NEXUS
International Journal of Science and Education

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

Problem-Based Learning in Mathematics: Increasing Student Engagement

Mary Jeane L. Bonggo

Abstract. This study explored the strategies of teachers in teaching problem-based learning in Mathematics to increase student engagement. There were ten (10) teachers of Davao Central District, Division of Davao City who participated in the study. This study made use of a phenomenological approach to extract the ideas of the participants. The in-depth interview was employed to gather information with regard to their respective teaching strategies and coping mechanisms. Using the thematic analysis, the following themes emerged: the strategies of teachers dealt with selecting relevant problems, facilitating student inquiry, and adjusting the complexity. The identified coping mechanisms with the challenges were intensifying student engagement, adapting to varied learning styles, and ensuring equity in learning. The insights drawn from the findings of the study were contextualizing relevance, enhancing lifelong learning skills, and imposing intrinsic motivation. Results revealed that teachers as facilitators of learning should accommodate learners' diverse needs to increase student engagement. Providing them with engaging and interactive activities can also develop critical and problem-solving skills. Moreover, scaffolding the lessons and providing meaningful opportunities for all so that learners can make connections and increase engagement and understanding. To make this study meaningful, publication in a reputable journal is essential.

KEY WORDS

1. problem-based learning 2. Mathematics 3. student engagement

Date Received: May 21, 2024 — Date Reviewed: May 23, 2024 — Date Published: June 5, 2024

1. Introduction

Mathematics education has long been a topic of discussion, with educators constantly seeking ways to enhance student engagement and improve learning outcomes. One approach that has gained traction in recent years is Problem-Based Learning (PBL). The traditional approach to teaching mathematics often involves the transmission of knowledge from teacher to student through lectures and repetitive exercises. However, research has shown that this passive learning method can lead to disengagement, lack of motivation, and limited understanding of mathematical concepts. On the other hand, PBL offers an alternative approach that actively engages students in the learning process, fostering a deeper connection between theory and practice. Engaging students in math is a critical issue globally, and several countries have been implementing various strategies to improve math education and student engagement. The Programme for International Student Assessment (PISA) rankings often serve

as a benchmark for math education. Countries like Singapore, China, Japan, and South Korea have consistently ranked high in math achievement and engagement according to PISA assessments. These countries often emphasize problem-solving, critical thinking, and conceptual understanding in their math curriculum, as revealed by the OECD (2018). Socioeconomic status (SES) strongly influences math engagement and achievement. Students from disadvantaged backgrounds often face barriers such as limited access to resources, inadequate school facilities, and lack of parental support, which hinder their engagement in mathematics (Reardon et al., 2019). Countries like Canada and Norway implement policies aimed at reducing socioeconomic disparities in education, thereby improving math engagement among marginalized groups. This finding is congruent with the notion of the OECD (2020). The integration of technology in math education is a global trend that can enhance student engagement. Countries like the United States and South Korea leverage educational technologies such as interactive apps, simulations, and online platforms to make mathematics more interactive and accessible as mentioned by Suh Park (2019). However, ensuring equitable access to technology remains a challenge in many regions, particularly in developing countries (UNESCO, 2019). In Malaysia, the study by Mokhtar et al. (2019) showed that students have difficulty understanding the keywords fail to convert to the correct mathematical sentence, mathematics comprehension, and basic concepts, and do not like to read long questions. Narratives of mathematics difficulty were also reported in Indonesia, where students faced difficulties in solving numeracy problems, placing unit number values, and distinguishing the symbols of counting operations (Sakilah et al., 2018). In addition, it showed that students have a lack of interest in reading math problems or practicing mathematical skills. In the Philippines, students have difficulty in comprehension, selecting a strategy, computing the problem, and careless solving skills (Mangulabnan, 2016). Preclaro's (2019) study also showed that Filipino students have learning difficulties such as retrieving mathematics facts, mathematics language, and solving word problems. In addition, it revealed that students faced various challenges in learning mathematics, including difficulty in comprehending the problem, selecting a strategy, and careless solving skills. Student engagement in math is a critical issue in the Philippines, as it is in many other countries. One challenge is making the math curriculum more relevant and engaging for students. Incorporating real-life applications and contextualizing math problems can enhance student interest and understanding, as mentioned by David et al. (2020). Ensuring that math teachers are well-trained and equipped with effective teaching strategies is crucial for fostering student engagement. Professional development programs focusing on innovative teaching methods can be beneficial (Ong Reyes, 2021). Integrating technology, such as educational apps and online resources, into math instruction can make learning more interactive and engaging for students, particularly in remote or underserved areas (Cruz Santos, 2023). By addressing these issues and implementing evidence-based strategies, educators in the Philippines can work towards improving student engagement and achievement in mathematics. Hence, considering all the existing issues regarding student engagement in mathematics, the research opted to explore problem-based learning as a strategy for teachers to increase student engagement in mathematics.

1.1. Purpose of the Study—The study was a phenomenological inquiry that explored problem-based learning in mathematics. It aimed to investigate the effectiveness of problem-based learning

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

in increasing student engagement. Problem-based learning (PBL) is an educational method that focuses on engaging students in solving real-world problems, encouraging critical thinking, collaboration, and independent learning. By conducting a study on PBL in mathematics, the researcher assessed whether this approach enhances student engagement compared to traditional instructional methods. Student engagement refers to students' level of involvement, interest, and motivation in their learning activities. Engaged students are more likely to actively participate, persist in their tasks, and develop a deeper understanding of the subject matter. Hung, W. (2019) discusses the practical challenges and strategies for designing effective PBL activities. Teachers must create real-world problems that are relevant and engaging for students, ensuring that these problems are complex enough to challenge students' critical thinking and problem-solving skills. The study would typically involve implementing problem-based learning strategies in a mathematics classroom and collecting data to measure student engagement. Data may be collected through observations, surveys, interviews, or assessments designed to gauge students' attitudes, behaviors, and perceptions toward mathematics and their learning experiences. The researcher also compared the engagement levels of students who receive problem-based instruction with those who receive traditional instruction. The study's findings may provide valuable insights into the effectiveness of problem-based learning in mathematics and its impact on student engagement. This information may help educators and policymakers make informed decisions about instructional practices and curriculum design to improve student's learning experiences and outcomes in mathematics.

1.2. Research Questions—In line to explore the strategies of teachers in teaching problem-based learning in mathematics, including the coping mechanisms with the challenges that they encountered, this study specifically sought answers to the following research questions:

(1) What are the strategies of teachers in teaching problem-based learning in mathematics?
(2) How do teachers cope with the challenges encountered in problem-based learning in Mathematics?
(3) What insights can be drawn from problem-based learning in Mathematics?

1.3. Definition of Terms—To fully understand the terms used in this study, the following are defined operationally: Problem-based learning (PBL). It was a teaching strategy in which teachers present content using real-world examples and scenarios. It is a strategy that organizes mathematics teaching around problem-solving activities with opportunities to think critically, present their own creative ideas, and communicate mathematically. Student engagement refers to the degree of attention, curiosity, interest, optimism, and passion that students show when they are learning or being taught.

1.4. Significant of the Study—Problem-based learning in mathematics can enhance students' mathematical learning experiences and outcomes and provide insights for educators and policymakers on effective instructional approaches in mathematics education. This study may find significance in the following: Department of Education. By incorporating PBL as a teaching and learning strategy, the department may encourage educators to design math lessons that revolve around real-world problems, fostering student engagement and critical thinking skills. The department may provide professional development opportunities for teachers to enhance their understanding and implementation of PBL in mathematics. School admin-

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

istrators. School administrators may advocate for and support the implementation of PBL in mathematics by promoting its benefits to teachers, parents, and the wider school community. They may allocate resources, provide professional development opportunities, and create a supportive environment for teachers to adopt PBL practices. Administrators may ensure that the school's mathematics curriculum aligns with the principles and goals of PBL. Administrators may organize professional development workshops, seminars, or coaching sessions to train teachers in PBL pedagogy and strategies specific to mathematics. They may also facilitate collaborative planning and sharing of best practices among teachers, creating opportunities for them to learn from each other's experiences and refine their PBL implementation. Teachers. Teachers act as facilitators, guiding students through the problem-solving process. They may provide support and resources, encourage critical thinking, and help students make connections between concepts. By offering guidance, teachers may ensure that students remain on track and meet the learning objectives. Teachers may select relevant and challenging problems that align with the learning objectives. Parents. Parents may provide a positive and supportive environment by encouraging their child's efforts in problem-solving and expressing belief in their ability to succeed. This motivation helps students develop a growth mindset and fosters a sense of engagement and perseverance. Parents may actively participate in their child's mathematical learning process. They may discuss math problems, ask probing questions, and show interest in their child's problem-solving strategies. Students. In PBL, students actively participate in solving authentic, meaningful mathematical problems. They may engage in inquiry, critical thinking, and problem-solving skills, which enhances their interest and motivation in the subject. PBL promotes collaborative learning, where students work together in small groups to solve problems. They may discuss ideas, share strategies, and learn from one another.

1.5. Theoretical Lens—This study dealt with the perspective of problem-based learning in mathematics as a way to increase student engagement. It was based on the Socio-Constructivism Theory - Lev Vygotsky: Lev Vygotsky was a Soviet psychologist who introduced the socio-constructivism theory. According to this theory, learning is a social process that occurs through interactions with others. In the context of PBL in mathematics, students collaborate and communicate with their peers, teachers, and experts to solve complex problems. By engaging in discussions and sharing their perspectives, students can construct mathematical knowledge and develop higher-order thinking skills. Social constructivism focuses on the collaborative nature of learning. Knowledge develops from how people interact with each other, their culture, and society at large. Students rely on others to help create their building blocks, and learning from others helps them construct their own knowledge and reality. Social constructivism was a learning theory propounded by Lev Vygotsky in 1968. The theory states that language and culture are the frameworks through which humans experience, communicate, and understand reality. According to Vygotsky, language and culture play essential roles both in human intellectual development and in how humans perceive the world. This is to say that learning concepts are transmitted by means of language, interpreted, and understood by experience and interactions within a cultural setting. Since it takes a group of people to have language and culture to construct cognitive structures, knowledge, therefore, is

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

not only socially constructed but co-constructed. The link here is that while the constructivist sees knowledge as what students construct by themselves based on the experiences they gather from their environment, the social constructivist sees knowledge as what students do in collaboration with other students, teachers and peers. Social constructivism describes as variety of cognitive constructivism that emphasizes the collaborative nature of learning under the guidance of a facilitator or in collaboration with other students. In social constructivism, children's understanding is shaped not only through adaptive encounters with the physical world but also through interactions between people in relation to a world that is not merely physical and apprehended by the senses but cultural, meaningful, and significant, and made so primarily by language. Social Constructivism recognizes the social aspect of learning and the use of conversation, interaction with others, and the application of knowledge as an essential aspect of learning and a means to achieving learning objectives. Vygotsky believed that the lifelong process of development is dependent on social interaction and that social learning actually leads to cognitive development. In other words, all learning tasks (irrespective of the level of difficulty), can be performed by learners under adult guidance or with peer collaboration. This theory helps to give a backup to the establishment of opportunities for students to collaborate with the teacher and peers in constructing knowledge and understanding. Social constructivism was also called collaborative learning because it was based on interaction, discussion, and sharing among students. This teaching strategy allows for a range of groupings and interactive methods. These may include total class discussions, small group discussions, or students working in pairs on given projects or assignments. The underlying factor of the theory is that learners work in groups sharing ideas, brainstorming, trying to discover cause and effect, finding answers to problems, or just creating something new to add to existing knowledge. This is also supported by Cognitive Load Theory (CLT). This was developed by educational psychologist John Sweller (2011). It was a theoretical framework that aimed to understand how the human mind processes information and how this impacts learning. The core idea behind CLT was that the capacity of working memory was limited, and when learners are presented with new information, they face a cognitive load - the mental effort required to process that information. In other words, this theory focuses on the limitations of working memory and suggests that effective learning occurs when cognitive load is managed appropriately. PBL tasks that were challenging but not overwhelming could help optimize cognitive load (Sweller, 1988). Shown in Figure 1 was the interconnection between the two research questions, the Lived experiences of Strategies of teachers in teaching problem-based learning in mathematics, and the coping mechanisms of teachers with the challenges in teaching problem-based learning in mathematics that would result in the common denominator which is Insights Learned from the experiences of Insights drawn from the findings of the study on problem-based learning in mathematics.

2. Methodology

This chapter discusses the research design, the role of the researcher, the research participants, the data collection and analysis, the trustworthiness, and the ethical considerations of the study. The three most common qualitative methods are participant observation, in-depth interviews, and focus groups. Each method was particularly suited for obtaining a specific type of data.

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

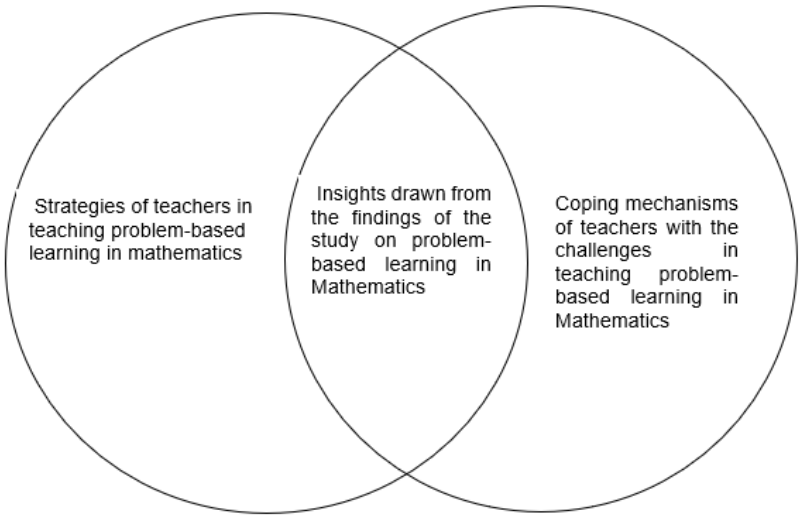

Fig. 1. The Conceptual Framework of the Study

Participant observation is appropriate for collecting data on naturally occurring behaviors in their usual contexts. In-depth Interviews (IDI) were optimal for collecting data on individuals' personal histories, perspectives, and experiences, particularly when sensitive topics are being explored. Focus groups are effective in eliciting data on the cultural norms of a group and in generating broad overviews of issues of concern to the cultural groups or subgroups represented. Patton (2002) defines phenomenology as an inquiry that asks the question," What is the structure and essence of the experience of his phenomenon for these people? "The goal of this research worked well with this definition in trying to understand the experiences of teachers while employing strategies in teaching problem-based learning in Mathematics. Giorgi (2007) cautioned researchers to be prepared for an investigation that is greater in both depth and breadth than the offered description implied. He suggested information be viewed as only the tip of the iceberg.

2.1. Philosophical Assumptions—A philosophical assumption is a framework used to collect, analyze, and interpret data in a specific field of study. It establishes the background used to reach conclusions and decisions. Typical philosophical assumptions have different types and were elaborated. A good research undertaking begins with the selection of the topic, problem, or area of interest, as well as the paradigm. Stanage (1987) traces 'paradigm ' back to its Greek (paradigm) and Latin origins (paradigm), meaning pattern, model, or example among examples, an exemplar or model to follow according to which design actions are taken. Differently stated, a paradigm is an action of submitting to a view. This view is supported by Denzin and Lincoln (2000), who defend a research paradigm as a "basic set of beliefs that guide action", dealing with first principles, "ultimate's or the researcher's worldview or philosophy. Ontology. This part of the research pertains to how the issue relates to the nature of reality. According to Creswell (2012), reality was subjective and multiple, as seen by participants in the study. The ontological issue addresses the nature of reality for the qualitative researcher. Reality is constructed by individuals involved in the research situation. Thus, multiple realists exist, such as the realities of the researcher, those of individuals being investigated, and those of the reader or audiences interpreting the study. In this study, realities on the strategies of teach-

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

ers were discussed by the participants and tried to look into their ways in coping with the challenges. In this study, I relied on the voices and interpretations of the participants through extensive quotes and themes that reflected their words and provided evidence of different perspectives. The answers of the participants to the study were coded and analyzed to build and construct the commonality and discreteness of responses. I made sure that the responses of the participants were carefully coded to ensure the reliability of the result. The researcher upheld the authenticity of the responses and precluded from making personal bias as the study progressed. Epistemology. This refers to the awareness of how knowledge claims are justified by staying as close to the participants as possible during the study in order to obtain firsthand information. Guba and Lincoln (1985), as cited by Creswell (2013), state that on the epistemological assumption, the researcher attempted to lessen distance himself or herself from the participants. He suggests that being a researcher he or she collaborates, spends time in the field with participants, and becomes an "insider" based on Davidson (2000) and Jones (2011). I identified phenomenology with thematic analysis as the best means for this type of study. In this regard, individual researchers "hold explicit belief." The intention of this study is to gather information from the participants or the teachers who employed problem-based learning as a teaching strategy. I assured that I would establish a close interaction with the participants to gain direct information that shed light on the knowledge behind the inquiry, particularly on the experiences and challenges of the teachers employing problem-based learning to increase student engagement. Axiology refers to the role of values in research. Creswell (2013) avers that the role of values in a study is significant. Axiology suggests that the researcher openly discusses values that shape the narrative and includes their own interpretation in conjunction with the interpretation of participants. I upheld the dignity and value of every detail of information obtained from the participants. The researcher understood the personal and value-laden nature of the information gathered from the study. Therefore, I preserved the merit of the participants' answers and carefully interpreted them in the light of the participants' personal interpretations. Rhetorics. This philosophical assumption stressed that the researcher may write in a literary, informal style using the personal voice, qualitative terms, and limited definitions. In the study, the researcher used the first person to elucidate the teachers' experiences as they employed strategies for teaching problem-based learning in class.

2.2. Qualitative Assumptions—The methodology was different from the method. The methodology was a creative and responsive approach to understanding questions and subject matter, while the method refers to the exact knowledge and procedure (Gerodias, 2013). In this study the strategies of the teachers employing problem-based learning were gathered through an In-Depth Interview (IDI) as well as the coping mechanisms with the challenges were extracted from the participants. The researcher's inquisitiveness on the experiences of the teachers as they employed problem-based learning became the basis for doing qualitative research, a means which Kalof and Dietz (2008), as cited from Gerodias, (2013) considered helpful in looking for "meanings and motivations that underline cultural symbols, personal experiences, and phenomena". By using phenomenology, this need was hoped to be addressed by bringing the stories of the parents in a manner that, as David (2005) wrote, the themes, symbols, and meaning of the experiences was presented. Phenomenological

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

research is based on two premises. The first is that experience was a valid, rich, and rewarding source of knowledge. According to Becker (1992), as cited in Morrissey Higgs, (2006), that experience is a source of knowledge and shapes one's behavior. From the definition, human experience was viewed as a cornerstone of knowledge about human phenomena and not as an unreliable source. The second premise of phenomenological research lies in the view that the everyday world is a valuable and productive source of knowledge and that we could learn much about ourselves and reap key insights into the nature of an event by analyzing how it occurs in our daily lives (Morrissey Higgs, 2006). By using phenomenology, which concerns the "what" and the "how" (Moustakas, 1995), the researcher hoped that the subjective experiences and perspectives of the participants, who happened to be teachers, would provide highlights as to how this problem-based learning increased engagement.

2.3. Design and Procedure—This study used qualitative research employing phenomenology. Interviews were conducted with a group of individuals who have first-hand knowledge of an event, situation, or experience. The interview(s) attempts to answer two broad questions (Moustakas, 1994). The data was then read and reread, and culled for phrases and themes that were then grouped to form clusters of meaning (Creswell, 2013). Through this process the researcher constructed the universal meaning of the event, situation or experiences and arrived at a more profound understanding of the phenomenon. In this study, phenomenology attempted to extract the most pure, untainted data and in some interpretations of the approach, bracketing was used by the researcher to document personal experiences with the subject to help remove him or herself from the process. One method of bracketing was memoing (Maxwell, 2013).

2.4. Research Participants—The participants in this study were composed of ten (10) informants. The selected informants were elementary Mathematics teachers from the Intermediate Level of Davao Central District, male or female, and had been in the service for at least 3 years and above with a very satisfactory / performance rating for three consecutive years. Qualitative analyses typically require a smaller sample size the quantitative analyses. Qualitative sample sizes should be large enough to obtain feedback for most or all perceptions. Obtaining most or all of the perceptions would lead to the attainment of saturation. Saturation occurs when adding more participants to the study does not result in additional perspectives or information. Glaser and Strauss (1967) recommend the concept of saturation for achieving an appropriate sample size in qualitative studies. For phenomenological studies, Creswell (1998) recommends five (5) to 25 and Morse (1994) suggests at least six (6). There are no specific rules when determining an appropriate sample size in qualitative research. Qualitative sample size may best be determined by the time allotted, resources available, and study objectives (Patton, 1990). Research Instrument I used an in-depth interview questionnaire to collect data and developed the interview questionnaire for the participants to answer. Experts were consulted to validate the researcher-made interview questionnaire, which underwent several procedures to accommodate their suggestions. Language and the conceptual levels of questions were considered to suit participants' understanding. The suitability of the items to the research

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

design, which excludes leading questions, and the alignment of the interview questions to the study's objective were also validated. The research interview aimed to explore teachers' experiences in employing strategies in problem-based learning to increase student engagement. Qualitative methods, like interviews, could help people comprehend social issues more deeply than merely quantitative approaches, like questionnaires (Stewart et al., 2008).

2.5. Ethical Considerations—Ethical considerations were of paramount importance in the design of this research study. The researcher needed to consider several ethical issues about the research participant groups addressed in this fieldwork. Ethical considerations could be specified as one of the most critical parts of the research. The researcher must also adhere to promoting the aims of the research, imparting factual knowledge, truth, and prevention of error. Social Value. Research was essential to society. In this study, the social value focuses on the experiences of teachers who employed strategies for problem-based learning. Thus, the social problem that pushed the interest of the researcher was the challenges faced by the teachers while employing problem-based learning. This study could serve as a basis for the higher authorities to create more programs and resolutions where the school and the stakeholders could benefit. Informed Consent. Gaining the trust and support of research participants was critical to informed and ethical academic inquiry and phenomenological research (Walker, 2007 as cited by Pellerin, 2012). All participants were given an informed consent form before scheduling the interviews and participating in the phenomenological research process. Each participant was required to provide a signed personal acknowledgment, consent, and an indication of a willingness to participate in the study release. The purpose of the informed consent letter was to introduce the research effort, provide contact information, articulate the intent of the study, request voluntary participation by the recipients, and identify the anticipated information that the informants were expected to provide. All participants were required to sign and return the letter of consent to the researcher before participating in the research. In the conduct and practice of this study, the Treaty Principle of Participation, as cited by McLeod (2009), was adhered to. The invitation to participate ensured that participation in the research was entirely voluntary in nature, and based on an understanding of adequate information. The participant recruitment and selection were lodged in the appendices of this study. The Vulnerability of Research Participants. The participants of this study were deemed capable of answering the research instrument for they were all professional teachers. Thus, the researcher ensured that participants could easily be reached through their contact number and address in case there were some clarifications or questions about the study. Risks, Benefits, and Safety. The recruitment of the respondents was free of coercion, undue influence, or inducement. Moreover, respondents were provided with the contact numbers of the chair of the panel or panel members in case they had queries related to the study. This was done to answer possible questions of the respondents. Furthermore, if respondents experienced possible discomfort and inconvenience while answering the questions, they were not compelled to participate in any manner. Further, the researcher had to ensure that the respondents were safe during the conduct of the survey and interview. Thus, the distribution of the questionnaire was conducted in a safe venue and administered at a convenient time. The dominant concern of this study was the Treaty Principle of Protection, as reflected in the respect for the rights of privacy and confi-

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

dentiality, and minimization of risk. This was done by assigning pseudonyms for each informant so as not to disclose their identity. The possibility of a degree of risk inherent to this was minimized by taking all reasonable steps to guarantee participant confidentiality. Privacy and Confidentiality of Information. This study observed the Data Privacy Act of 2002 to ensure that the data cannot be traced back to their real sources to protect participants' identities. Thus, utmost care was taken to ensure the anonymity of the data sources. Hence, any printed outputs that were carried out from this study were kept in anonymity. Furthermore, all the issues were given consideration so that there would be no conflict of interest among the researcher and the respondents. Any type of misleading information, as well as representation of primary data findings in a biased way, were avoided. Justice. The respondents were informed of the researcher's role and their corresponding role during data gathering. They were then briefed that they had to be fully honest in answering the survey questions and that any type of communication about the research was done with honesty. Similarly, they were informed that they were the ones to benefit first from the study's results. Transparency. The results of the study could then be accessed by the respondents and heads of the participating schools because the information is available and is placed on CD or other storage devices, which can be requested from the researcher to provide. Also, by learning about the results of the study, classroom teachers would be aware of the significance of the study and its contribution to their personal and professional development. Further, each of the participants was advised that they had the right to withdraw their information at any time up to the completion of the data collection process and that they could request to be allowed to verify their transcript after the interview was carried out. The participants were provided with the opportunity to amend or remove any information which they felt might identify them. The researcher reserved the right to employ the use of pseudonyms, and changing names and/or non-significant dates in the interest of the protection of the identity of the participant in all subsequent data analysis and reporting. Qualification of the Researcher. The researcher ensured that he/she had the needed qualifications to conduct the study. The researcher had completed the academic requirements, passed the comprehensive examination before thesis writing, which was the last requirement to obtain the researcher's master's degree, and was qualified to conduct the study physically, mentally, emotionally, and financially. Also, the advisee-adviser tandem ensured that the study would reach its completion. Adequacy of Facilities. The researcher strove to complete the study successfully within the specified time and that he/she was equipped with the necessary resources. Likewise, the technical committee would help enhance the paper by giving the needed suggestions and recommendations. The researcher also had to ensure that she/he had enough funds to continue and finish the research. Community Involvement. The researcher showed respect for the local traditions, culture, and views of the respondents in this study. Moreover, this study would not involve any use of deceit in any stage of its implementation, specifically in the recruitment of the participants or methods of data collection. Furthermore, the researcher deemed it necessary to express their great pleasure for their wholehearted participation in the conduct of this study. Plagiarism and Fabrication as the researcher. The researcher respected other works by adequately citing the author and rewriting what someone else has said in their own way. Understood the context of the study and avoided copying–and pasting the text verbatim from the reference paper. Used quotes to indicate that the text had been taken from another paper. Similarly, he/she would assure them that honesty was s evident in working on the manuscript and

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

that there was no intentional misrepresentation in the study and making up of data and/or results or purposefully putting forward conclusions that were not accurate.

2.6. Role of the Researcher—The researcher's role in this study was to attempt to access the thoughts and feelings of study participants. This involved asking informants to talk about things that were very personal to them. Sometimes, the experiences being explored were fresh in the participant's mind, whereas on other occasions, reliving past experiences would be difficult. The primary responsibility of the researcher was to safeguard participants and their data. Mechanisms for such safeguarding were clearly articulated to participants and approved by a relevant research ethics review board before the research began.

2.7. Data Collection—The following was the step-by-step process of gathering the data needed. Securing endorsement. The researcher provided an ethics compliance certificate from the Dean of the Graduate School of Rizal Memorial Colleges to pursue the study in the 2nd week of November 2023. Asking permission from the Schools Division Superintendent. The researcher asked permission from the Schools Division Superintendent to conduct the study on the 1st week of December 2023 in the identified schools. The researcher sent a letter addressed to the Schools Division Superintendent with the attached Chapters 1 and 2 together with the research instrument, which explained the objectives of the study and the identification of the participants. The researcher waited for the response of the SDS before the conduct of it. Asking permission from the school heads. After securing the approval of the SDS, the researcher sent letters to the principals of the schools explaining the study to be conducted in their schools during the second and third weeks of December 2023. Obtaining consent from the participants. The researcher asked permission from the participants. During the first week of January 2024, they were formally oriented about the study and the process they would undergo as participants. Conducting the interview. The researcher conducted the in-depth interview using the interview questionnaire during the second and third weeks of January 2024. The profile of the participants was taken, notes were jotted down, and conversations were recorded using a sound recorder for ease of transcription. The researcher carefully listened and responded actively during the interviews. Transcribing the responses of the interviewees. The researcher transcribed the interviewees' responses precisely by recalling their answers from the sound recorder on the fourth week of January 2024. Data Coding and Thematizing. After the transcription, the data were categorized and coded for the whole month of February 2024. Then, themes were extracted, and individual data within the participants were compared and contrasted to come up with patterns and trends.

2.8. Data Analysis—In this study, thematic analysis was utilized to analyze the gathered data. The researcher analyzed the answers of the participants from the conducted interviews using Creswell's Model, specifically the identifying of themes approach. According to Creswell (2012), themes in qualitative research are similar codes aggregated together to form a major idea in the database. Familiarization with the data is common to all forms of qualitative analysis. The researcher immersed herself in and became intimately familiar with their data,

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

reading and re-reading it and noting any initial analytic observations. Coding was also a common element of many approaches to qualitative analysis, involving generating pithy labels for important features of the data of relevance to the (broad) research question guiding the analysis. Coding is not simply a data reduction method; it is also an analytic process, so codes capture both a semantic and conceptual reading of the data. The researcher coded every data item and ended this phase by collating all their codes and relevant data extracts. Searching for themes was the coherent and meaningful pattern in the data relevant to the research question. The researcher ended this phase by collating all the coded data relevant to each theme. Reviewing themes. The researcher reflected on whether the themes tell a convincing and compelling story about the data and began to define the nature of each individual theme and the relationship between the themes. Defining and naming themes: The researcher prepared a detailed analysis of each theme, identifying the 'essence' of each theme and constructing a concise, punchy, and informative name for each theme. Writing up involves weaving together the analytic narrative and data extracts to tell the reader a coherent and persuasive story about the data and contextualizing it in relation to existing literature.

2.9. Framework of Analysis—According to Braun and Clark (2006) methods of qualitative data analysis fall in two groups. The first group consists of methods driven by an epistemological or theoretical position, which have limited variability in how they are applied within their frameworks, such as conversation analysis (CA) and interpretative phenomenological analysis (IPA) and methods which are situated within a broad theoretical framework and can therefore be used in a variety of ways within those frameworks , such as grounded theory (GT), discourse analysis (DA) narrative analysis (NA). The second group includes methods independent of theory and epistemology, which can be applied across a range of different theoretical and epistemological approaches and are, therefore, very flexible. One such method is thematic analysis, which, through theoretical freedom, "provides flexible and useful research tool, which can potentially provide a rich and detailed, yet complex account of data (Braun and Clark, 2006). I observed several steps in conducting a thematic analysis. The first stage in extracting qualitative data for analysis from the tape recordings was transcription. This was done to gain greater familiarity with the data and deeper insight. I relied on my own resources to do the transcription with the use of my personal computer and some reliable headphones. I spent several nights to listen to the interviews to deepen my understanding on the nuances of the language and semantics of the participants. Practice varied considerably in terms of agreeing conventions with transcribers. Some negotiated themselves to lay-out and conventions required, including researchers who wanted the kind of detailed transcriptions appropriate for conversations or narrative analysis. Others were sometimes less directly involved, and accepted the conventions generally used by the one transcribing the information. The next step as data extraction and analysis. I used manual techniques based on note taking and summary while listening to the recordings. My manual technique usually included some process of verbatim recordings of selected spoken words. I selected quotations about central issues, or when what was said seemed important or interesting. I used a number of different techniques as taught to me by my thesis adviser. I marked up transcripts with colored pens or sorted data by cutting and pasting. I used forms of thematic grids and charts, the framework technique as

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

developed by the National Centre for Social Research (Ritchie et al., 2003). This technique was useful to me in the process of coding, sorting, and collecting data for interrogation. This technique was very useful in understanding links and relationships between issues. All these efforts and procedures included saving verbatim spoken words from the transcripts, which could be cross-referenced to the thematic displays or the maps. To summarize, Braun and Clarke (2006) outlined a thematic analysis method that consisted of six phases for analyzing the data. I familiarized myself with the data by reading the whole data set and noting down initial ideas; I generated initial codes, with code being the most essential segment of the raw data that can identify a feature of the data that appears attractive; I searched for themes by sorting different codes into potential themes and collated all data extracts within identified themes; I reviewed the themes and refined them further (at the level of coded data extracts and the entire data set) and produced a thematic map showing relationships between themes and sub-themes; I defined and named themes, making sure they give the reader immediate sense of what the theme is all about, and I wrote the report to convince the reader of the merit and validity of the analysis (within and across the themes). I used data extracts embedded within an analytic narrative to make arguments related to the research question.

2.10. Trustworthiness of the Study—Trustworthiness was all about establishing credibility, transferability, confirmability, and dependability. In qualitative studies, trustworthiness was significant. Because the research study's results and findings depend on the researcher's conduct. The trustworthiness of a research study was essential to evaluate its worth. Due to the nature of the qualitative study, honesty in all the data and details was required. Trustworthiness made the researcher's study worthy of reading, sharing, and being proud of. Credibility was how confident the qualitative researcher was in the truth of the research study's findings. The researcher in this study believed that honesty in everything she did was essential to attain worthwhile success. The researcher had no derogatory records or administrative issues, which ruined her integrity. Lincoln and Guba (2000) stated that credibility refers to the idea of internal consistency, where the main issue was "how we ensure rigor in the research process and how we communicate to others that we have done so." Transferability was how the qualitative researcher demonstrated that the research study's findings were applied to other contexts. In this case, "other contexts" could mean similar situations, similar populations, and similar phenomena. Gasson (2004) emphasizes transferability as the extent to which the reader could provide a generalization of the study based on his context and could address the core issue of "how far a researcher may make claims for a general application of the theory." Confirmability was the degree of neutrality in the research study's findings. In other words, this means that the findings were based on participants' responses and not the researcher's potential bias or personal motivations. This involves ensuring that researcher bias does not skew the interpretation of what the research participants said to fit a particular narrative. The information used in the audit trail in this situation is thoughtfully recorded by the researcher, which highlights every step of data analysis that was made in order to provide a rationale for the decisions made. This helps establish that the research study's findings accurately portray participants' responses. Gasson (2004) states that confirmability is based on the acknowledgment that research was never objective. Dependability was the extent to which other researchers could re-

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

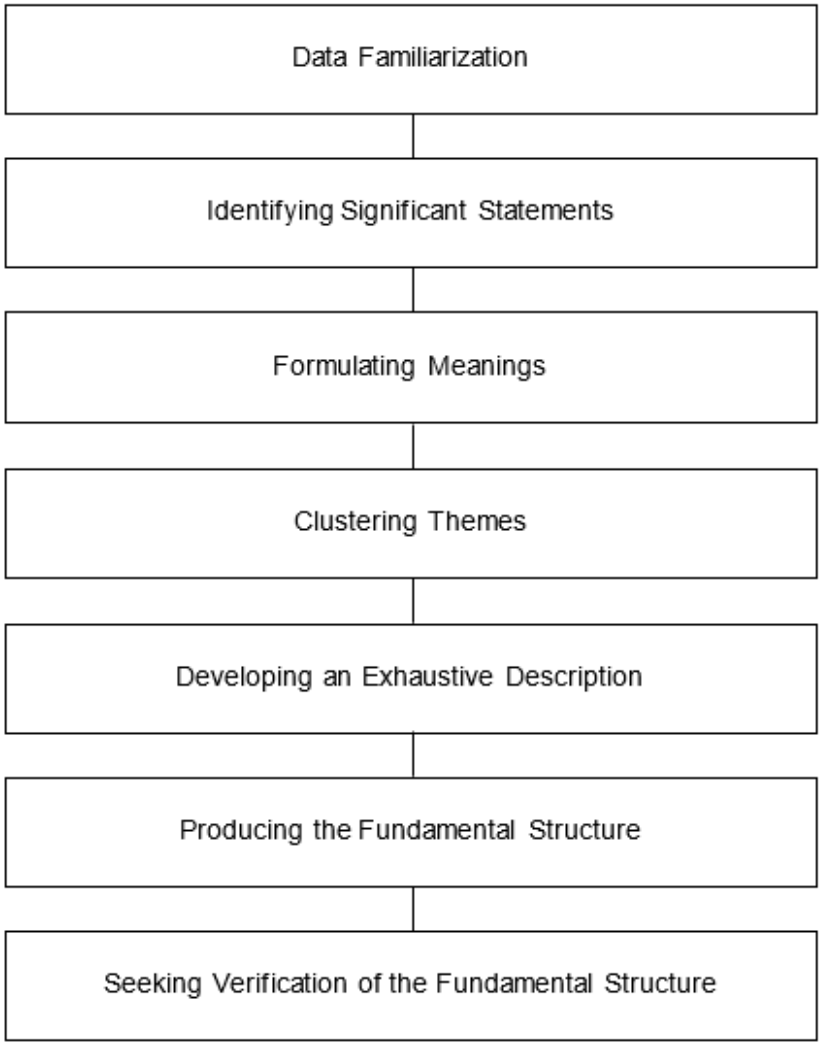

Fig. 2. Analytical Framework of the Study

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

peat the study and ensure that the findings were consistent. In other words, if a person wanted to replicate your study, they should have enough information from your research report to do so and obtain similar findings as your study did. A qualitative researcher could use an inquiry audit to establish dependability, which requires an outside person to review and examine the research process. The data analysis ensured that the findings were consistent and could be repeated. In this component, using the database was crucial in backing up information collected and noting changes for all types of research studies. All the data collected must be kept appropriately for future use as references. Gasson (2004) states that dependability deals with the core issue of "how a study was conducted should be consistent across time, researchers, and analysis techniques."

3. Results and Discussion

This chapter presents and discusses the study's results regarding its aim and the themes that emerged from the data gathered. The results present the description and background of the participants assigned to pseudonyms to conceal their identity.

3.1. Strategies of teachers in teaching problem-based Learning in Mathematics— Problem-Based Learning (PBL) is an instructional approach that places students as problem solvers and encourages active, inquiry-based learning. Increasing student engagement in a PBL environment involves employing various strategies to stimulate curiosity, foster collaboration, and promote critical thinking.

3.1.1. Selecting Relevant Problems—. The participants describe that in problem-based learning (PBL), selecting relevant problems is a fundamental step that shapes the entire learning experience for students. PBL is an instructional approach that places students in the role of active problem solvers, where they work collaboratively to investigate and solve complex, real-world problems. The selection of relevant problems is crucial for capturing students' interest, fostering motivation, and ensuring that the learning outcomes align with educational objectives. PBL emphasizes real-world problems that have practical applications in students' lives or future careers. These problems should reflect authentic challenges that professionals in the field might encounter. Relevant problems are authentic and meaningful to students. They should be able to connect the problem to their own experiences, interests, or aspirations, making the learning process more engaging and purposeful. Participant 3 emphasized the importance of involving everyone in solving a problem to foster engagement. Educators can ensure that all students are actively engaged in the learning process by providing activities that activate students' interests. This approach encourages participation and promotes a sense of ownership over learning outcomes, leading to increased motivation and deeper understanding. Likewise, Participant 4 underscored the significance of relating mathematics to the real world to enhance student engagement. Educators can create a more dynamic and interactive learning environment by giving students choices and using incentives like prizes. Further, Participant 5 emphasized the importance of inclusive problem-solving by encouraging active participation from everyone involved. This approach fosters collaboration and ensures that diverse perspectives are considered in finding solutions. It also highlighted the significance of connecting learning to real-

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

world contexts, enabling students to see the relevance and applicability of what they are learning. Offering students choices empowers them to take ownership of their learning journey, fostering autonomy and intrinsic motivation. This corroborates with the research of Hmelo-Silver (2020), which explored the impact of student interest on PBL outcomes. Selecting problems that align with students' interests fosters motivation, curiosity, and a sense of ownership in the learning process. Further, Dochy, Segers, Van den Bossche, and Gijbels (2018) highlighted the importance of stimulating intrinsic motivation by incorporating problems that capture students' attention and curiosity. Engaged students are more likely to invest time and effort in problem-solving.

3.1.2. Facilitating Student Inquiry—Facilitating student inquiry is a core aspect of Problem-Based Learning (PBL). In a PBL environment, students actively participate in their learning by engaging in the inquiry process, which involves asking questions, seeking information, and solving problems. PBL introduces a complex, real-world problem that lacks a clear solution. This problem serves as the focal point for student inquiry. The problem presented in PBL is designed to be intriguing and arouse students' curiosity. It should motivate them to explore and seek solutions by posing questions and conducting investigations. By facilitating student inquiry in this way, PBL promotes a deep understanding of content and cultivates lifelong learning skills. Students become active participants in their education, developing the ability to ask meaningful questions, conduct research, collaborate effectively, and apply their knowledge to solve complex problems. Participant 2 shared the importance of hands-on math learning experiences, which allow students to engage with mathematical concepts tangibly and actively. By providing differentiated instruction, teachers can cater to students' individual learning needs and preferences, ensuring that each student receives the support and challenge they require to succeed in math. Thus, Participant 7 also revealed the value of real-time problem-solving activities, which challenge students to apply their mathematical knowledge and skills to solve authentic and relevant problems. By posing challenging and relevant problems, teachers encourage students to think critically and creatively, fostering the development of problem-solving skills. This finding is relevant to Walker Leary's (2018) meta-analysis, which examined the impact of PBL on critical thinking skills across various disciplines and contexts. Their findings highlighted the importance of designing authentic problems that stimulate deep inquiry and reflection among students. Likewise, the study's findings were supported by the study of Hmelo-Silver DeSimone. (2019), who cited how PBL promotes active engagement and critical thinking among students. They discuss the iterative nature of inquiry in PBL, emphasizing the role of reflection in deepening understanding and fostering metacognitive skills. Participant 9 stressed the importance of tailoring lessons to students' interests and abilities, recognizing that personalized learning experiences can increase motivation and engagement. By offering choices and allowing students to explore math topics that resonate with them, teachers empower students to take ownership of their learning and pursue areas of interest within the mathematics curriculum. Moreover, Participant 10 mentioned the value of fostering peer-to-peer interaction in the mathematics classroom. Group projects or activities where students collaborate to solve problems promote teamwork and encourage active engagement and participation. Research by Duch (2019) emphasized the role of facilitators in guiding student inquiry. Effective facilitation involves asking probing questions, providing timely feedback, and en-

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

couraging students to explore multiple perspectives. A study by Savery (2019) highlighted the importance of scaffolding inquiry skills. Facilitators should provide necessary support and guidance to help students develop the skills required for effective inquiry, gradually allowing for increased independence.

3.1.3. Adjusting Complexity—The participants work with their students and discover that adjusting the complexity in Project-Based Learning (PBL) is crucial to ensuring that the projects align with students' developmental levels, skill sets, and learning goals. Research literature provides insights into various strategies for adjusting complexity in PBL. The literature often emphasizes the importance of scaffolding, where teachers support and guide students as they engage in complex tasks. Scaffolding helps students build the skills needed to complete more challenging aspects of the project. Differentiation is another crucial concept, involving tailoring instruction to meet the diverse needs of students. PBL can be differentiated by adjusting the complexity of tasks, resources, and assessment methods. Researchers discuss the gradual release of responsibility from the teacher to the students as they become more proficient in handling complex tasks. This process involves moving from explicit instruction to guided practice and, eventually, independently applying knowledge and skills. Adaptive instruction involves teachers continuously assessing students' progress and adjusting the project's complexity accordingly. This responsive approach ensures students are appropriately challenged and supported throughout the PBL process. The literature suggests that PBL projects should be designed with flexibility, allowing teachers to modify or adapt certain elements based on the students' evolving needs and capabilities. This adaptability ensures that projects remain relevant and engaging. Participant 1 said that it is important to make math not only understandable but also enjoyable for students. By tailoring teaching approaches to students' interests and needs, educators can significantly enhance engagement in learning mathematics. Further, Participant 6 suggested incorporating puzzles and games into mat lessons to make them more exciting and engaging. Whether using actual board games, applications, or resources from educational sites, integrating interactive activities adds an element of fun to the learning process. By gamifying math instruction, educators can stimulate students' interest, promote active participation, and reinforce mathematical concepts enjoyably and memorably. Furthermore, Participant 8 highlighted the importance of engaging multiple senses in teaching to cater to different learning styles. By incorporating visual aids such as diagrams and charts, auditory aids like verbal explanations or educational videos, and tactile experiences such as hands-on activities or manipulatives, educators can provide diverse learning opportunities. This multisensory approach ensures that students with varying preferences and strengths have the opportunity to comprehend and retain information effectively. The finding was supported by Hung and Loyens (2020), who discussed practical strategies for designing complex problems that challenge students' thinking and promote deep learning in PBL. They emphasize the importance of aligning task complexity with students' prior knowledge and skills to ensure optimal engagement and learning outcomes. The present findings of the study were consistent with the results findings of Savery (2019). Savery provided insights into the characteristics of effective PBL tasks, including their complexity level. By comparing PBL practices across different educational contexts, this survey highlights best practices for designing complex problems that foster student inquiry and critical thinking. Moreover, the findings of the study were affirmed by the

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

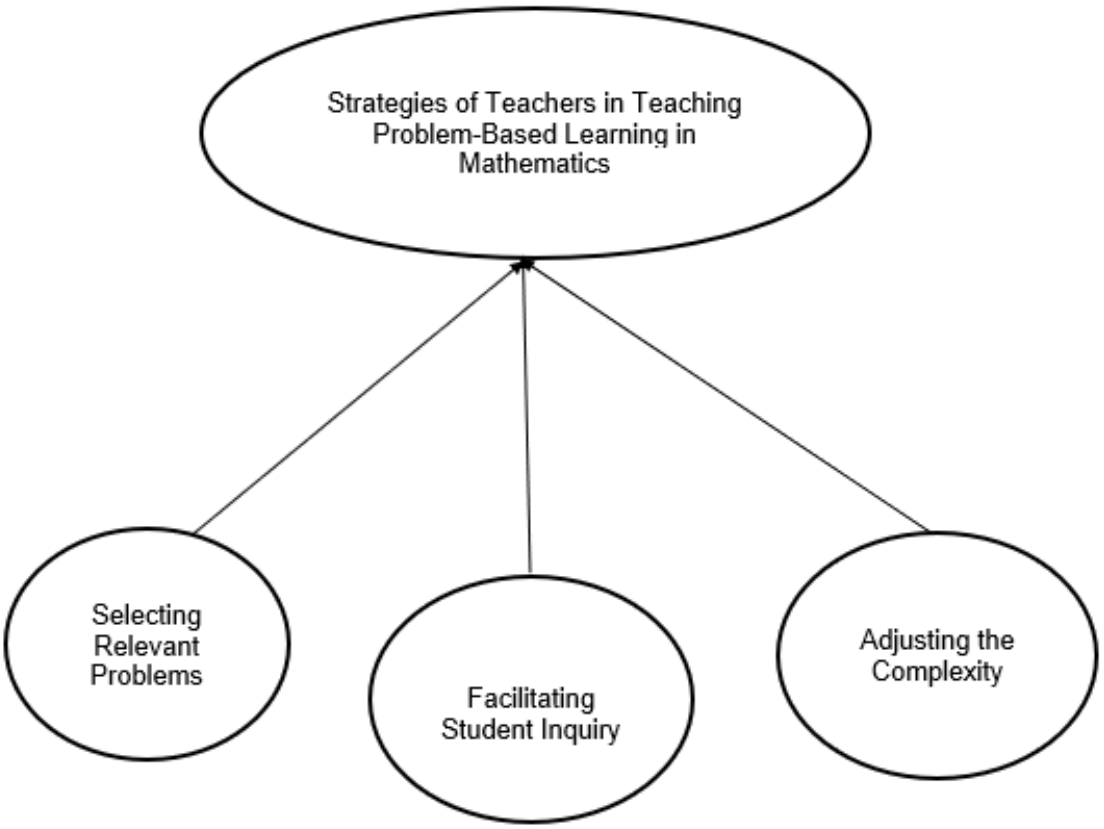

Fig. 3. Emerging themes on the strategies of teachers in teaching problem-based learning in Mathematics

study of Pear (2019) who discussed the gradual release of responsibility model, which involves moving from teacher-directed instruction to increased student independence. In PBL, adjusting complexity includes gradually transferring responsibility for learning to students as they become more proficient problem solvers. The study's findings were also consistent with those of Hattie and Timperley's feedback model (2020), which supported differentiated instruction. Adjusting complexity involves providing timely and specific feedback to address individual learning needs and guide students toward deeper understanding. Based on Figure 3, three themes emerged from the participants' responses: selecting relevant problems, facilitating student inquiry, and adjusting the complexity. These themes imply that teachers focus on selecting relevant and relatable problems to students' lives or current events. Selecting relevant problems helps students see the real-world applications of their learning concepts. The problems chosen should reflect authentic challenges that professionals in the field might face. This authenticity can motivate students by showing them the practical implications of the knowledge and skills they are acquiring. In facilitating student inquiry, teachers provide appropriate support and scaffolding to guide students through the inquiry process. This involves offering resources, guidance, and feedback to help students navigate and solve problems effectively. Creating an environment that encourages students to ask questions, explore multiple solutions, and pursue their own lines of inquiry fosters a sense of ownership and curiosity in their learning.

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

3.2. Coping mechanisms of teachers with the challenges in teaching problem-based learning in Mathematics—

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

As educators, we employ problem-based learning (PBL) to increase student engagement. Despite various challenges, many adopt coping strategies to overcome these obstacles. Implementing engaging and relevant problems can help capture students' interest. Connecting problems to real-world scenarios or allowing students to choose problems related to their interests can enhance motivation.

3.2.1. Intensifying Student Engagement—Incorporate active learning techniques within the PBL process. Use strategies like think-pair-share, small group discussions, and hands-on activities to keep students actively involved in the learning process. By implementing these strategies, teachers can enhance student engagement in problem-based learning, fostering a positive and dynamic learning environment. Walker Leary (2018) meta-analysis examined variations in student engagement across different types of PBL tasks and disciplines. Their findings underscored the importance of fostering collaboration and communication skills to intensify student engagement in PBL. Bell and Walker (2019) investigated the effectiveness of computer-based scaffolding in promoting collaboration and engagement in PBL tasks, particularly in STEM education. Their findings highlight the potential of technology-enhanced supports to intensify student engagement in collaborative problem-solving activities. Participant 1 shared the multifaceted nature of student engagement in numeracy, pointing out that factors such as interest, motivation, and commitment to learning mathematical concepts all play a role. Recognizing and addressing students' diverse needs is crucial for creating a more inclusive and engaging learning experience. By implementing methods tailored to individual students' needs, educators can foster greater participation and understanding among learners, ultimately enhancing their overall numeracy skills. Participant 4 acknowledged that some learners may feel discouraged or lack interest and participation in numeracy activities. To address this, the participant suggests shifting towards a more student-centered approach to learning. Engaging students through student-centered activities, such as brainstorming sessions and real-world connections, can help reinvigorate their interest and motivation in numeracy. The study's foregoing results were consistent with the findings made by Hung and Loyens (2020). They provided insights into practical strategies for implementing PBL effectively to intensify student engagement. They discuss the importance of creating a supportive learning environment, fostering collaboration, and providing timely feedback to enhance student motivation and participation. Similarly, Hmelo-Silver and DeSimone (2019) highlighted that PBL is an instructional model promoting active student engagement. They discussed how the iterative nature of PBL tasks encourages deep inquiry and critical thinking, leading to heightened engagement and learning outcomes.

3.2.2. Adapting to Varied Learning Styles—Strategies for teachers to accommodate different learning styles within a PBL framework. Savery (2019) provides insights into the diverse learning styles encountered in PBL settings across different educational contexts. Understanding the varied cognitive preferences and approaches to learning among students is crucial for adapting PBL tasks effectively. Walker Leary's (2018) meta-analysis explored variations in student engagement and learning outcomes in PBL across different disciplines and problem types. Understanding these differences can inform educators on how to tai-

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

lor PBL tasks to accommodate varied learning styles and preferences. Participant 2 identified various factors that can influence student engagement and performance in numeracy, including gender, socioeconomic status, parents' educational level, instructional strategies, and methods, teaching competency in math education, motivation or concentration, as well as the instrument and procedure of grading. Participant 7 highlighted the significance of positive interactions between teachers and students in fostering class participation in numeracy. When students feel understood and supported by their teacher, they are more likely to actively engage in learning activities. The findings were consistent with the results of the study of Colliver (2020). He explored the effectiveness of PBL in accommodating individual learning preferences and styles. By presenting authentic problems that resonate with students' interests and experiences, PBL tasks can effectively engage learners with diverse backgrounds and learning styles. Further, the result was consistent with the major findings made by Ertmer and Simons (2018). They discussed strategies for supporting K-12 teachers in adapting PBL tasks to cater to varied learning styles in diverse classroom settings. Ertmer and Simons address the importance of providing flexible learning opportunities and differentiated instruction to effectively meet the needs of all students.

3.2.3. Ensuring Equity in Learning—Ensuring equity in learning is essential in problem-based learning (PBL) to provide all students with equal opportunities for success. Choose problems that are culturally relevant, inclusive, and relatable to a diverse group of students. Savery (2019) explored the implementation of PBL across diverse educational contexts, shedding light on how socioeconomic disparities may impact access to PBL experiences. Understanding these disparities is crucial for designing equitable PBL initiatives. Ertme and Simons (2018) discussed strategies for supporting K-12 teachers in implementing PBL in diverse classrooms, including those with varying socioeconomic backgrounds. They addressed challenges related to equity and offered recommendations for promoting inclusivity in PBL practices. Participant 3 highlighted how engagement in numeracy strengthens students' numeracy skills, including attention span, comprehension, and analytical skills. By actively participating in numeracy activities, students develop these essential skills, which in turn contribute to their overall engagement with mathematics. Educators can promote engagement by providing meaningful and relevant numeracy experiences that challenge students to apply their skills and think critically about mathematical concepts. Similarly, Participant 6 pointed out the negative perception some students may have towards mathematics, viewing numbers as intimidating and making mistakes as something to be feared. This perception can create pressure and anxiety, inhibiting students' willingness to explore mathematics and engage fully in numeracy activities. Educators can address this issue by fostering a supportive and encouraging learning environment where mistakes are viewed as opportunities for growth and learning. This study finding is congruent with the notion of a comprehensive study by Bell Walker (2019), which examines the effectiveness of computer-based scaffolding in supporting equitable learning experiences in PBL, particularly in STEM education. Their findings highlight the potential of technology-enhanced support to provide all students with access to resources and assistance. Collive (2020) discussed the importance of equitable assessment practices in PBL, ensuring that assessment tasks are fair and unbiased for all students. Educators can design assessments

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

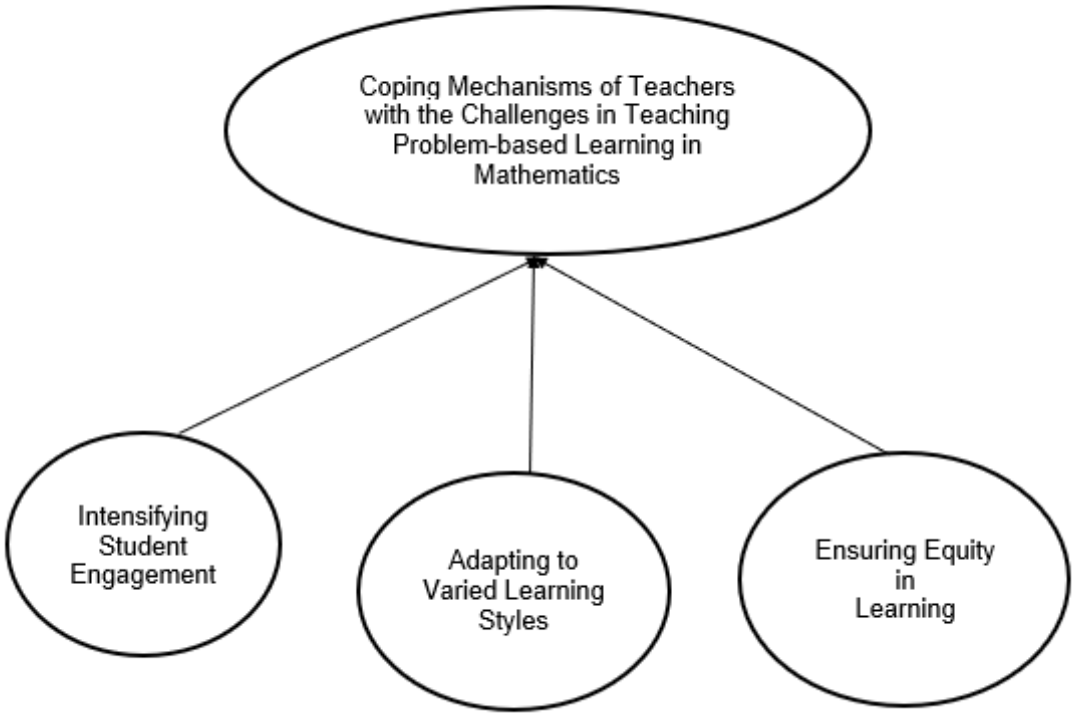

Fig. 4. Emerging themes on coping mechanisms of teachers with the challenges in teaching problem-based learning in Mathematics

that accurately measure student learning and progress by considering diverse learning styles and backgrounds. Bannister and Shelby (2020) highlighted the importance of creating a culturally responsive PBL environment. Facilitators should be aware of cultural differences and strive to foster an inclusive atmosphere where all students feel valued and heard. Figure 4 shows three themes emerging from the participants' responses: intensifying student engagement, adapting to varied learning styles, and ensuring equity in learning. For intensifying student engagement, participants emphasized the importance of actively involving students in the learning process.

3.3. Educational Management Insights from the Findings of the Study—The participants shared their educational management insights and these were narrowed down to generate themes. These themes were carefully analyzed and formulated based on what came from informants' accounts and reflections. The subthemes are shown below:

3.3.1. Contextualizing Relevance—The study underscores the critical role contextual relevance in Problem-Based Learning (PBL). It refers to the emphasis on connecting mathematical concepts and skills to real-world situations or problems that students may encounter outside the classroom. It involves presenting mathematical content in a context that has practical applications, making the learning experience more meaningful and engaging for students. Here's how contextual relevance is integral to PBL. PBL tasks involve presenting students with au-

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

thentic, real-world problems that require the application of mathematical concepts to find solutions. These problems mirror situations students might encounter in their lives, making the learning experience more tangible and relevant. Instead of learning abstract mathematical concepts in isolation, PBL encourages students to apply these concepts to solve problems in a specific context. Contextualizing relevance helps bridge the gap between theoretical knowledge and practical application. Students see how mathematical principles are not just theoretical constructs but tools that can be used to address everyday challenges and make informed decisions. When students recognize the real-world significance of what they are learning, they are more likely to be engaged and motivated. Contextualizing mathematical problems in familiar situations can spark curiosity and a desire to understand and solve problems, fostering a positive attitude toward learning. Participant 1 mentioned the effectiveness of Problem-Based Learning (PBL) in increasing student engagement by incorporating key features aligned with effective pedagogy. PBL fosters relevance by addressing real-world problems, autonomy by allowing students to explore solutions independently, collaboration through group work, critical thinking by encouraging analysis and problem-solving, and a sense of ownership in the learning process. On the other hand, Participant 6 emphasized the value of hands-on, competitive, and motivating strategies in promoting engagement and critical thinking among students. These strategies encourage active participation, facilitate the sharing of ideas, and stimulate students' curiosity and problem-solving skills. By incorporating these dynamic and interactive approaches into instruction, educators can create an engaging learning environment that inspires students to think critically, collaborate with their peers, and excel in numeracy. A study of Dochy et al. (2023) highlighted the significance of connecting learning materials to students' prior experiences. PBL should draw on learners' existing knowledge and experiences to make new information more accessible and relevant.

3.3.2. Enhancing Life-long Learning Skills—The study emphasizes the importance of Problem-Based Learning (PBL) in fostering life-long learning skills, which are essential for continuous personal and professional development. Walker, Leary (2018) explore the role of collaboration and communication in PBL tasks. Collaborative problem-solving activities in PBL promote interpersonal skills and effective communication, which are essential for life-long learning and professional development. Participant 2 revealed the teaching strategies that promote self-directed learning and critical thinking through problem-solving. By guiding students to explore and solve problems independently, educators foster skills such as self-motivation, initiative, and analytical thinking. This approach empowers students to take ownership of their learning and develop the ability to apply mathematical concepts to real-world situations, preparing them for success in academic and professional settings. Similarly, Participant 5 highlighted the effectiveness of problem-based learning (PBL) in increasing engagement by immersing learners in real-world scenarios. PBL encourages active participation and critical thinking by presenting students with authentic problems that require analysis, inquiry, and problem-solving skills. The findings of the study agree with the findings of Hung Loyens, (2020). They discussed the role of PBL in fostering self-directed learning skills, a key component of life-long learning. Through PBL, students take ownership of their learning process, identifying learning goals, seeking relevant information, and evaluating their own progress.

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

Ertmer and Simons (2018) addressed strategies for supporting K-12 teachers in facilitating self-directed learning in PBL environments. By providing guidance and scaffolding, educators can empower students to take initiative in their learning journey, fostering life-long learning skills. Participant 8 suggested providing students with resources, guiding questions, and hands-on experiences to foster active exploration. This approach encourages students to take an active role in their learning by conducting research, analyzing data, and experimenting to find solutions. By engaging in these activities, students develop critical thinking skills, problem-solving abilities, and a deeper understanding of mathematical concepts. Jonassen's work (2020) highlighted problem-solving as a key component of lifelong learning. PBL provides opportunities for students to develop critical thinking skills, fostering their ability to analyze and solve complex problems independently. In a study by Bruce (2023), information literacy is crucial for lifelong learning. PBL requires students to locate, evaluate, and use information effectively. Research suggests that the information literacy skills developed in PBL transfer to real-world, lifelong learning contexts.

3.3.3. Imposing Intrinsic Motivation—Intrinsic motivation, the inner drive to engage in an activity for its own sake rather than for external rewards, plays a significant role in Problem-Based Learning (PBL). Walker Leary (2018) explored how collaboration and social interaction in PBL tasks can enhance intrinsic motivation among students. By working together to solve complex problems, students experience a sense of belonging and community, which fosters intrinsic motivation. Colliver (2020) discussed the effectiveness of PBL in promoting collaboration and social interaction, which are essential for intrinsic motivation. Through group discussions, peer feedback, and teamwork, students develop interpersonal skills and a sense of camaraderie that enhances their intrinsic motivation to learn. Participant 3 emphasized the importance of students' participation and the improvement of critical thinking skills through problem-based learning, particularly in mathematics. Problem-based learning can activate students' interest, especially when the problems relate to their personal experiences, allowing them to share ideas and engage more deeply with the material. Participant 4 highlighted the collaborative aspect of problem-solving in a problem-based learning approach. By collaborating with peers to come up with solutions to problems, students engage in deeper learning than traditional methods. Through collaboration, students are exposed to diverse perspectives, engage in discussions, and learn from one another's insights. Participant 7 highlighted the benefits of group work activities in increasing learner engagement, especially in problem-based learning (PBL) contexts. Through teamwork and collaboration, students have opportunities to work together and share their ideas while solving problems. Research by Hidi and Renninger (2020) encapsulated that situating learning tasks in a context that aligns with students' interests enhances intrinsic motivation. PBL scenarios that resonate with students' curiosity and passions contribute to sustained engagement and motivation. In the study of Ainley (2023), personal interest is a key factor in sustaining motivation. Research suggests that PBL activities that tap into individual interests and allow for personalized exploration contribute to increased intrinsic motivation among students. Based on Figure 5, three themes emerged from the participants' responses: contextualizing relevance, enhancing life-long learning skills, and imposing intrinsic motivation. Contextualizing relevance refers to the emphasis on connecting learning to real-

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

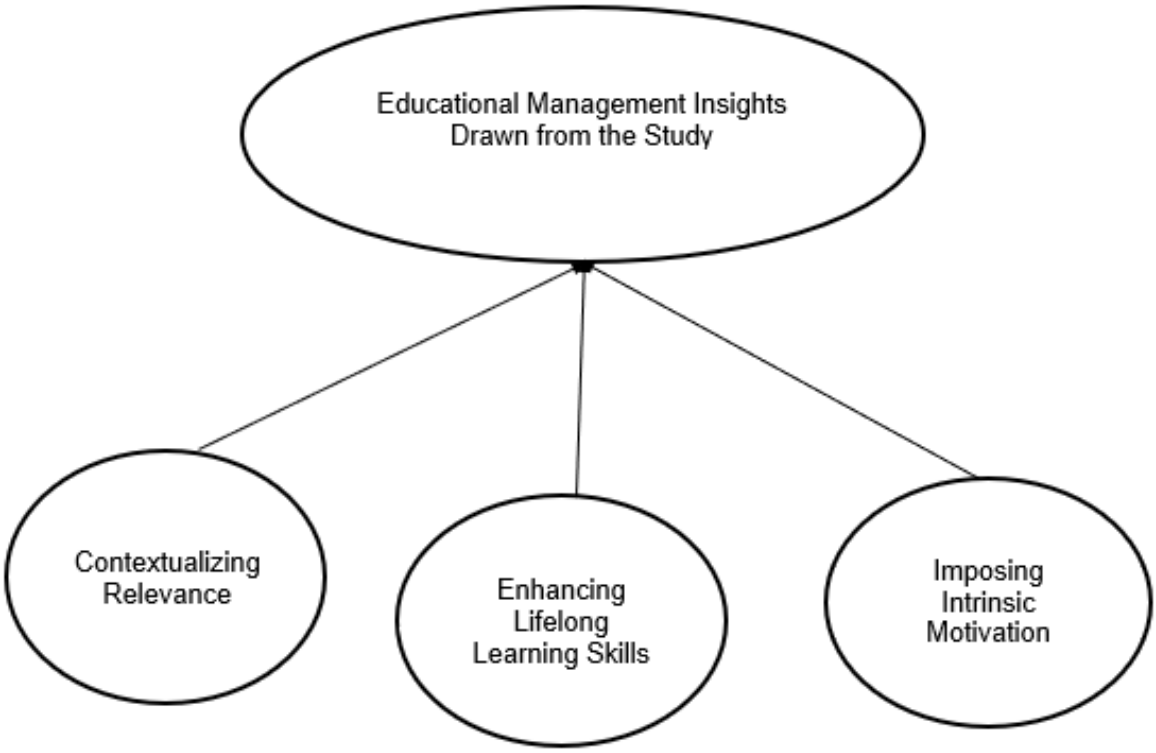

Fig. 5. Emerging themes on the educational management insights drawn from the study

world situations or problems. Participants in PBL experiences recognize the importance of making the educational content meaningful and applicable to practical scenarios. This theme underscores the idea that learning is more effective when it is situated within a context that mirrors real-life challenges.

4. Implications and Future Directions

Exploring problem-based learning in mathematics was characterized by a careful and evidence-based examination of the implications of PBL on teaching, learning, and educational outcomes. It reflects a commitment to advancing knowledge, contributing to educational practices, and fostering a culture of continuous improvement in the field. Understanding this exposure's implications and future directions was essential for policymakers, school administrators, and teachers to enhance literacy and educational outcomes.

4.1. Findings—The educational management insights drawn from the study identified contextualizing relevance, enhancing life-long learning skills, and imposing intrinsic motivation as emerging themes. Participants in PBL experiences recognize the importance of making the educational content meaningful and applicable to practical scenarios. This theme underscores the idea that learning is more effective when it is situated within a context that mirrors real-life challenges. In addition, PBL participants have highlighted skills development that

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

extend beyond the immediate academic context. These skills include critical thinking, problem-solving, effective communication, adaptability, and a continuous learning mindset. PBL was seen as a platform that imparts subject-specific knowledge and equips learners with the tools necessary for ongoing personal and professional growth. Intrinsic motivation in PBL suggests that participants who engage in problem-solving activities experience a heightened sense of motivation from within. The authentic and relevant nature of problems presented in PBL tasks and the autonomy given to students fosters a natural desire to understand and solve challenges, contributing to a positive and self-driven learning experience. These three themes together illustrate the holistic and student-centered nature of PBL. Integrating contextual relevance, life-long learning skills, and intrinsic motivation aligns with active learning and learner engagement principles, making PBL an effective approach to fostering subject mastery and a deeper and enduring passion for learning.

4.2. Implications—The study showcased that by employing diverse teaching strategies, PBL has the potential to significantly enhance student engagement by providing meaningful and real-world problem-solving experiences. Integrate problem-based learning that emphasizes researchers exploring the implications of PBL and expresses a sense of cautious optimism. While acknowledging the positive outcomes associated with PBL, they also recognize challenges or areas where further research and refinement are needed. Establish clear guidelines and standards for developing, selecting, and distributing appropriate learning materials that align with curriculum goals. On strategies of teachers in teaching problem-based learning in Mathematics, three themes emerged from the participants' responses: selecting relevant problems, facilitating student inquiry, and adjusting the complexity. These themes implied that the participants recognized selecting relevant problems, and teachers focused on selecting relevant and relatable problems to students' lives or current events. In selecting relevant problems, helps students see the real-world applications of the concepts they are learning. This authenticity could motivate students by showing them the practical implications of the knowledge and skills they were acquiring. In facilitating student inquiry, teachers provide appropriate support and scaffolding to guide students through the inquiry process. This involves offering resources, guidance, and feedback to help students navigate and solve problems effectively. Creating an environment that encourages students to ask questions, explore multiple solutions, and pursue their lines of inquiry fosters a sense of ownership and curiosity in their learning. Teachers might adjust the complexity of problems to cater to individual learning levels, recognizing the diverse needs and abilities of students. This ensures that all students are appropriately challenged without feeling overwhelmed or disengaged. Teachers design a series of problems with increasing complexity to provide a structured progression of difficulty. This allows students to build on their knowledge and skills gradually, promoting a sense of accomplishment. On teachers' coping ways with the challenges in problem-based learning, three themes emerged from the participants' responses: intensifying student engagement, adapting to varied learning styles, and ensuring equity in learning. Participants emphasized the importance of actively involving students in the learning process. Engaged students are more likely to be motivated, participate in class discussions, and take ownership of their learning. Strategies to enhance student engagement include interactive teaching methods, technology integration,

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

and creating a positive and inclusive learning environment. Adapting to varied learning styles highlights the recognition that students have diverse learning preferences and styles. The participants have expressed a need for educators to employ various teaching methods and resources to accommodate these differences. This could involve incorporating visual aids, hands-on activities, group work, and other approaches to cater to how students absorb and process information. Ensuring equity in learning implies providing all students with fair and equal opportunities to succeed, regardless of their background, socio-economic status, or other factors. Participants have stressed the importance of implementing policies and practices that promote inclusivity and equal access to education. This could involve addressing issues such as access to resources, technology, and support services to level the playing field for all students. Understanding and adopting these three themes can contribute to the development of effective and inclusive educational practices. They suggest a recognition of the learning environment's multifaceted nature and the importance of tailoring educational approaches to meet students' diverse needs.

4.3. Future Directions—Problem-based learning (PBL) in mathematics focusing on increasing student engagement has specific implications for policymakers, school administrators, and teachers. Each stakeholder group plays a crucial role in shaping the educational environment. Policymakers may focus on integrating PBL into national or regional curriculum frameworks, ensuring that it becomes a standard practice across educational institutions. For school administrators, they may provide resources and support for teacher training and professional development programs focused on PBL methodologies. Teachers may invest in ongoing training and support to effectively implement PBL in classrooms and encourage collaboration among teachers to share best practices and resources. For parents, they may provide resources and guidance to support PBL activities at home, fostering continuity between school and home learning environments. The Learners may actively engage in problem-solving activities, take ownership of their learning process, and foster collaboration and teamwork skills through group-based PBL projects. Future researchers may conduct studies to assess the long-term impact of PBL on student outcomes, including academic achievement, career readiness, and lifelong learning skills, and explore innovative variations of PBL, such as technology-enhanced PBL or interdisciplinary PBL, to further optimize student engagement and learning outcomes. Overall, future efforts in PBL will likely focus on refining implementation strategies, fostering collaboration among stakeholders, and continuously leveraging research to improve student engagement and learning outcomes.

5. References

Akcanca, N. (2020). 21st century skills: The predictive role of attitudes regarding stem education and problem-based learning. *International Journal of Progressive Education*, *16*(5), 443–458. https://doi.org/10.29329/ijpe.2020.277.27

Arends, R., & Kilcher, A. (2020). *Teaching for student learning: Becoming an accomplished teacher*. Taylor & Francis Group.

Azwar, S. (2020). *Tes prestasi*. Pustaka Pelajar.

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

Barron, B., & Darling-Hammond, L. (2018). Teaching for meaningful learning: A review of research on inquiry-based and cooperative learning. *George Lucas Educational Foundation*.

Barrows, H. S., & Kelson, A. C. (2019). Problem-based learning in secondary education and the problem-based learning institute. *Interdisciplinary Journal of Problem-Based Learning*, *13*(2), 24–34.

Bell, E., Walker, A. E., Kim, N. J., & Lefler, M. (2019). Synthesizing results from empirical research on computer-based scaffolding in stem education: A meta-analysis. *Review of Educational Research*, *89*(2), 210–250.

Bendici, R. (2020). Real math: Providing real-world context for mathematics with relevant examples and hands-on projects improves retention and learning outcomes. *District Administration*, *56*(3), 47–48.

Botty, H., & Shahrill, M. (2019). Narrating a teacher's use of structured problem-based learning in a mathematics lesson. *Asia Journal of Social Sciences & Humanities*, *4*(1), 156–164.

Boyce, C., & Neale, P. (2020). *Conducting in-depth interview: A guide for designing and conducting in-depth interviews for evaluation input*.

Bruce, J. A. (2023). Fennema-sherman mathematics attitudes scales: Instruments designed to measure attitudes toward the learning of mathematics by females and males. *Journal for Research in Mathematics Education*, *7*(5), 324–326.

Chakrabarty, S., & Muhamed, N. (2023). Problem based learning: Cultural diverse students' engagement, learning and contextualized problem solving in a mathematics class. *Wcik E-Journal of Integration Knowledge*, 38–49.

Chen, X., Liu, J., & Zhang, D. (2020). Effects of problem-based learning on mathematics achievement and mathematics self-efficacy: A systematic review. *International Journal of Educational Research*, *103*, 101621.

Chiu, M. H., Lin, C. P., & Tang, J. F. (2019). Effects of problem-based learning on students' mathematics self-efficacy, self-regulated learning, and metacognition in elementary school. *Journal of Educational Psychology*, *111*(6), 1004–1024.

Cleary, T. J., & Zimmerman, B. J. (2020). Examining self-regulation as a mediator in the effects of self-regulated learning interventions. *Educational Psychology*, *42*(3), 158–176.

Colliver, J. A. (2020). Effectiveness of problem-based learning curricula: Research and theory. *Academic Medicine*, *95*(6), 793–803.

Corbetta, P. (2023). *Social research: Theory methods and techniques* [https://www.scirp.org/reference/ReferencesPapers?ReferenceID=1811845]. SAGE Publications Ltd.

Creswell, J. W. (2022). *Educational research: Planning, conducting, and evaluating quantitative and qualitative research* (4th) [https://www.scirp.org/reference/ReferencesPapers?ReferenceID=757162]. Pearson.

Creswell, J. W. (2023). *Qualitative inquiry and research design: Choosing among five approaches* (3rd) [https://www.researchgate.net/publication/283906211_Creswell_JW_2013_Qualitative_inquiry_and_research_design_Choosing_among_five_approaches_3e_ed_London_Sage_Approches_inductives_2015_Hakim_Ben_Salah_Note_de_lecture_1-4]. SAGE.

Cruz, A., & Santos, E. (2023). Exploring the use of educational technology to enhance student engagement in mathematics: A case study of philippine schools.

David, R., Estudillo, G., & Del Prado, J. (2020). Enhancing the relevance of mathematics education in the philippines.

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

Dochy, J. (2019). Cognitive evaluation theory and some comments on the calder and staw critique. *Journal of Personality and Social Psychology*, *35*(1), 81–85.

Dochy, S. V. D. B., & Gijbels, D. (2018). Interest, learning, and the psychological processes that mediate their relationship. *Journal of Educational Psychology*, *94*(3), 545–561.

Dolmans, D. H. J. M., Loyens, S. M. M., Marcq, H., & Gijbels, D. (2019). Modeling domain learning: Profiles from the field of special education. *Journal of Educational Psychology*, *95*(3), 545–557.

Duch, B. (2019). Gender and interest processes in response to literary texts: Situational and individual interest. *Learning and Instruction*, *12*, 411–428.

Fajrina, S., Lufri, L., & Ahda, Y. (2020). Science, technology, engineering, and mathematics (stem) as a learning approach to improve 21st century skills: A review. *International Journal of Online and Biomedical Engineering (IJOE)*, *16*(07), 95–104. https://doi.org/10.3991/ijoe.v16i07.14101

Fast, L. A. (2018). Self-efficacy and standardized test performance [Accessed on 22 November 2017 of http://rap.ucr.edu/efficacy.pdf].

Fatade, A. O., Mogari, D., & Arigbabu, A. A. (2023). Effect of problem-based learning on senior secondary school students' achievements in further mathematics. *Acta Didactica Napocensia*, *6*(3), 29–44.

Fi, C. D., & Degner, K. M. (2022). Teaching through problem solving. *The Mathematics Teacher*, *105*(6), 455–459. https://doi.org/10.5951/mathteacher.105.6.0455

Fonna, M., & Mursalin, M. (2018). Role of self-efficacy toward students' achievement in mathematical multiple representation ability (mmra). *Jurnal Ilmiah Peuradeun*, *6*(1), 31–40.

Fredricks, J. A., Filsecker, M., & Lawson, M. A. (2019). Student engagement, context, and adjustment: Addressing definitional, measurement, and methodological issues. *Learning and Instruction*, *43*, 1–4.

Gasser, K. W. (2021). Five ideas for 21st century math classrooms. *American Secondary Education*, *39*(3), 108–116. http://www.jstor.org/stable/23100426

Gerlings, A. (2018). Knot your typical math problem. *Teaching Children Mathematics*, *24*(7), 414–417. https://doi.org/10.5951/teacchilmath.24.7.0414

Goldthorp, S. A. (2023). Problem solving with laser precision. *Mathematics Teaching in the Middle School*, *19*(2), 70–72. https://doi.org/10.5951/mathteacmiddscho.19.2.0070

Guba, E. G. (2018). Judging interpretations: But is it rigorous? trustworthiness and authenticity in naturalistic evaluation. *New Directions for Evaluation*, *114*, 11–25. https://experts.illinois.edu/en/publications/judging-interpretations-but-is-it-rigorous-trustworthiness-and-au

Gurpinar. (2018). Developing students' appreciation for what is taught in school. *Educational Psychologist*, *43*(3), 132–141.

Hattie, J., & Timperley, H. (2018). The role of subject-matter knowledge and interest in the processing of linear and nonlinear texts. *Review of Educational Research*, *64*(2), 201–252.

Hidi, S. E., & Renninger, K. A. (2019). Children's competence and value beliefs from childhood through adolescence: Growth trajectories in two male-sex-typed domains. *Developmental Psychology*, *38*(4), 519–533.

Hmelo-Silver, C. E. (2020). Two scales of attitude towards mathematics. *Journal for Research in Mathematics Education*, *5*(2), 66–71.

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

Hmelo-Silver, C. E., & Barrows, H. S. (2019). Facilitation, reflection, and scaffolding in problem-based learning environments. *The Interdisciplinary Journal of Problem-based Learning*, *13*(1), 2.

Hmelo-Silver, C. E., & DeSimone, C. (2019). Problem-based learning: An instructional model of active engagement. *Educational Psychology Review*, *31*(2), 287–297.

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2020). Scaffolding and achievement in problem-based and inquiry learning: A response to kirschner, sweller, and clark (2006). *Educational Psychologist*, *41*(2), 99–107.

Hmelo-Silver, C. E., & Eberbach, C. (2023). Technology-enhanced problem-based learning: A critical review. *Journal of Educational Technology & Society*, *26*(1), 77–89.

Huang, S. Y., & Wu, H. H. (2022). Effects of problem-based learning on self-regulated learning and mathematics self-efficacy in a flipped classroom. *Interactive Learning Environments*, 1–18.

Hummell, L. (2019). 21st century skills: Critical thinking skills. *Children's Technology and Engineering*, 5–6.

Hung, D. (2019). Rebecca's in the dark: A comparative study of problem-based learning and direct instruction/experiential learning in two 4th-grade classrooms. *Journal of Elementary Science Education*, *21*(1), 1–16.

Hung, W. (2019). Theory to reality: A few issues in implementing problem-based learning. *Educational Technology Research and Development*, *67*(4), 1–24.

Hung, W. (2020). Problem-based learning: A learning environment for enhancing learning transfer. *New Directions for Teaching and Learning*, (161), 51–61.

Hycner, R. H. (2018). Phenomenological qualitative methods applied to the analysis of cross-cultural experience in novel educational social contexts. https://www.researchgate.net/publication/360194484_Phenomenological_Qualitative_Methods_Applied_to_the_Analysis_of_Cross-Cultural_Experience_in_Novel_Educational_Social_Contexts

Imoko, B. I., & Ajai, J. T. (2019). Gender differences in mathematics achievement and retention score: A case of problem based learning method. *International Journal of Research in Education and Science*.

Irby, B. J., Brown, G., Lara-Alecio, R., & Jackson, S. (2019). *The handbook of educational theories*. Information Age Publishing.

Jenkins, D. A., & Alfred, M. V. (2018). Critical race theory and the inclusion of race and racism in the college curriculum. *Teachers College Record*, *120*(14), 1–20.

Jonassen, D. H., & Hung, W. (2023). Problem solving and cognitive flexibility in problem-based learning. *Educational Technology Research and Development*, *71*(1), 41–56.

Jonassen, P. (2023). *Learning to solve problems: A handbook for designing problem solving learning environments*. Routledge.

Kim, P., Hong, J., Bonk, C., & Lim, J. (2021). Effects of group reflection variations in project-based learning integrated in a web 2.0 learning space. *Interactive Learning Environments*, *29*(1), 1–14.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2020). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *57*(1), 75–86.

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

Kirschner, P. A., Sweller, J., & Clark, R. E. (2021). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *52*(2), 71–83.

Kirschner, P. A., Sweller, J., & Clark, R. E. (2022). Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching. *Educational Psychologist*, *57*(1), 75–86.

Kress, N. E. (2018). 6 essential questions for problem solving. *The Mathematics Teacher*, *111*(3), 190–196. https://doi.org/10.5951/mathteacher.111.3.0190

Lee, H. J., Kim, M. K., & Choi, H. J. (2018). Undergraduate students' self-efficacy and achievement in mathematics: The mediation role of self-regulated learning strategies. *International Journal of Mathematical Education in Science and Technology*, *49*(3), 358–374.

Lewis, C. C., Perry, R. R., Friedkin, S., & Roth, J. R. (2022). Improving teaching does improve teachers. *Journal of Teacher Education*, *63*(5), 368–375. https://doi.org/10.1177/0022487112446633

Liu, H., Wu, Y. J., & Yang, J. Z. (2021). The effects of problem-based learning on elementary students' mathematics self-efficacy and learning motivation: The mediating role of collaborative problem-solving ability. *Asia Pacific Education Review*, 1–15.

Lunenburg, F. C. (2021). Self efficacy in the workplace: Implications for motivation and performance. *International Journal of Management, Business, and Administration*, *14*(1), 1–6.

Mangulabhan, M. (2019). Difficulties encountered by the students in mathematical problems. https://www.academia.edu/34837407/difficulties_encountered_by_the_students_in_mathematical_problems

May, D. K. (2019). Mathematics self-efficacy and anxiety questionnaire [Doctor of Philosophy Dissertation, University of Georgia].

McCallum, W. G. (2019). 3 ways to support problem-based instruction. *National Association of Elementary School Principals*, 42–43.

Merriam, S. B. (2019). *Qualitative research: A guide to design and implementation*. Jossey-Bass.

Mokhtar, M. A. M., Ayub, A. F. M., Said, R. R., & Mustakim, S. S. (2019). Analysis of year four pupils' difficulties in solving mathematical problems involving fraction. *International Journal of Academic*.

Mukhid, A. (2019). Self-efficacy: Perspektif teori kognitif sosial dan implikasinya terhadap pendidikan. *Journal Tadris*, *4*(1), 106–122.

National Council of Teachers of Mathematics. (2020). *Principles and standards for school mathematics* [Research in Business and Social Sciences, 9(11), 1560–1569]. NCTM. http://dx.doi.org/10.6007/IJARBSS/v9-i11/6766

Norman, G. R., & Schmidt, H. G. (2020). Effectiveness of problem-based learning curricula: Theory, practice and paper darts. *Medical Education*, *34*, 721–728.

O'Brien, T. C., Wallach, C., & Mash-Duncan, C. (2021). Problem-based learning in mathematics. *The Mathematics Enthusiast*, *8*, 147–160.

OECD. (2018). *Pisa 2018 results (volume iii): What school life means for students' lives*.

OECD. (2020). *Equity in education: Breaking down barriers to social mobility*.

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024

Parker Siburt, C. J., Bissell, A. N., & Macphail, R. A. (2021). Developing metacognitive and problem-solving skills through problem manipulation. *Journal of Chemical Education*, *88*(11), 1489–1495. https://doi.org/10.1021/ed100891s

Patton, M. (2020). Two decades of developments in qualitative inquiry: A personal, experiential perspective. https://doi.org/10.1177/1473325002001003636

Peer Evaluation and Assessment Resource. (2019). A model of domain learning: Reinterpreting expertise as a multidimensional, multistage process. In D. Y. Dai & R. J. Sternberg (Eds.), *Motivation, emotion, and cognition: Integrative perspectives on intellectual functioning and development* (pp. 273–298). Lawrence Erlbaum Associates, Inc.

Perez, E. D., & Ye, Y. (2023). The relationship between mathematics self-efficacy and mathematics achievement of mathayomsuksa students in the english program of st. joseph bangna school. *Assumption Journal*, *5*(2), 82–92.

Peters, J., Loh, K. C., & Cooper, M. E. (2018). Problem-based learning in medicine and beyond: A brief overview. *New Directions for Teaching and Learning*, *68*, 1–12. https://doi.org/10.1002/tl.20265

Polkinghorne, J. (2020). Science and theology in the twenty-first century. https://doi.org/10.1111/1467-9744.00324

Polly, D. (2018). Supporting opportunities for productive struggle: Implications for planning mathematics lessons. *Teaching Children Mathematics*, *23*(8), 454–457.

Preclaro, M. (2019). The acquisition of mathematics skills of filipino children with learning difficulties: Issues and challenges.

Prince, M. (2024a). Does active learning work? a review of the research. *Journal of Engineering Education*, *93*(3), 223–231.

Prince, M. (2024b). How subject-matter knowledge affects recall and interest. *American Educational Research Journal*, *31*(2), 313–337.

Reardon, S. F., Kalogrides, D., & Shores, K. A. (2019). The geography of racial/ethnic test score gaps. *American Journal of Sociology*, *124*(5), 1452–1510.

Rosenbaum, M. S., Otalora, M. L., & Ramírez, G. C. (2018). Promoting problem-based learning in retailing and services marketing course curricula with reality television. *Journal of Education for Business*, *90*(4), 182–191. https://doi.org/10.1080/08832323.2015.1014456

Sakilah, N., Rini, C., Magdalena, I., & Unaenah, E. (2018). Analysis of difficulties in mathematics learning in second grade of elementary schools (case study in one of south jakarta elementary schools).

Savery, J. R. (2019). Domain knowledge: Evolving themes and emerging concerns. *Educational Psychologist*, *27*(1), 33–51.

Savery, J. R. (2021). Overview of problem-based learning: Definitions and distinctions. *Journal of Problem-Based Learning in Higher Education*, *9*(1), 5–16.

Schutz, A. (2020). *Social class, social action and education: The failure of progressive democracy*. Palgrave Macmillan. https://www.researchgate.net/publication/260741308_Social_class_social_action_and_education_The_failure_of_progressive_democracy_Aaron_Schutz_2010_New_York_Palgrave_Macmillan_55_270_pp_ISBN_978-0-230-10591-1

ISSN 3028-1261
10.5281/zenodo.12529436/NIJSE.2024