the impact of PBL on student motivation, engagement, and learning outcomes. The themes are holistic development, higher order thinking skills and real-world-relevance.

Theme 1. Holistic Development

Problem-based learning promotes holistic development as emphasized on the narration of the participants. Science educators highlighted the comprehensive benefits of PBL:

"PBL, if done correctly, would have a great impact on the total development of our students" -PBL1.

"As my students engage in collaborative problem-solving, they develop critical thinking and self-directed learning skills, which are integral to their overall academic and personal development."-PBL4

Theme 2. Higher Order Thinking Skills

Higher order thinking skills (HOTS) are significantly fostered within problem-based learning (PBL) environments, as these approaches require students to analyze, evaluate, and create solutions to real-world problems. This active engagement not only enhances students' motivation to learn but also stimulates their intrinsic interest in the subject matter, leading to deeper comprehension and retention of knowledge. Consequently, the integration of

Science educators noted the specific cognitive benefits of PBL:

"Clearly, it motivates them to use higher order thinking skills" -PBL2.

"Using PBL strategies, students are motivated and they emphasize the value of HOTS (higher order thinking skills)." -PBL5

Theme 3. Real-World Relevance

The real-world relevance of Problem-Based Learning (PBL) significantly enhances student motivation and engagement by allowing learners to relate their studies to authentic problems and scenarios they may encounter outside the classroom. Some of the participants' perspective emphasizes the practical application of PBL:

"When my students engage with realistic issues, they are more likely to take ownership of their learning, resulting in improved critical thinking skills and a deeper understanding of the subject matter" -PBL 1

"The emphasis on real-world problems in PBL has been shown to positively impact learning outcomes." -PBL10

4. Discussion

Design and Implementation of PBL Activities

In the design and implementation of PBL activities the following are important considerations:

Alignment to the learning objectives and real-world situations is important in designing PBL activities. Mahajan et al., (2017) pointed the importance of the alignment of the activities and learning outcomes. Ensuring the alignment, teacher is assured of what the students will learn or achieved. Further, the integration of real-life problems results to students' active participation and ownership of their learning process, which is vital for attaining educational goals in a more meaningful way (Thomas, 2000). Sakir & Kim (2020) revealed in their study that students' learning activities and outcomes in biology were improved when they are given a clear view on what they have to learn in a certain activity. The participants of the study emphasized that aligning learning objectives with PBL activities ensures attainment of intended learning outcomes.

Variation of approaches in Problem-based learning (PBL) are vital for addressing the different needs of the learners. With such, the students will be given the chance to discover and developed the skills and talents they want

(Sheeba, 2019). Teachers use varied strategies in implementing PBL activities as Tawfik et al., (2020), affirmed that the use of PBL is considered by the learners to be an opportunity to be active agents in the learning process because their teachers design and use approaches that address their varying needs and wants.

Bagay et al., (2023), mentioned in their study that through collaborative activities students can engage with other students to share ideas and conduct brainstorming with them, collaboration allows learners to work together to talk about real-world problems and later on ensures the enhancement of their problem-solving skills and their critical skills. The participants of this study agree to the findings of Alrahlah (2016) that collaboration is an opportunity for the students to share ideas, knowledge and respect each other when they do activities in group. To consider learners as social beings they need to blend and mingle with their classmates to exchange ideas, information and knowledge.

Assessment strategies in Problem-Based Learning (PBL) focus on evaluating students' collaboration, critical thinking, and problem-solving skills rather than solely on traditional memorization (Bagay et al., 2023). According to van der Vleuten (2019) assessment strategies have been the agenda since the conception of problem-based learning. The type of assessment is based on the type of lessons that was presented that are always based on the learning outcomes. This statement agrees to the narration of participants about assessment strategies.

Strategies employed to foster collaboration in Problem-Based Learning (PBL)

When implementing PBL strategies science educators usually assign groups to foster collaboration. Nookong and Wanapiroon (2015) said that when students are in group students do not automatically develop problem-solving skills and critical thinking skills because at first students think individually in solving the given problems in PBL model. (Yew and Go, 2016) emphasized that when educators implement collaborative learning such as creative diverse team, students tend to manifest

collaborative skills upon grouping them into group that has diverse abilities and background (Amalia, 2018).

Assigning roles in collaborative learning activities is common practice among educators. In the study, participants find it beneficial to assign roles in the PBL activities because it fosters collaboration by specifying that each role is needed to accomplish such task in a particular PBL activities, this was supported by He et al., (2023) reiterating that in a collaborative learning study, each member has a role and that role is expected to contribute in the collaborative learning process.

To foster collaboration is to involve both the teachers and students in the conception and construction of the problem (He et al., 2023). The participants of the study emphasized that collaborative planning strategies is necessary to encourage students and teachers to foster collaboration through brainstorming and specifying their expertise.

Assessing student learning and problem-solving skills in Problem-Based Learning (PBL)

McDonalds, (2025) articulated that regular assessment of knowledge and competencies is important in PBL and it is gained throughout the curriculum. This strategy is important for them to effectively measure student progress and problem-solving skills quantifying learners' abilities and performance. (Sri., 2021). Using different assessment strategies to gain a holistic understanding of student capabilities. Science educators stated that through self-assessments and peer feedback, science educators can promote a collaborative environment where students reflect on both their contributions and those of their peers.

Science educators mentioned that direct observation and formative assessment are important strategies in evaluating student progress and problem-solving skills in problem-based learning (PBL) (Akçay, 2009). Norcici et al., (2018) mentioned that the effective implementation of constructive alignment, there is a need for a shift from traditional summative

assessment into authentic assessment. Science teachers further shared the importance of direct observation as an example of authentic assessment.

Brookhart (2013) pointed that the use of rubrics on the learning process, make the process more successful and goal-oriented. It is also noted that with proper guidance, learners will know how to learn from the rubrics and develop all the required skills for the task. Science educators explained that the use of rubrics provides clarity and consistency.

Professional development opportunities that enhance skills in implementing Problem-Based Learning (PBL)

Diverse training and courses are important for the educators to be equipped with the skills needed to effectively implement Problem-Based Learning (PBL) in their classroom (Gorghiu et al., 2015). The participants of the study narrated that the different trainings and courses helped them understand the implementation of Problem-based learning is their teaching career, thus making them confident in applying PBL strategies in their teaching. Moreover, the narratives of the participants illustrated how structured educational programs, such as targeted methods of teaching courses, can significantly improve an educator's ability to implement PBL effectively. By gaining certification or completing units focused on teaching methodologies, science educators are better equipped with the pedagogical tools necessary for facilitating PBL in their classrooms.

Attendance to the seminar and collaborative learning helps the participants enhance their application of PBL strategies. It is on these trainings, seminar that teachers are encouraged to share experiences, refine their problem-solving techniques, and collectively address challenges associated with PBL, thus enhancing their instructional skills. (Sheeba, 2019). In the study science teachers shared the role of collaborative learning environments where science educators can exchange ideas and strategies. According to them, workshops and seminars not only update teachers on current PBL practices but also foster

a community of practice that can provide ongoing support and shared experiences.

Pursuing advanced degrees and online learning opportunities plays a crucial role in professional development. These educational paths can deepen an educator's understanding of pedagogical theory as well as practical applications of PBL, ultimately benefiting student learning outcomes.

Impact of Problem-Based Learning (PBL) on student motivation, engagement, and learning outcomes

Akay (2009) mentioned that in holistic development in the PBL promotes functional approach that significantly increase emotional, social, and cognitive growth, leading to the enhancement of student motivation and engagement. Effective implementation of PBL can lead to more than just academic gains; it promotes overall student development. When students are engaged in PBL, they are not only acquiring knowledge but are also developing critical life skills, thereby enhancing their motivation to learn. Harun et al., (2012) revealed that the level students' motivation can be increased encouraging them to achieve deep learning through systematic motivation towards learning process in PBL.

Higher order thinking skills through PBL can markedly improve learning outcomes, equipping students with essential skills necessary for their future academic and professional endeavors (Sheeba, 2019). These observations of the science educator highlight how PBL encourages students to move beyond rote memorization, pushing them to analyze, evaluate, and create. By challenging students to think critically and solve complex problems, PBL fosters deeper cognitive engagement, which is essential for sustained motivation and improved learning outcomes.

In the study, science teachers mentioned that PBL not only makes learning more contextual and relevant but also helps students see the broader impact of their education on society. By working on real-world issues, students become more engaged and motivated, understanding that

their learning has direct implications for their communities and future endeavors.

5. Conclusion

In conclusion, successful implementation of Problem-based learning employs a comprehensive strategy. Science educators' highlights aligning of the learning objectives with real-life situations, utilizing varied teaching strategies to cater the needs of the students and promoting collaborations through activities in group and specifying roles and responsibilities. The participants use effective assessment strategies in PBL implementation such as formative, summative assessments and authentic assessment which are important in gauging students' abilities and problem-solving skills.

The study further highlights the importance of continuing professional development for science

educators. Diverse training, collaborative learning opportunities and access to online resources empowers teachers to enhance their PBL techniques and be informed with the current best practices. This continuous learning, in turn, directly impacts student outcomes, fostering holistic development, enhancing higher-order thinking skills, and increasing student engagement through the real-world relevance of PBL activities.

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