

**PROBLEM-BASED LEARNING AS AN INSTRUCTIONAL STRATEGY FOR
STRENGTHENING GRADE 10 STUDENTS' PROBLEM-SOLVING SKILLS
OF MEASURES OF POSITION**

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Bachelor of Secondary Education
Major in Mathematics

by

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APPROVAL SHEET

This thesis entitled, “**PROBLEM-BASED LEARNING AS AN INSTRUCTIONAL STRATEGY FOR STRENGTHENING GRADE 10 STUDENTS PROBLEM-SOLVING SKILLS IN MEASURES OF POSITION**”, prepared and submitted by **Darife S. Bahoy** in partial fulfillment of the requirements for the degree **Bachelor of Secondary Education Major in Mathematics**, has been examined and is recommended for acceptance and approval for Oral Examination.

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DEDICATION

I, the researcher, wholeheartedly dedicate this humble academic work:

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who have been my constant source of strength,

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my academic journey;

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ABSTRACT

Problem-Based Learning (PBL) has been recognized as an effective instructional strategy in improving learners' problem-solving skills, engagement, and motivation in Mathematics. This study examined the effect of Problem-Based Learning on students' problem-solving skills in measures of position and probability during the School Year 2025–2026 in one of the public secondary schools in Ozamiz City. A one-group pretest-posttest design was utilized through instructional sessions that incorporated problem-based activities, collaborative tasks, and real-life mathematical situations. The participants were purposively selected and completed pretest and posttest assessments on problem-solving skills, engagement, and motivation. Statistical tools such as frequency, percentage, mean, standard deviation, and paired t-test were used to analyze the data. Findings revealed that before the implementation of Problem-Based Learning, learners demonstrated low problem-solving skills, engagement, and motivation in measures of position and probability. After the intervention, learners' problem-solving skills, engagement, and motivation improved. The results further revealed a statistically significant difference between the learners' scores before and after the implementation of Problem-Based Learning. These findings confirm that Problem-Based Learning is an effective instructional strategy for enhancing learners' problem-solving skills, engagement, and motivation in Mathematics.

Keywords: *Problem-Based Learning, engagement, mathematics, measures of position, motivation, probability, problem-solving skills*

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Chapter 1

INTRODUCTION

Context and Rationale

When we teach mathematics, we are not just teaching numbers, we are guiding students to think critically, recognize patterns, and apply knowledge in real-life situations. Mathematics becomes meaningful when learners can connect concepts to everyday problems, yet many still find it abstract or intimidating. Despite its importance, students often struggle with topics like statistics, probability, and problem-solving, especially when lessons fail to engage them in applied contexts (Santos, 2023). This struggle is reflected in the 2022 PISA results, where Filipino students scored only 355 in math, well below the OECD average of 472, revealing difficulties in interpreting data and applying knowledge in practical situations (PISA, 2022). Problem-based learning (PBL) has been shown to help students apply mathematical concepts to real-world problems effectively (Rézio et. al., 2022).

Students continue to struggle with mathematics because traditional teaching often emphasizes memorization over conceptual understanding, with “rote procedures” dominating classrooms (Cruz & Dela Peña, 2022). Integrating problem-based learning (PBL) has been shown to improve students’ critical thinking, problem-solving, and creative thinking while helping them connect concepts to practical situations (Hasbi & Fitri, 2023). PBL also promotes collaboration and communication skills, and ethnomathematics-based PBL models further enhance critical thinking in mathematics learning (Syahniah et al., 2024). Clearly, students need more than formulas and worksheets; they require meaningful,

engaging experiences that make mathematics relevant to their everyday lives (OECD, 2022).

In today's rapidly changing society, students often struggle with mathematics because traditional teaching emphasizes memorization over understanding, limiting their ability to solve real-world problems (Cruz & Dela Peña, 2022). Problem-Based Learning (PBL) offers a practical approach that fosters critical thinking, problem-solving, and creative engagement with mathematical concepts (Muliawati & Aldin, 2024). By tackling real-life problems, learners develop collaboration, communication, and analytical skills while connecting abstract ideas to everyday situations (Sihaloho & Saragih, 2024). PBL creates meaningful learning experiences that extend beyond formulas and worksheets, helping students see the relevance of mathematics in their daily lives (OECD, 2022).

Research has demonstrated that problem-based and contextual instruction improves comprehension, retention, and confidence in solving mathematical problems (Hasbi & Fitri, 2023). By engaging with problems rooted in real-life scenarios, learners can bridge the gap between abstract concepts and practical applications, thereby enhancing their critical thinking and problem-solving skills in mathematics (Muliawati & Aldin, 2024). PBL also fosters motivation and persistence, as students actively investigate, discuss, and propose solutions, which contributes to deeper learning (Sihaloho & Saragih, 2024). Constructivist principles further support PBL as an effective instructional strategy, as learning is most meaningful when students actively construct knowledge by linking new concepts to prior understanding (Syahnia et al., 2024).

Through problem-solving in authentic contexts, learners develop both cognitive and emotional engagement, allowing them to connect mathematical concepts to practical

situations (Rézio et al., 2022). PBL encourages collaboration, reflection, and critical thinking, which strengthens understanding and promotes mastery of mathematical concepts (Bosica et al., 2021). Studies highlight that real-life and problem-based approaches enhance learners' problem-solving skills and appreciation of mathematics (Ng et al., 2020). Applying mathematical concepts to everyday situations, such as analyzing data, interpreting patterns, or solving practical problems, helps students perceive mathematics as relevant and useful, fostering curiosity, intrinsic motivation, and active participation (Wijayanti et al., 2022).

Despite the benefits of problem-based and contextual instruction, many classrooms still rely heavily on traditional, abstract teaching methods that emphasize memorization over meaningful engagement (Cruz & Dela Peña, 2022). Such approaches limit students' ability to connect mathematical concepts to real-life situations and reduce opportunities for critical thinking and problem-solving (Amalia et al., 2024). There remains a need for instructional strategies, such as PBL, that integrate collaborative problem-solving with authentic scenarios to enhance understanding and develop practical competencies in mathematics (Rézio et al., 2022). Implementing these strategies allows learners to actively investigate, discuss, and apply concepts, fostering deeper comprehension and relevance of mathematical knowledge in everyday contexts (Sihaloho & Saragih, 2024).

There appears to be an empirical gap in prior research. Few studies have rigorously examined the direct effects of problem-based learning on students' mastery of measures of position and probability. Some unexplored aspects, particularly the development of higher-order thinking skills (HOTS) and effective problem-solving strategies, are crucial for secondary mathematics education. While existing studies highlight engagement and

relevance (Hasbi & Fitri, 2023), fewer investigate how PBL improves students' analytical, interpretive, and application skills in Statistics and Probability (Muliawati & Aldin, 2024).

Previous research has largely focused on qualitative analyses of students' attitudes and perceptions toward problem-based learning (Sihaloho & Saragih, 2024), rather than quantitative studies measuring mastery and application outcomes (Syahnia et al., 2024). No study has empirically evaluated whether PBL leads to measurable improvements in students' ability to use statistical concepts meaningfully beyond the classroom (Wijayanti et al., 2022). Very little research has addressed the long-term effects of problem-based and contextual instruction on students' engagement, appreciation, and cognitive development in understanding Statistics and Probability as part of everyday life (Miles, 2017).

Problem-Based Learning (PBL) follows a structured process that promotes active engagement and critical thinking among learners (Hasbi & Fitri, 2023). It begins with presenting a real-world problem that is relevant and meaningful to students' experiences. Learners then collaborate to identify what they already know, determine learning needs, and gather resources to solve the problem (Muliawati & Aldin, 2024). During this process, students conduct research, analyze information, and propose solutions while applying mathematical concepts (Sihaloho & Saragih, 2024). Finally, learners present their findings, reflect on their reasoning, and receive feedback, ensuring knowledge is constructed through inquiry and active problem-solving (Syahnia et al., 2024).

Problem-Based Learning (PBL) is highly effective in teaching measures of position and probability because it connects abstract concepts to real-life situations and engages students with authentic tasks such as analyzing survey results or calculating statistical measures and probabilities (Rézio et al., 2022; Wijayanti et al., 2022). This approach

strengthens computational and interpretive skills, helping learners reason, solve problems, and appreciate the relevance of Statistics and Probability beyond the classroom (Ng et al., 2020). Aligned with SDG 4: Quality Education, PBL promotes learner-centered instruction and fosters motivation, confidence, and mastery, preparing students to apply statistical reasoning in everyday life and future academic tasks (Wibowo et al., 2025).

This research examines the effect of Problem-Based Learning (PBL) on strengthening Grade 10 students' mastery of measures of position and probability during the S.Y. 2025–2026 in one of the secondary public schools in Ozamiz City. The study aims to show how engaging students in real-world problem-solving improves their understanding, analytical skills, and application of statistical and probabilistic concepts. It addresses an empirical gap regarding the effectiveness of PBL in developing both competence and practical problem-solving abilities. The findings can guide teachers and policymakers in improving mathematics instruction. Ultimately, the study seeks to enhance meaningful learning beyond the classroom in public schools across Ozamiz City.

Strategy

Problem-Based Learning (PBL) is an instructional approach that engages students in solving real-world problems while developing critical thinking and problem-solving skills. The goal is to make learning interactive and meaningful by connecting mathematical concepts to authentic situations. Students work collaboratively to analyze problems, identify necessary information, and apply statistical and probabilistic concepts to propose solutions. This strategy encourages active participation, enhances conceptual understanding, and strengthens practical application of measures of position and probability.

PBL is a structured approach where learners tackle complex problems in small groups to achieve shared learning objectives. Research shows that PBL improves academic performance, motivation, and higher-order thinking skills (Amalia et al., 2024). Real-life problem-solving enhances understanding, retention, and relevance of mathematical concepts (Rézio et al., 2022). PBL fosters collaboration, analytical reasoning, and practical application of mathematics, making it especially effective in secondary education (Hezron et al., 2024). Additionally, PBL promotes engagement, confidence, and the ability to apply concepts beyond the classroom (Rahayu & Firdaus, 2025).

To implement PBL in teaching measures of position and probability, begin by identifying clear learning objectives aligned with statistical and probabilistic concepts. Design real-world problems, such as analyzing survey data, interpreting test scores, or calculating probabilities from daily scenarios. Form small collaborative groups with diverse abilities and learning styles. Guide students through identifying known information, determining learning gaps, and researching solutions. Encourage discussion, critical thinking, and application of formulas to propose and justify solutions.

Establish a structured workflow so that groups systematically tackle all problem scenarios, integrating reflection sessions to discuss findings. Use formative assessments to evaluate both individual understanding and group performance. Provide guidance and scaffolding as needed, ensuring that students remain engaged and on-task. Conclude with a synthesis session to consolidate learning and reinforce critical concepts. Gather feedback for improvement to ensure that PBL strengthens mastery, problem-solving skills, and meaningful application of measures of position and probability.

Statement of the Problem

This study aimed to determine the effect of Problem-Based Learning (PBL) as an instructional strategy for strengthening grade 10 students' problem-solving skills of position during the School Year 2025–2026 in one of the public secondary schools in Ozamiz City. Specifically, it will seek to answer the following questions:

1. What is the learners' problem solving skills in measures of position before the implementation of Problem-Based Learning?
2. What is the learners' problem solving skills in measures of position after the implementation of Problem-Based Learning?
3. What is the learners' level of engagement and motivation in measures of position before the implementation of Problem-Based Learning?
4. What is the learners' level of engagement and motivation in measures of position after the implementation of Problem-Based Learning?
5. Is there a significant difference in the learners' problem solving skills in measures of position before and after the implementation of Problem-Based Learning?
6. Is there a significant difference in the learners' level of engagement and motivation in measures of position before and after the implementation of Problem-Based Learning?

Null Hypotheses

H₀₁: There is no significant difference in the learners' problem solving skills in measures of position before and after the implementation of Problem-Based Learning

H₀₂: There is no significant difference in the learners' level of engagement before and after the implementation of Problem-Based Learning.

RESEARCH METHODOLOGY

Research Design

This study employed a quantitative research approach using a one-group pretest-posttest design to examine the effectiveness of Problem-Based Learning (PBL) in strengthening Grade 10 students' mastery of measures of position and probability. A pretest-posttest design was used as a widely accepted research methodology that evaluates the effectiveness of an intervention by measuring participants' knowledge or skills before and after the instructional treatment (Hasbi & Fitri, 2023). In the context of PBL, this design allowed researchers to assess how real-world, problem-based tasks influenced students' mastery, problem-solving skills, and application of statistical and probabilistic concepts (Muliawati & Aldin, 2024). This design had chosen due to its practicality in classroom settings and its ability to measure learning gains over a defined instructional period (Rézio et al., 2022).

Research Setting

This study was conducted in one of the secondary public high schools in Ozamiz City, Misamis Occidental, Philippines. This institution offered a complete senior high school program, including Grade 10 mathematics, which cover statistics and probability. The research focused on Grade 10 students enrolled in the mathematics strand, particularly those studying measures of position and probability.

A single section of Grade 10 students was selected as respondents for this study. This group was ideal for examining the effects of Problem-Based Learning (PBL) on mastery

and problem-solving skills, as these learners developed foundational competencies in statistical reasoning (Hasbi & Fitri, 2023). By assessing their experiences with PBL, this study aimed to determine how problem-based instructional methods will influence mathematical understanding, analytical thinking, and practical application of statistical and probabilistic concepts (Muliawati & Aldin, 2024). PBL provided opportunities for learners to engage in collaboration, discussion, and active problem-solving (Rézio et al., 2022). It also foster critical thinking and deeper conceptual understanding (Sihaloho & Saragih, 2024).

Respondents of the Study

This study included Grade 10 students enrolled in a public high school in Ozamiz City, Misamis Occidental, Philippines, for the S.Y. 2025–2026. Purposive sampling was employed to ensure that the selected respondents were actively studying measures of position and probability and directly engaged in problem-solving activities (Hasbi & Fitri, 2023). Only students who were consent to participate was included, ensuring adherence to ethical research standards (Sihaloho & Saragih, 2024). This selection aimed to address the gap in research on the effectiveness of Problem-Based Learning (PBL) in improving students' mastery, problem-solving skills, and application of statistical and probabilistic concepts (Muliawati & Aldin, 2024). By focusing on this group, the study provided insights into how PBL can enhance meaningful learning in secondary mathematics (Rézio et al., 2022).

Research Instrument

The study used the following questionnaire as a data gathering instrument:

A. Problem-Based Learning Assessment Test (Appendix A). This researcher-designed test developed to evaluate Grade 10 students' mastery and problem-solving skills in measures of position and probability before and after the implementation of Problem-Based Learning (PBL). The test was created based on previous studies emphasizing the effectiveness of PBL in enhancing students' analytical thinking, conceptual understanding, and practical problem-solving abilities (Hasbi & Fitri, 2023). It consisted of 50 items structured around real-life problem scenarios, aligned with PBL activities conducted over four sessions spanning four weeks. Each session will last 60 minutes, including a 10-minute pretest, a 40-minute PBL instructional activity, and a 10-minute posttest. The test was measured problem-solving performance based on statistical reasoning, logical application of measures of position and probability, and strategy development for analyzing real-world data problems (Rézio et al., 2022).

To assess students' mastery and problem-solving skills, the study used a 5-point Likert scale, where 5 represents the highest level of proficiency and 1 represents the lowest:

Scores	Remarks
47-50	Outstanding
44-46	Very Satisfactory
42-43	Satisfactory
40-41	Fair
38-39	Poor
1-37	Very Poor

The validity and reliability of the PBL Assessment Test were established through expert consultations, pilot testing, and statistical validation. Mathematics educators and assessment specialists reviewed the test content to ensure alignment with Grade 10 competencies in statistics and probability. A pilot study was conducted to assess clarity, coherence, and difficulty, and Cronbach's alpha was used to measure internal consistency. Previous research highlights that PBL assessments enhance students' problem-solving abilities, critical thinking, and engagement, as they provide authentic, meaningful tasks that connect mathematics to real-life scenarios (Syahnia et al., 2024).

B. Student Engagement and Problem-Solving Motivation Questionnaire (Appendix B). This researcher-made questionnaire was designed to assess students' engagement and motivation levels in a Problem-Based Learning (PBL) environment. The instrument uses a 5-point Likert scale, with responses ranging from Strongly Disagree (1) to Strongly Agree (5), adapted from Song et al. (2025). It comprises 20 items categorized into four key constructs: Cognitive Engagement (5 items), Affective Engagement (5 items), Behavioral Engagement (5 items), and Motivation (5 items). These constructs evaluate how students interact with PBL activities, their level of enthusiasm, and their persistence in problem-solving tasks. This questionnaire was highly relevant to the study as it measures the impact of PBL on student engagement and motivation in learning measures of position and probability.

The instrument was administered as both a pre-assessment before the intervention and a post-assessment after completing all PBL sessions, allowing for a comparative analysis of changes in student engagement and motivation. Previous research has shown that PBL positively influences student participation, collaboration, and willingness to

tackle authentic problem-solving tasks, making it an essential aspect of this study (Sihaloho & Saragih, 2024).

The validity and reliability of the Student Engagement and Problem-Solving Motivation Questionnaire were established through expert consultations, pilot testing, and statistical validation. Mathematics educators and assessment specialists reviewed the questionnaire items to ensure alignment with Grade 10 competencies in statistics and probability and with PBL instructional objectives. A pilot study was conducted to assess clarity, coherence, and relevance, and Cronbach's alpha was used to determine internal consistency. Previous research highlights that questionnaires measuring engagement and motivation in PBL environments effectively capture students' cognitive, affective, and behavioral responses, providing insight into their participation and persistence in problem-solving tasks (Muliawati & Aldin, 2024).

Responses	Continuum	Interpretation
5 – Strongly Agree	4.20-5.00	Extremely High
4 – Agree	3.40-4.19	High
3 – Neutral	2.60-2.39	Moderate
2 – Disagree	1.80 – 2.59	Low
1 – Strongly Disagree	1.00 – 1.79	Extremely Low

C. Lesson Plan (Appendix C). In this study, Problem-Based Learning (PBL) was integrated into the Grade 10 mathematics curriculum, focusing on measures of position and probability. Each of the four sessions began with a pretest to assess students' initial mastery of the concepts, followed by a teacher-facilitated PBL activity, where students engaged in collaborative problem-solving tasks based on real-life scenarios. For example, students

might analyze statistical data from local markets, calculate probabilities related to daily events, or interpret measures of position in community-based datasets. After completing the PBL activities, a posttest was administered to evaluate learning gains and measure the impact of PBL on students' mastery and problem-solving skills. By comparing pretest and posttest scores, this study assessed the effectiveness of PBL in enhancing students' understanding, analytical thinking, and ability to apply statistical and probabilistic concepts to real-world situations (Baiduri et al., 2020).

Data Collection

Prior to data collection, the researcher sought formal approval to conduct the study by submitting letters to the appropriate authorities. The process began with a letter to the School Principal of the selected secondary public high school in Ozamiz City. Once the Principal's approval was granted, a letter was sent to the Program Head and subsequently to the class Adviser, with each authority's consent obtained prior to implementing any data collection procedures. Each letter detailed the objectives, methodology, and scope of the study to ensure full transparency and compliance with institutional policies. After securing institutional approvals, the researcher distributed informed consent forms to the parents or guardians of the STE-10 students, along with assent forms for the students themselves. These forms ensured that parents provide formal permission for their children to participate and that students voluntarily agree to take part in the study.

The study focused on enhancing mastery and problem-solving skills in measures of position and probability through Problem-Based Learning (PBL). Data collection spanned four sessions conducted over four weeks, with each session lasting 60 minutes. Each session begins with a pretest measuring students' initial understanding, followed by PBL activities

facilitated by the researcher, where students engage in collaborative, real-life problem-solving tasks. Each session concluded with a posttest to evaluate immediate learning gains. Although the format of the pretests and posttests will remain consistent, the content will vary to match the objectives of each session.

In addition to the session-based assessments, a pre-assessment questionnaire and PBL mastery administered before the first session to establish baseline mastery and problem-solving skills. After the final session, a post-assessment was conducted to measure overall improvement. Mean scores from the pretests and posttests, as well as the engagement and motivation questionnaire, was analyzed to determine changes in mastery, problem-solving performance, and student engagement. The use of standardized scoring rubrics for all assessments ensured reliable and objective measurement of students' growth throughout the study.

Ethical Consideration

Before conducting the study, ethical considerations were carefully established to prioritize the well-being, rights, and privacy of all participants. Approval will be sought from the Misamis University Research Ethics Board (MUREB) to ensure compliance with institutional and ethical research standards. Additionally, the researcher will ensure that all ethical standards are followed to protect the well-being of the respondents. Approval to conduct the study will be sought from the School Principal, the Grade Level Head, and the class Adviser, with each authority's consent obtained prior to any data collection. These approvals will confirm that the study complies with institutional and research guidelines. Informed consent procedures will be implemented for all participants. Parents or guardians of the selected STE-10 students were provided formal consent, and the students themselves

will give assent, indicating their voluntary participation. Participants will be fully informed of the study's objectives, procedures, potential benefits, and possible risks, and they will have the option to withdraw at any time without negative consequences.

Confidentiality and anonymity were strictly maintained. All collected data will exclude personally identifiable information, and participants will be assigned coded identifiers. Both digital and physical data will be securely stored, with digital files encrypted and physical copies kept in a locked cabinet accessible only to the researcher. These measures will comply with Republic Act No. 10173 (Data Privacy Act of 2012), ensuring participants' privacy, dignity, and security.

The study will be designed to minimize risks and prevent harm. Activities, including Problem-Based Learning (PBL) tasks, will be conducted in a safe and supportive environment, with close supervision to avoid physical, psychological, or emotional distress. By adhering to these ethical considerations, the researcher will safeguard participant welfare while maintaining the integrity and credibility of the study.

Data Analysis

This study utilized the following statistical methods for data analysis using JAMOV software:

Frequency and percentage were employed to examine learners' mastery of measures of position and probability before and after the implementation of Problem-Based Learning (PBL).

Mean and standard deviation were utilized to measure the learners' problem-solving skills in statistics and probability before and after the implementation of PBL. The

mean represented overall performance, while the standard deviation indicated the consistency of responses among participants.

A *paired t-test* were conducted to explore significant differences in learners' mastery of measures of position and probability before and after the implementation of PBL. Likewise, it was applied to assess variations in learners' problem-solving skills before and after the implementation of PBL. This statistical procedure aimed to evaluate the effectiveness of PBL in strengthening students' mastery, analytical thinking, and problem-solving capabilities in real-life statistical and probabilistic contexts.

Dissemination Plan

The findings of this study were disseminated to school administrators, Grade 10 mathematics teachers, and participating students through organized reporting sessions, presentations, and simplified result summaries. These dissemination activities aim to help stakeholders understand how Problem-Based Learning (PBL) enhances students' mastery of measures of position and probability. Ethical procedures such as consent, assent, and data confidentiality will be highlighted when discussing results, ensuring transparency and respect for participants' rights. Furthermore, the results will be shared with the wider academic community through School Learning Action Cells (SLAC), Collaborative Expertise sessions, university presentations, and potential publications, contributing to the improvement of mathematics instruction in secondary education.

Utilization Plan

The results of the study were utilized through Poster Presentation and Publication. A poster summarizing the key findings, conclusions, and recommendations will be

prepared and displayed during academic or research dissemination events. This will allow educators, school stakeholders, and other researchers to easily understand the outcomes of the study and apply its insights in their own contexts. Additionally, the study will be prepared for publication in an academic journal or an institutional research repository to ensure that its contributions reach a wider audience. This will support further research on strengthening pupil engagement, enhancing learning retention, and promoting the effective use of Problem-Based Learning strategies.

Cost Estimate

The estimated budget in the conduct of this study is broken down below from the personal money of the proponent. The proponent has personal laptop and printer.

Materials	Amount
1 ream A4 US bond paper	Php 195.00
1 ream short US bond paper	Php 180.00
1 set 664 ink	Php 1,179.00
2 sliding folders	Php 15.00 x 2 (Php 30.00)
Tokens (any school supplies)	Php 1, 500.00
Snack	Php 1, 500.00
Total	Php 4, 584.00

RESULTS AND DISCUSSIONS

Learners' Problem-Solving Skills in Measures of Position in Mathematics Before the Implementation of Problem-Based Learning

The data in Table 1 shows the learners' problem-solving skills in measures of position in Mathematics before the implementation of Problem-Based Learning (PBL). Overall, their performance was very poor, with an overall mean score of ($M = 22.67$, $SD = 3.91$). All learners ($n = 30$, 100%) were classified under the "Did Not Meet Expectations" level, highlighting a widespread difficulty in solving mathematical problems related to measures of position. These findings suggest that the learners had limited understanding and application of concepts such as quartiles, deciles, and percentiles. This indicates that traditional teaching approaches were not effective in helping learners develop their problem-solving skills in Mathematics.

Several factors may have contributed to this poor performance. These include low student engagement, limited opportunities for critical thinking, lack of collaborative learning activities, minimal exposure to real-life mathematical situations, and insufficient practice in problem-solving tasks. Traditional lecture-based instruction may not have addressed the different learning needs and styles of students, resulting in poor retention and understanding of mathematical concepts. To address these challenges, Problem-Based Learning (PBL) was introduced as an instructional strategy. PBL engages learners in solving contextualized and meaningful problems that encourage active participation, inquiry, and collaboration. This approach aims to enhance learners' engagement,

motivation, and critical thinking skills while allowing them to apply mathematical concepts in authentic situations.

Problem-Based Learning provides a strong alternative to traditional instruction by promoting active learning, collaboration, and higher-order thinking skills. Research by Boye and Agyei (2023) and Sihaloho and Saragih (2024) supports the effectiveness of PBL in improving students' mathematical understanding and critical thinking abilities. Similarly, Maskur et al. (2020) emphasized that PBL enhances learners' creative thinking and problem-solving performance in Mathematics. In addition, Kim et al. (2022) found that guided inquiry and scaffolding within PBL environments significantly improve learners' ability to analyze and solve problems effectively. These findings imply that PBL can help bridge learning gaps and improve students' confidence and engagement in Mathematics.

In summary, the very poor pretest results reveal the limitations of traditional teaching methods and support the need for implementing Problem-Based Learning in teaching measures of position. PBL can strengthen learners' problem-solving skills by promoting active participation, collaboration, and deeper understanding of mathematical concepts. The findings justify the need for more learner-centered instructional approaches that foster engagement, critical thinking, and meaningful learning experiences in Mathematics.

Table 1

Learners' Problem-Solving Skills in Measures of Position in Mathematics Before the Implementation of Problem-Based Learning

Performance	Frequency	Percentage	M	SD
Did Not Meet Expectations	30	100.00	22.67	3.91
Overall Performance	30	100.00	22.67	3.91

Scale: 42-50 (Outstanding); 38-41 (Very Satisfactory); 34-37 (Satisfactory); 30-33 (Fairly Satisfactory); 29 and below (Did Not Meet Expectations)

Learners' Problem-Solving Performance in Mathematics After the Implementation Problem-Based Learning

The data in Table 2 shows how learners performed in problem-solving for Mathematics after the implementation of Problem-Based Learning (PBL). Overall, the learners' performance significantly improved, with an overall mean score of ($M = 43.13$, $SD = 2.05$), which falls under the Outstanding category. Most learners ($n = 28$, 93.33%) achieved an Outstanding rating with a mean score of ($M = 45.25$, $SD = 2.05$), while only a few learners ($n = 2$, 6.67%) were classified under the Very Satisfactory category with a mean score of ($M = 41.00$, $SD = 0.00$). These findings indicate a remarkable improvement in learners' problem-solving skills in measures of position after the implementation of PBL. The results suggest that learners developed a deeper understanding of mathematical concepts and became more capable of solving complex mathematical problems effectively.

Several factors may have contributed to this significant improvement in learners' performance. Through Problem-Based Learning, students were exposed to real-life and meaningful mathematical situations that encouraged active participation, collaboration, and critical thinking. Learners became more engaged in the learning process because they

were given opportunities to explore solutions, share ideas, and apply mathematical concepts in authentic contexts. The interactive and student-centered nature of PBL may have increased learners' confidence, motivation, and persistence in solving mathematical problems. As a result, students were able to better understand measures of position and improve their overall mathematical performance.

To address the previous issues of poor performance and low engagement, Problem-Based Learning was introduced as an innovative instructional approach. PBL encourages learners to actively construct knowledge through problem-solving, inquiry, and collaboration. Instead of relying solely on traditional lecture-based teaching, learners participate in discussions, investigations, and cooperative learning activities that promote deeper understanding of concepts. This approach helps students become independent thinkers and active participants in the learning process. Through continuous engagement in meaningful problem-solving tasks, learners were able to strengthen their analytical and reasoning skills in Mathematics.

Problem-Based Learning provides an effective strategy for improving mathematical achievement and problem-solving abilities. Studies by Boye and Agyei (2023) revealed that PBL significantly enhances students' learning outcomes and engagement in Mathematics. Similarly, Maskur et al. (2020) emphasized that PBL improves learners' creative thinking and mathematical problem-solving performance. Sihaloho and Saragih (2024) also found that PBL develops students' critical thinking skills and active participation during Mathematics instruction. Furthermore, Kim et al. (2022) highlighted that guided inquiry and scaffolding in PBL environments help learners build confidence and persistence in solving challenging tasks. These studies support the findings

of the present study, showing that PBL can effectively improve both academic performance and students' attitudes toward Mathematics.

In summary, the post-test results in Table 3 highlight the effectiveness of Problem-Based Learning in improving learners' problem-solving performance in Mathematics. The shift from "Did Not Meet Expectations" during the pretest to "Outstanding" after the intervention confirms the positive impact of PBL on students' learning. This instructional approach successfully addressed the learning gaps observed before the intervention by fostering engagement, collaboration, critical thinking, and active participation. The findings support the continued use of Problem-Based Learning as a learner-centered strategy that enhances both mathematical achievement and problem-solving skills in Mathematics.

Table 2

*Learners' Problem-Solving Performance in Mathematics
After the Implementation Problem-Based Learning*

Performance	Frequency	Percentage	M	SD
Outstanding	28	93.33	45.25	2.05
Very Satisfactory	2	6.67	41.00	0.00
Overall Performance	30	100.00	43.13	2.05

Scale: 42-50 (Outstanding); 38-41 (Very Satisfactory); 34-37 (Satisfactory); 30-33 (Fairly Satisfactory); 29 and below (Did Not Meet Expectations)

Learners' Level of Engagement and Motivation in Mathematics Before the Implementation of Problem-Based Learning

The data in Table 3 shows the learners' level of engagement and motivation in Mathematics before the implementation of Problem-Based Learning (PBL). Overall, learners were classified as less engaged, with an overall mean score of ($M = 2.10$, $SD = 0.30$). This indicates that students were not fully involved in the learning process and showed limited interest, participation, and enthusiasm during Mathematics lessons. The findings suggest that learners lacked active involvement and motivation in tasks related to measures of position, which may have negatively affected their mathematical performance and understanding.

The learners' cognitive engagement was also classified as less engaged ($M = 2.12$, $SD = 0.21$). This implies that students exerted limited mental effort in understanding and solving mathematical problems. They may have struggled in analyzing concepts, connecting ideas, and applying critical thinking skills during discussions and activities. The low standard deviation indicates that most learners shared similar levels of low cognitive engagement, reflecting a common difficulty in maintaining focus and deep thinking during Mathematics lessons. Such findings suggest that traditional instructional methods may not have sufficiently stimulated students' curiosity and analytical thinking abilities.

In terms of affective engagement, the learners obtained a mean score of ($M = 1.97$, $SD = 0.40$), which also falls under the less engaged category. This indicates that students had low emotional attachment and interest toward Mathematics. Learners may have viewed the subject as difficult or uninteresting, resulting in feelings of frustration, anxiety, or lack of confidence when solving mathematical problems. Since affective engagement greatly influences students' willingness to participate in classroom activities, low emotional

connection to the subject may have contributed to their limited participation and persistence in learning.

For behavioral engagement, the mean score was ($M = 2.07$, $SD = 0.35$), which likewise reflects a less engaged level. This means that learners showed low levels of participation, attentiveness, and involvement during classroom discussions and activities. Behavioral engagement includes completing tasks, asking questions, and actively cooperating in learning activities, which appeared to be minimal among the learners. The results imply that students lacked initiative and consistent participation in Mathematics lessons, possibly due to limited opportunities for interactive and collaborative learning experiences.

Regarding motivation in problem-solving, the learners obtained a mean score of ($M = 1.86$, $SD = 0.33$), which was also classified as less engaged. This suggests that students were not highly motivated to persist in solving mathematical problems, especially when faced with challenging tasks. Learners may have lacked confidence in their abilities and were easily discouraged when encountering difficulties in measures of position. Low motivation in problem-solving may hinder the development of perseverance, reasoning, and higher-order thinking skills needed for success in Mathematics.

To address the low levels of engagement and motivation shown in Table 2, Problem-Based Learning (PBL) can be implemented to improve the learning experience in Mathematics. The findings reveal that learners were less engaged across all dimensions, including cognitive, affective, behavioral, and motivational engagement, indicating a widespread disconnection from the subject. Through PBL, learners are exposed to real-life and meaningful problems that encourage active participation, collaboration, and inquiry-

based learning. This approach can help students become more mentally engaged, emotionally connected, and behaviorally involved in the learning process while strengthening their motivation to solve mathematical problems.

Problem-Based Learning promotes cognitive engagement by encouraging learners to analyze, reason, and solve authentic mathematical tasks collaboratively. Studies by Boye and Agyei (2023) and Maskur et al. (2020) support the effectiveness of PBL in improving students' mathematical thinking and problem-solving skills. Similarly, Sihaloho and Saragih (2024) emphasized that PBL enhances critical thinking and active participation among learners. Kim et al. (2022) further noted that guided inquiry and scaffolding within PBL environments improve learners' confidence and persistence in solving problems. These findings suggest that PBL can significantly increase students' engagement and motivation in Mathematics by creating a more interactive and learner-centered environment.

Overall, Problem-Based Learning can create a more meaningful and engaging learning environment in Mathematics. It provides opportunities for learners to actively participate, collaborate with peers, and apply mathematical concepts in real-life situations. Through improved engagement across cognitive, affective, behavioral, and motivational dimensions, students are more likely to develop confidence, persistence, and positive attitudes toward Mathematics. The shift from traditional instruction to Problem-Based Learning can therefore help learners become more motivated, participative, and effective problem solvers in Mathematics.

Table 3

*Learners' Level of Engagement and Motivation in Mathematics
Before the Implementation of Problem-Based Learning*

Constructs	M	SD	Remarks
Cognitive Engagement	2.12	0.21	Less Engaged
Affective Engagement	1.97	0.40	Less Engaged
Behavioral Engagement	2.07	0.35	Less Engaged
Motivation in Problem-Solving	1.86	0.33	Less Engaged
Overall Engagement	2.10	0.30	Less Engaged

Scale: 4.20-5.00 (Highly Engaged); 3.40-4.19 (Engaged); 2.60-3.39 (Moderately Engaged); 1.80-2.59 (Less Engaged); 1.00-1.79 (Least Engaged)

**Learners' Level of Engagement and Motivation in Mathematics
After the Implementation of Problem-Based Learning**

The data in Table 4 shows the learners' level of engagement and motivation in Mathematics after the implementation of Problem-Based Learning (PBL). Overall, all engagement and motivation were extremely high ($M = 4.40$, $SD = 0.31$). This indicates that learners became highly involved in the learning process and displayed strong participation, enthusiasm, and focus during Mathematics activities. The findings suggest that students were more motivated and willing to engage actively in meaningful learning experiences. The implementation of Problem-Based Learning likely played an important role in improving learners' engagement and motivation in Mathematics.

The level of cognitive engagement among learners was also rated extremely high ($M = 4.29$, $SD = 0.27$). This means that students became deeply involved in thinking, analyzing, and solving mathematical problems. Learners were able to apply concepts critically and connect mathematical ideas more effectively through problem-solving activities. The use of authentic and challenging tasks in PBL encouraged students to think

critically and become mentally engaged in learning. According to Boye and Agyei (2023), Problem-Based Learning significantly improves learners' creative thinking and higher-order thinking skills in Mathematics.

In terms of affective engagement, the mean score of ($M = 4.42$, $SD = 0.21$) also falls within the extremely high category. This indicates that learners developed a stronger emotional connection and positive attitude toward Mathematics. Students likely found the subject more meaningful, enjoyable, and relevant because they were actively involved in collaborative and real-life problem-solving activities. PBL created a supportive and interactive learning environment that helped reduce anxiety and increase students' confidence in learning Mathematics. Sihaloho and Saragih (2024) emphasized that Problem-Based Learning enhances learners' motivation and positive attitudes toward Mathematics instruction.

For behavioral engagement, learners obtained a mean score of ($M = 4.47$, $SD = 0.18$), reflecting an extremely high level of participation. This means that students consistently participated in classroom discussions, completed activities, and collaborated actively with their peers. Through PBL, learners became more responsible and active participants in the learning process. The problem-solving tasks encouraged students to interact, share ideas, and work cooperatively in finding solutions to mathematical problems. Sihaloho and Saragih (2024) reported that Problem-Based Learning improves students' active participation and classroom involvement in Mathematics learning.

Regarding motivation in problem-solving, learners achieved a mean score of ($M = 4.43$, $SD = 0.27$), which also falls under the extremely high category. This suggests that students became highly motivated to solve mathematical problems and persisted even when

faced with challenging tasks. The collaborative and inquiry-based nature of PBL likely encouraged learners to become more confident and resilient in solving problems related to measures of position. Learners also developed perseverance and determination because they were encouraged to explore different strategies and solutions. Kim et al. (2022) found that guided inquiry and scaffolding within Problem-Based Learning environments improve students' confidence and persistence in problem-solving activities.

Problem-Based Learning addressed all aspects of engagement, including cognitive, affective, behavioral, and motivational engagement. By incorporating real-life situations, collaborative activities, inquiry-based tasks, and meaningful problem-solving experiences, learners became more interested and actively involved in Mathematics. PBL transformed the classroom into a more learner-centered and interactive environment where students were encouraged to think critically, participate actively, and collaborate with others. As a result, learners developed greater confidence and more positive attitudes toward Mathematics.

Problem-Based Learning enhances cognitive engagement by encouraging learners to analyze, reason, and solve authentic mathematical problems collaboratively (Boye and Agyei, 2023). It also improves affective engagement by creating meaningful and enjoyable learning experiences that foster positive attitudes toward Mathematics (Sihaloho and Saragih, 2024). Behavioral engagement is strengthened through active participation, collaboration, and classroom interaction during problem-solving activities (Sihaloho and Saragih, 2024). Motivation in problem-solving is also enhanced because learners are encouraged to persist, explore solutions, and apply critical thinking skills in solving real-life mathematical problems (Kim et al., 2022). Furthermore, Rézio et al. (2022) emphasized

that Problem-Based Learning promotes deeper understanding and engagement in Mathematics through authentic and applied learning experiences.

Overall, Problem-Based Learning created a more engaging, interactive, and learner-centered learning environment in Mathematics. The implementation of PBL improved students' focus, motivation, participation, and attitudes toward the subject. With extremely high levels of engagement across all dimensions, learners were able to develop important skills such as critical thinking, collaboration, creativity, and perseverance. The shift from traditional teaching approaches to Problem-Based Learning effectively addressed learners' needs and improved their learning experiences. As a result, students not only performed better academically but also became more confident, motivated, and enthusiastic in solving mathematical problems.

Table 4

*Learners' Level of Engagement and Motivation in Mathematics
After the Implementation of Problem-Based Learning*

Constructs	M	SD	Remarks
Cognitive Engagement	4.29	0.27	Extremely High
Affective Engagement	4.42	0.21	Extremely High
Behavioral Engagement	4.47	0.18	Extremely High
Motivation in Problem-Solving	4.43	0.27	Extremely High
Overall Engagement	4.40	0.31	Extremely High

Note. scale: 4.20-5.00 (Extremely High); 3.40-4.19 (High); 2.60-3.39 (Moderate); 1.80-2.59 (Low); 1.00-1.79 (Extremely Low)

Significant Difference Between the Learners' Problem-Solving Performance Before and After the Implementation of Problem Based Learning

The data in Table 5 compares learners' engagement levels before and after the implementation of Problem-Based Learning (PBL). The results reveal a very highly significant improvement across all variables, as shown by p-values of 0.000, which are far below the .001 significance level. This leads to the rejection of the null hypothesis (H_0), which stated that there is significant difference between learners' engagement levels before and after the implementation of PBL. These findings confirm that Problem-Based Learning has a strong positive effect on learners' cognitive, affective, behavioral engagement, motivation in problem-solving, and overall confidence. The marked increase from pre- to post-assessment indicates that PBL effectively enhances learners' active participation and deeper understanding in Mathematics.

Specifically, the t-value for cognitive engagement is 37.83*** ($p = 0.000$), indicating a very highly significant improvement in learners' intellectual involvement after the implementation of PBL. This suggests that students became more engaged in analyzing, reasoning, and solving mathematical problems with greater depth and understanding. Through real-world problem situations and collaborative inquiry, learners were able to construct meaningful mathematical connections and develop higher-order thinking skills. Boye and Agyei (2023) emphasized that Problem-Based Learning significantly improves learners' engagement and conceptual understanding in Mathematics, while Agustin et al. (2020) highlighted that PBL promotes deeper cognitive processing through meaningful and contextualized learning experiences.

For affective engagement, the result shows a t-value of 31.48*** ($p = 0.000$), which also indicates a very highly significant improvement. This means that learners developed more positive attitudes, enjoyment, and emotional connection toward Mathematics after the implementation of PBL. Students became less anxious and more confident in facing mathematical tasks due to the supportive and interactive learning environment. Aprilita and Handican (2023) found that students generally perceive PBL positively, as it increases interest and reduces negative emotions toward Mathematics, while Sakir and Kim (2020) noted that PBL enhances students' emotional engagement and learning satisfaction through active participation.

Regarding behavioral engagement, the t-value is 33.15*** ($p = 0.000$), showing a very highly significant difference between pre- and post-implementation results. This indicates that students became more active, participative, and consistent in completing mathematical tasks. The collaborative nature of PBL encouraged learners to engage in group discussions, share solutions, and take responsibility for their learning. Ng et al. (2020) stressed that cooperative problem-based learning increases student participation and interaction, while Sihaloho and Saragih (2024) found that PBL enhances students' active involvement and critical engagement in Mathematics learning activities.

For motivation in problem-solving, the t-value is 34.37*** ($p = 0.000$), the highest level of significance among the engagement variables. This suggests that learners became more persistent, determined, and motivated in solving mathematical problems after exposure to PBL. The use of real-life and challenging problems encouraged students to explore multiple strategies and persist despite difficulties. Maskur et al. (2020) reported that PBL significantly enhances mathematical creativity and motivation, while Yunita et al.

(2020) confirmed through meta-analysis that PBL positively influences learners' problem-solving motivation and creative thinking in Mathematics.

Finally, the overall confidence recorded a t-value of 34.21*** ($p = 0.000$), indicating a very highly significant improvement in learners' self-belief in their mathematical abilities. This shows that students became more confident in solving problems independently and explaining their reasoning. The continuous exposure to structured problem-solving tasks helped strengthen their academic self-efficacy. Syahnia et al. (2024) found that PBL enhances learners' critical thinking and confidence in Mathematics, while Wijayanti et al. (2022) emphasized that problem-based strategies significantly improve learners' mathematical problem-solving confidence and performance.

In conclusion, the findings in Table 6 provide strong evidence that Problem-Based Learning significantly improves learners' cognitive, affective, behavioral engagement, motivation in problem-solving, and overall confidence in Mathematics. These results confirm that PBL is an effective instructional approach in developing deeper understanding, active participation, and stronger self-confidence among learners. By engaging students in meaningful, real-world problem situations, PBL transforms the learning experience into a more interactive, collaborative, and student-centered process that ultimately enhances mathematical performance and engagement.

Table 6

Significant Difference Between the Learners' Problem-Solving Performance Before and After the Implementation of Problem Based Learning

Variables	<i>t</i> value	<i>p</i> value	Decision
Pre-Cognitive Engagement			
Post-Cognitive Engagement	37.83***	0.000	Reject Ho
Pre-Affective Engagement			
Post-Affective Engagement	31.48***	0.000	Reject Ho
Pre-Behavioral Engagement			
Post-Behavioral engagement	33.15***	0.000	Reject Ho
Pre-Motivation in Problem-Solving			
Post- Motivation in Problem-Solving	34.37***	0.000	Reject Ho
Overall Confidence	34.21***	0.000	Reject Ho

*Note: Scale: *** $p < .001$ (Very Highly Significant); ** $p < 0.01$ (Highly Significant); * $p < 0.05$ (Significant); $p > 0.05$ (Not significant)*

Ho: There is no significant difference between the learners' level of engagement before and after the implementation of gamified learning strategies.

Significant Difference Between the Learners' Engagement and Motivation Before and After the Implementation of Problem Based Learning

The data in Table 6 shows the significant difference in learners' problem-solving performance in Mathematics before and after the implementation of Problem-Based Learning (PBL). The mean score before PBL was ($M = 22.67$, $SD = 3.91$), which is interpreted as very low performance under the "Did Not Meet Expectations" level. After the implementation of PBL, the mean score increased significantly to ($M = 43.13$, $SD =$

2.05), which falls under the “Outstanding” category. The computed t-value of ($t = 25.99$) with a p-value of ($p = 0.000$) indicates a highly significant difference between the pretest and posttest results. Since the p-value is less than 0.001, the null hypothesis is rejected, confirming that there is a significant improvement in learners’ problem-solving performance after the implementation of Problem-Based Learning.

The very low pretest performance suggests that learners initially struggled in understanding and applying mathematical concepts related to measures of position. This may be attributed to the limitations of traditional teaching methods, which often focus on procedural learning rather than conceptual understanding and real-life application. As noted by Boye and Agyei (2023), traditional instruction may not effectively develop learners’ higher-order thinking skills, resulting in weak problem-solving performance. Similarly, Maskur et al. (2020) emphasized that students often perform poorly in Mathematics when learning environments do not promote critical thinking and engagement.

In contrast, the significant increase in posttest scores highlights the effectiveness of Problem-Based Learning in improving students’ mathematical performance. Through PBL, learners were exposed to real-life problems that required analysis, collaboration, and critical thinking. This learner-centered approach allowed students to actively construct knowledge rather than passively receive information. Sihaloho and Saragih (2024) found that PBL significantly enhances students’ critical thinking skills and mathematical understanding by engaging them in meaningful problem-solving tasks. In addition, Kim et al. (2022) explained that scaffolding and guided inquiry in PBL environments help learners develop confidence and persistence in solving complex problems.

The decrease in standard deviation from ($SD = 3.91$) before PBL to ($SD = 2.05$) after PBL indicates that learners' performance became more consistent. This suggests that not only did high-performing students improve, but lower-performing students also caught up, leading to a more balanced achievement level. According to Wijayanti et al. (2022), Problem-Based Learning promotes equitable learning outcomes by allowing students to progress through structured problem-solving experiences at their own pace. This consistency reflects improved understanding and reduced learning gaps among students.

The findings of this study are supported by Rézio et al. (2022), who emphasized that Problem-Based Learning enhances students' ability to apply mathematical concepts in real-world contexts, leading to improved achievement. Likewise, Yunita et al. (2020) confirmed through meta-analysis that PBL has a positive effect on students' mathematical thinking and performance across different learning settings. Furthermore, Boye and Agyei (2023) also highlighted that PBL significantly improves students' engagement and problem-solving performance in Mathematics. These studies collectively reinforce the idea that Problem-Based Learning is an effective instructional strategy for improving Mathematics learning outcomes.

In conclusion, the results in Table 5 provide strong evidence that Problem-Based Learning significantly improves learners' problem-solving performance in Mathematics. The highly significant difference between pretest and posttest scores confirms the effectiveness of PBL in addressing learning gaps and enhancing student achievement. By promoting active learning, collaboration, and critical thinking, PBL helps learners develop deeper understanding and stronger problem-solving skills. The findings support the integration of Problem-Based Learning as an effective instructional strategy to improve

Mathematics performance, build learner confidence, and foster meaningful learning experiences.

Table 6

Significant Difference Between the Learners' Engagement and Motivation Before and After the Implementation of Problem Based Learning

Variables	M	SD	T-value	p-value
Before Engaging in Problem-Based Learning	22.67	3.91	25.99***	0.000
After Engaging in Problem-Based Learning	43.13	2.05		

Scale: *** $p < .001$ (Highly Significant); ** $p < 0.01$ (Highly Significant); * $p < 0.05$ (Significant); $p > 0.05$ (Not significant)

SUMMARY, FINDINGS, CONCLUSION, AND RECOMMENDATION

Summary

This study examined the effect of Problem-Based Learning (PBL) on learners' mastery and problem-solving skills in measures of position and probability during the School Year 2025–2026 in a public secondary school in Ozamiz City. It aimed to answer the following specific questions: (1) What is the learners' problem-solving skills in measures of position before the implementation of Problem-Based Learning? (2) What is the learners' engagement and motivation in measures of position before the implementation of Problem-Based Learning? (3) What is the learners' problem-solving skills in measures of position after the implementation of Problem-Based Learning? (4) What is the learners' level of engagement and motivation in measures of position after the implementation of Problem-Based Learning? (5) Is there a significant difference in the learners' problem-solving skills and motivation in measures of position before and after the implementation of Problem-Based Learning? (6) Is there a significant difference in the learners' level of engagement and problem-solving motivation in measures of position before and after the implementation of Problem-Based Learning?

The study used a one-group pretest-posttest research design involving selected learners from a public secondary school. The learners' problem-solving skills, engagement, and motivation were measured before and after the implementation of Problem-Based Learning strategies. The research instruments included a validated problem-solving test in measures of position and probability, as well as survey questionnaires assessing learners'

engagement and motivation. The data gathered were analyzed using mean, standard deviation, and paired sample t-test to determine the significant differences between pretest and posttest results.

Findings

The following are the salient findings of this study:

1. Learners' problem-solving skills in measures of position before the implementation of Problem-Based Learning were very poor, with all students classified under "Did Not Meet Expectations" and scoring below the minimum proficiency level.
2. After the implementation of Problem-Based Learning, learners' problem-solving performance significantly improved and was classified as Outstanding, with most learners achieving high levels of mastery in measures of position.
3. The learners' level of engagement and motivation in Mathematics before the implementation was generally low, with all engagement dimensions (cognitive, affective, behavioral, and motivation in problem-solving) classified as less engaged.
4. Learners' level of engagement and motivation after the intervention was rated as Extremely High, indicating marked improvement across all engagement constructs, including cognitive, affective, behavioral engagement, and motivation in problem-solving.
5. There was a statistically significant difference between the learners' problem-solving performance before and after the implementation of Problem-Based Learning.
6. There was a statistically significant difference between the learners' level of engagement and motivation before and after the implementation of Problem-Based Learning.

Conclusion

Based on the findings, the following conclusions were drawn:

1. Learners demonstrated very poor problem-solving skills in measures of position before the implementation of Problem-Based Learning, as all students were classified under “Did Not Meet Expectations” and scored below the minimum proficiency level. This indicates that learners had limited understanding and difficulty in applying mathematical concepts when taught using traditional methods.

2. Problem-Based Learning significantly improved learners’ problem-solving performance in Mathematics. After the intervention, learners’ performance was classified as Outstanding, with most achieving high levels of mastery in measures of position. This shows that PBL is effective in enhancing learners’ understanding and application of mathematical concepts.

3. Before the implementation of Problem-Based Learning, learners’ level of engagement and motivation in Mathematics was generally low across all dimensions, including cognitive, affective, behavioral engagement, and motivation in problem-solving. This suggests that learners were not actively involved or interested in Mathematics learning, which may have contributed to their low performance.

4. After the implementation of Problem-Based Learning, learners’ engagement and motivation became extremely high across all constructs. This indicates that learners became more active, interested, and emotionally involved in Mathematics learning, showing greater willingness to participate and solve problems.

5. There is a statistically significant difference in learners’ problem-solving performance before and after the implementation of Problem-Based Learning. This

confirms that PBL has a significant positive effect on improving learners' mathematical achievement.

6. There is a statistically significant difference in learners' level of engagement and motivation before and after the implementation of Problem-Based Learning. This implies that PBL effectively enhances learners' cognitive, behavioral, and emotional engagement, as well as their motivation in Mathematics.

Recommendation

Based on the findings and conclusions, the following recommendations are made:

1. Mathematics teachers are encouraged to continue integrating Problem-Based Learning (PBL) strategies in their instruction to further enhance learners' problem-solving skills, engagement, and motivation. Teachers may design real-life and contextualized problems that promote critical thinking, collaboration, and active participation. This approach can make Mathematics more meaningful and help sustain learners' high level of performance and interest.

2. Curriculum developers may strengthen Mathematics learning materials by incorporating Problem-Based Learning activities such as real-world problem scenarios, guided inquiry tasks, and collaborative exercises. These materials should be designed to sustain learners' engagement and support the development of higher-order thinking skills in measures of position and other mathematical topics.

3. School administrators may provide continuous support through training, seminars, and mentoring programs focused on the effective implementation of Problem-Based Learning. Providing adequate instructional materials, time allocation, and classroom

support will help teachers implement PBL more effectively and consistently across Mathematics classes.

4. Policymakers may consider strengthening educational policies that promote learner-centered approaches such as Problem-Based Learning in Mathematics instruction. Including PBL in curriculum frameworks and teacher training programs can ensure its wider adoption and sustainability in improving students' mathematical competence and engagement.

5. Future researchers may conduct further studies on the long-term effects of Problem-Based Learning on students' academic achievement, engagement, and motivation in Mathematics. They may also explore its effectiveness across different grade levels, topics, and learning contexts to further validate and enhance its application in education.

6. Learners are encouraged to actively participate in Problem-Based Learning activities by engaging in discussions, collaborating with peers, and taking initiative in solving mathematical problems. Active participation in PBL activities can help learners further develop their critical thinking, communication, teamwork, and problem-solving skills, leading to deeper understanding and improved academic performance.

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Appendix A

Pretests and Posttests (Problem-Based Learning Assessment Test)

Name: _____ Grade and Section: _____
School: _____ Score: _____

Directions: Read each situation carefully. Choose the letter of the correct answer. Write your answer on the space provided before each number.

PROBLEM SITUATION 1: STUDENT PERFORMANCE ANALYSIS

A mathematics teacher recorded the quiz scores of 9 students to determine who needs remediation and enrichment: 12, 15, 18, 20, 22, 25, 27, 30, 33

- ____ 1. The teacher wants to identify the median performance of the class. What conclusion can be made using Q2?
- | | |
|---|---|
| A. Half of the students scored below 20 | C. Half of the students scored below 25 |
| B. Half of the students scored below 22 | D. Half of the students scored below 30 |
- ____ 2. If a student belongs to Q1, what does it imply about their performance?
- | | |
|---------------------------------|--------------------------------|
| A. They are in the top 25% | C. They are exactly average |
| B. They are below most students | D. They are the highest scorer |
- ____ 3. Why is Q3 important in interpreting student scores?
- | |
|---|
| A. It identifies the lowest score |
| B. It shows the midpoint of data |
| C. It separates the top 25% of students |
| D. It removes outliers |

PROBLEM SITUATION 2: STUDENT ALLOWANCE DISTRIBUTION

A class adviser recorded weekly allowances: 100, 120, 130, 150, 160, 170, 180, 200, 220, 240

- ____ 4. What does P25 represent in this situation?
- | |
|---|
| A. Students who receive the highest allowance |
| B. Students below the lowest 25% spending level |
| C. Students at the median allowance level |
| D. Students above 75% allowance level |
- ____ 5. If a student's allowance is at P75, what can be concluded?
- | |
|--------------------------------------|
| A. They are among the lowest earners |
| B. They are in the middle group |

- C. They belong to higher allowance group
- D. They are the lowest spender

- ____ 6. Why is knowing P50 useful to the adviser?
- A. To identify the highest spender
 - B. To represent the typical student allowance
 - C. To remove extreme values
 - D. To change allowance system

PROBLEM SITUATION 3: EXAM RESULTS INTERPRETATION AND ACADEMIC DECISION-MAKING

A Grade 10 mathematics teacher conducted a 40-item quarterly examination. The scores of 15 students were recorded as follows:

18, 21, 23, 25, 27, 28, 30, 32, 34, 35, 36, 38, 40, 42, 45

- ____ 7. Based on the situation, what does the second quartile (Q2) represent in the class performance?
- A. It represents the lowest performing students in the class
 - B. It represents the highest performing students in the class
 - C. It represents the middle or typical performance of the class
 - D. It represents only the passing students
- ____ 8. If a student's score falls within the first quartile (Q1), what can the teacher conclude about the student's performance?
- A. The student belongs to the top-performing group
 - B. The student performed below most of the class and may need remediation
 - C. The student is exactly at the average level
 - D. The student is among the highest achievers
- ____ 9. The teacher plans to give enrichment activities to students who belong to the third quartile (Q3). What is the best interpretation of this decision?
- A. These students are struggling and need help
 - B. These students represent the lowest 25% of the class
 - C. These students are performing above average and need advanced tasks
 - D. These students failed the exam

PROBLEM SITUATION 4: STORE SALES ANALYSIS AND BUSINESS DECISION-MAKING

A small retail store owner recorded the daily sales (in pesos) over a 10-day period to evaluate the store's performance and identify sales patterns. The recorded daily sales are as follows:

50, 60, 70, 80, 90, 100, 110, 120, 130, 140

- ____ 10. What does D5 represent in business decision-making?

- A. Lowest sales performance
 - B. Average sales performance
- C. Highest sales performance
 - D. Random sales value
- ___ 11. If sales fall below D1, what does it indicate?
 - A. Excellent performance
 - B. Poor sales performance
 - C. Average performance
 - D. High profit
- ___ 12. Why is D9 important for the business owner?
 - A. To identify lowest income
 - B. To identify top-performing sales days
 - C. To compute mean sales
 - D. To remove sales data

PROBLEM SITUATION 5: STUDY HABITS ANALYSIS AND ACADEMIC PERFORMANCE MONITORING

A Grade 10 class adviser conducted a study habits survey to understand how much time students spend studying at home each week. The recorded number of study hours of 9 students are as follows:

1, 2, 3, 4, 5, 6, 7, 8, 9

- ___ 13. What does P50 tell about student study habits?
 - A. Half of students study below this time
 - B. All students study equally
 - C. No students study below it
 - D. It is the highest study time
- ___ 14. If a student is in P75, what does it indicate?
 - A. They study less than most students
 - B. They study more than most students
 - C. They study the least
 - D. They do not study
- ___ 15. What is the importance of percentiles in study habits analysis?
 - A. To rank students fairly
 - B. To remove weak students
 - C. To reduce study time
 - D. To change grades automatically

PROBLEM SITUATION 6: HEIGHT ANALYSIS FOR CLASS MONITORING

A school nurse conducted a health screening of 8 Grade 8 students to monitor their physical development. The recorded heights (in centimeters) are as follows:

140, 145, 150, 155, 160, 165, 170, 175

- ___ 16. What does Q2 represent in interpreting student height?
 - A. Shortest student
 - B. Tallest student
 - C. Middle height value
 - D. Random value

- ____ 17. What does Q1 help identify?
- A. Taller students
 - B. Shorter students
 - C. Average students
 - D. Fast learners
- ____ 18. Why are quartiles useful in real-life data interpretation?
- A. They simplify decision-making
 - B. They remove all data
 - C. They increase errors
 - D. They randomize values

PROBLEM SITUATION 7: ACADEMIC PERFORMANCE AND INTERVENTION

A mathematics teacher uses measures of position to evaluate student performance and decide appropriate interventions such as remediation, enrichment, and recognition.

- ____ 19. The teacher uses the second quartile (Q2) to describe the class performance. What is the best interpretation of Q2 in this situation?
- A. It represents the lowest performing students
 - B. It represents the middle or typical performance of the class
 - C. It represents only the failing students
 - D. It represents the highest achiever
- ____ 20. If a student belongs to the first quartile (Q1), what does this imply about their performance?
- A. The student performed above most of the class
 - B. The student is exactly average
 - C. The student belongs to the lower-performing group
 - D. The student is the highest scorer
- ____ 21. The teacher gives enrichment activities to students in the third quartile (Q3). What is the most appropriate justification for this decision?
- A. They are struggling learners
 - B. They are in the middle level
 - C. They are performing above average
 - D. They failed the exam

PROBLEM SITUATION 8: SCHOOL ATTENDANCE MONITORING

A Grade 8 adviser recorded the number of days students were present in a month: 18, 19, 20, 21, 22, 23, 24, 25, 26, 27

- ____ 22. What does the median attendance (Q2) represent in this situation?
- A. The lowest attendance record
 - B. The highest attendance record
 - C. The typical number of days students are present
 - D. The total number of absences

- ____ 23. If a student's attendance falls in Q1, what conclusion can be made?
- A. The student has very high attendance
 - B. The student may need attendance intervention
 - C. The student has perfect attendance
 - D. The student is above average
- ____ 24. Why are percentiles useful in analyzing attendance records?
- A. To eliminate absences
 - B. To identify patterns and classify attendance levels
 - C. To increase school fees
 - D. To reduce class size

PROBLEM SITUATION 9: LIBRARY USAGE ANALYSIS

A school librarian recorded the number of books borrowed by students in a week:
2, 3, 4, 5, 6, 7, 8, 9, 10, 11

- ____ 25. What does the 50th percentile (P50) represent in this situation?
- A. The lowest number of books borrowed
 - B. The highest number of books borrowed
 - C. The typical number of books borrowed by students
 - D. The total number of books in the library
- ____ 26. If a student belongs to P75, what does this indicate?
- A. The student borrowed fewer books than most
 - B. The student is in the average group
 - C. The student borrowed more books than most students
 - D. The student did not borrow books
- ____ 27. How can the librarian use measures of position in decision-making?
- A. To remove books
 - B. To understand borrowing behavior and improve reading programs
 - C. To reduce library hours
 - D. To assign grades

PROBLEM SITUATION 10: QUIZ PERFORMANCE COMPARISON

A teacher compared quiz scores of students in two sections:

Section A: 15, 18, 20, 22, 25, 28, 30, 32

Section B: 10, 12, 15, 18, 20, 22, 25, 27

- ____ 28. Which section has a higher median performance?
- | | |
|--------------|-------------------------|
| A. Section A | C. Both are equal |
| B. Section B | D. Cannot be determined |
- ____ 29. Why is comparing quartiles between sections useful?

- A. To identify cheating students
- B. To determine which section performs better overall
- C. To remove low scores
- D. To change exam questions

- ____ 30. What does Q3 represent in comparing two sections?
- A. The lowest performance level
 - B. The average performance
 - C. The upper performance group
 - D. The failing students

PROBLEM SITUATION 11: STUDENT BEHAVIOR AND TIME MANAGEMENT

A teacher recorded the number of hours students spend on social media per day:
1, 2, 3, 4, 5, 6, 7, 8, 9

- ____ 31. What does the median social media usage represent?
- A. The highest usage
 - B. The lowest usage
 - C. The typical daily usage
 - D. The total usage
- ____ 32. If a student is in Q3 for social media usage, what does it imply?
- A. They use social media more than most students
 - B. They use it less than most students
 - C. They do not use social media
 - D. They are average users
- ____ 33. How can this data help teachers?
- A. To ban social media completely
 - B. To understand student time management habits
 - C. To increase homework
 - D. To reduce class size

PROBLEM SITUATION 12: FINAL DECISION MAKING

A school administrator uses statistical measures to improve academic programs.

- ____ 34. Which measure divides data into four equal parts?
- A. Percentile
 - B. Decile
 - C. Quartile
 - D. Mean
- ____ 35. Which measure divides data into 100 equal parts?
- A. Quartile
 - B. Decile
 - C. Percentile
 - D. Median
- ____ 36. Which measure is most appropriate for identifying the top 10% of students?
- A. Q1
 - B. D1
 - C. P90
 - D. Q2
- ____ 37. Why are measures of position important in education?

- A. To rank students fairly and interpret data meaningfully
- B. To punish low-performing students
- C. To remove grading systems
- D. To simplify teaching

- ____ 38. What does Q2 best represent in any data set?
- A. Lowest value
 - B. Highest value
 - C. Middle value
 - D. Random value
- ____ 39. Which group represents students above Q3?
- A. Lowest performers
 - B. Average performers
 - C. Top-performing students
 - D. Failing students
- ____ 40. What is the main purpose of using percentiles in education?
- A. To group students into meaningful performance levels
 - B. To reduce workload
 - C. To eliminate exams
 - D. To increase school fees
- ____ 41. If a student improves from Q1 to Q2 level, what does this indicate?
- A. Declining performance
 - B. Improvement in performance
 - C. No change
 - D. Failure
- ____ 42. Which interpretation is correct for students below P25?
- A. High achievers
 - B. Average students
 - C. Students needing support
 - D. Top performers
- ____ 43. What is the advantage of using measures of position instead of raw scores?
- A. They simplify interpretation of performance
 - B. They increase confusion
 - C. They remove data
 - D. They are unnecessary
- ____ 44. Which measure best identifies the typical student performance?
- A. Q1
 - B. Q2
 - C. Q3
 - D. P100
- ____ 45. What does a high P75 value indicate in student performance?
- A. Weak performance
 - B. Strong performance
 - C. No performance
 - D. Random performance
- ____ 46. Why should teachers analyze quartiles in exam results?
- A. To understand student distribution of performance
 - B. To reduce teaching effort
 - C. To avoid grading
 - D. To replace exams
- ____ 47. Mode of 3, 5, 7, 5, 9, 5, 11:

- A. 3
- B. 5

- C. 7
- D. 9

- ____ 47. What does a student in D9 represent?
- A. Low performance group
 - B. Middle group
 - C. Top 10% group
 - D. Failing group
- ____ 48. Which measure is most useful in identifying academic excellence?
- A. Q1
 - B. Q2
 - C. Q3
 - D. D1
- ____ 49. What is the relationship between Q2 and P50?
- A. They are unrelated
 - B. They are equal
 - C. Q2 is higher
 - D. P50 is lower
- ____ 50. Overall, measures of position help teachers to:
- A. Understand, interpret, and make decisions based on data
 - B. Remove students
 - C. Replace teaching
 - D. Avoid analysis

Appendix B

Learners' Engagement and Problem-Solving Motivation Questionnaire (PBL)

Directions: The following statements describe how you approach engagement, motivation, and problem-solving in a Problem-Based Learning (PBL) environment. Please indicate the extent to which each statement applies to you by selecting the most appropriate response. Use the following scale:
Use the following scale: 5 – Slightly Agree | 4 – Neutral | 3 – Slightly Disagree | 2 – Disagree | 1 – Strongly Disagree

Constructor/Indicators	5	4	3	2	1
A. Cognitive Engagement					
1. I actively participate in PBL problem-solving activities.					
2. I try different strategies to solve math problems in a gamified setting.					
3. I focus on improving my mathematical problem-solving skills through PBL.					
4. I analyze my mistakes and adjust my approach when working on PBL problems.					
5. I apply what I learn from PBL activities to real-world mathematical problems.					
B. Affective Engagement					
6. I feel more motivated to solve math problems when engaged in PBL.					
7. I enjoy learning mathematics more when it involves real-life problem-solving.					
8. I feel a sense of accomplishment when I complete a PBL math challenge.					
9. I am excited to participate in math activities that involve collaborative problem-solving.					
10. I feel more confident in solving mathematical problems after PBL activities.					
C. Behavioral Engagement					
11. I actively work with my group to complete PBL tasks successfully.					
12. I willingly engage in extra problem-solving challenges during PBL sessions.					
13. I spend more time practicing math when solving real-world problems in PBL.					
14. I remain persistent even when I struggle with a math problem in PBL activities.					

15. I collaborate with classmates to improve our performance in PBL tasks.					
D. Motivation in Problem-Solving					
16. I challenge myself to solve more difficult problems during PBL activities.					
17. I set goals for improving my problem-solving skills in PBL tasks.					
18. I feel motivated to keep trying when I don't succeed in solving a problem immediately.					
19. I believe PBL helps me develop better problem-solving strategies in mathematics.					
20. I prefer using PBL over traditional methods for improving my mathematical problem-solving skills.					

Appendix C

SAMPLE OF THE FILLED-OUT QUESTIONNAIRE

Name: Maj. B. Alopa Grade and Section: STE 10 - Ciner
School: Danua City National High School Score: 26/50

Directions: Read each situation carefully. Choose the letter of the correct answer. Write your answer on the space provided before each number.

PROBLEM SITUATION 1: STUDENT PERFORMANCE ANALYSIS
A mathematics teacher recorded the quiz scores of 9 students to determine who needs remediation and enrichment: 12, 15, 18, 20, 22, 25, 27, 30, 33

B 1. The teacher wants to identify the median performance of the class. What conclusion can be made using Q2?
A. Half of the students scored below 20
B. Half of the students scored below 22
C. Half of the students scored below 25
D. Half of the students scored below 30

B 2. If a student belongs to Q1, what does it imply about their performance?
A. They are in the top 25%
B. They are below most students
C. They are exactly average
D. They are the highest scorer

D 3. Why is Q3 important in interpreting student scores?
A. It identifies the lowest score
B. It shows the midpoint of data
C. It separates the top 25% of students
D. It removes outliers

PROBLEM SITUATION 2: STUDENT ALLOWANCE DISTRIBUTION
A class adviser recorded weekly allowances: 100, 120, 130, 150, 160, 170, 180, 200, 220, 240

B 4. What does P25 represent in this situation?
A. Students who receive the highest allowance
B. Students below the lowest 25% spending level
C. Students at the median allowance level
D. Students above 75% allowance level

D 5. If a student's allowance is at P75, what can be concluded?
A. They are among the lowest earners
B. They are in the middle group
C. They belong to higher allowance group
D. They are the lowest spender

B 6. Why is knowing P50 useful to the adviser?

Name: Stephen J. Jones
 School: Greene Co. NYS

Grade and Section: STE 10 - Silver
 Score: 29/30

Directions: Read each situation carefully. Choose the letter of the correct answer. Write your answer on the space provided before each number.

PROBLEM SITUATION 1: STUDENT PERFORMANCE ANALYSIS

A mathematics teacher recorded the quiz scores of 9 students to determine who needs remediation and enrichment: 12, 15, 18, 20, 22, 25, 27, 30, 33

- B ① The teacher wants to identify the median performance of the class. What conclusion can be made using Q2?
- A. Half of the students scored below 20
 - B. Half of the students scored below 22
 - C. Half of the students scored below 25
 - D. Half of the students scored below 30
- D ② If a student belongs to Q1, what does it imply about their performance?
- A. They are in the top 25%
 - B. They are below most students
 - C. They are exactly average
 - D. They are the highest scorer
- B ③ Why is Q3 important in interpreting student scores?
- A. It identifies the lowest score
 - B. It shows the midpoint of data
 - C. It separates the top 25% of students
 - D. It removes outliers

PROBLEM SITUATION 2: STUDENT ALLOWANCE DISTRIBUTION

A class adviser recorded weekly allowances: 100, 120, 130, 150, 160, 170, 180, 200, 220, 240

- A ④ What does P25 represent in this situation?
- A. Students who receive the highest allowance
 - B. Students below the lowest 25% spending level
 - C. Students at the median allowance level
 - D. Students above 75% allowance level
- C ⑤ If a student's allowance is at P75, what can be concluded?
- A. They are among the lowest earners
 - B. They are in the middle group
 - C. They belong to higher allowance group
 - D. They are the lowest spender
- C ⑥ Why is knowing P50 useful to the adviser?

Name: Benjamin Y. Chong Grade and Section: SR - Grade 10
 School: PSMS Score: 91/100

Directions: Read each situation carefully. Choose the letter of the correct answer. Write your answer on the space provided before each number.

PROBLEM SITUATION 1: STUDENT PERFORMANCE ANALYSIS

A mathematics teacher recorded the quiz scores of 9 students to determine who needs remediation and enrichment: 12, 15, 18, 20, 22, 25, 27, 30, 33

- B 1. The teacher wants to identify the median performance of the class. What conclusion can be made using Q2?
- A. Half of the students scored below 20
 - B. Half of the students scored below 22
 - C. Half of the students scored below 25
 - D. Half of the students scored below 30
- E 2. If a student belongs to Q1, what does it imply about their performance?
- A. They are in the top 25%
 - B. They are below most students
 - C. They are exactly average
 - D. They are the highest scorer
- C 3. Why is Q3 important in interpreting student scores?
- A. It identifies the lowest score
 - B. It shows the midpoint of data
 - C. It separates the top 25% of students
 - D. It removes outliers

PROBLEM SITUATION 2: STUDENT ALLOWANCE DISTRIBUTION

A class adviser recorded weekly allowances: 100, 120, 130, 150, 160, 170, 180, 200, 220, 240

- B 4. What does P25 represent in this situation?
- A. Students who receive the highest allowance
 - B. Students below the lowest 25% spending level
 - C. Students at the median allowance level
 - D. Students above 75% allowance level
- E 5. If a student's allowance is at P75, what can be concluded?
- A. They are among the lowest earners
 - B. They are in the middle group
 - C. They belong to higher allowance group
 - D. They are the lowest spender
- B 6. Why is knowing P50 useful to the adviser?

Name: Aira Arjeha A Nur Grade and Section: STE 10- Citar
 School: Davao City National High School Score: 49/50

Directions: Read each situation carefully. Choose the letter of the correct answer. Write your answer on the space provided before each number.

PROBLEM SITUATION 1: STUDENT PERFORMANCE ANALYSIS

A mathematics teacher recorded the quiz scores of 9 students to determine who needs remediation and enrichment: 12, 15, 18, 20, 22, 25, 27, 30, 33

- B 1. The teacher wants to identify the median performance of the class. What conclusion can be made using Q2?
- | | |
|---|---|
| A. Half of the students scored below 20 | C. Half of the students scored below 25 |
| B. Half of the students scored below 22 | D. Half of the students scored below 30 |
- B 2. If a student belongs to Q1, what does it imply about their performance?
- | | |
|---------------------------------|--------------------------------|
| A. They are in the top 25% | C. They are exactly average |
| B. They are below most students | D. They are the highest scorer |
- C 3. Why is Q3 important in interpreting student scores?
- | |
|---|
| A. It identifies the lowest score |
| B. It shows the midpoint of data |
| C. It separates the top 25% of students |
| D. It removes outliers |

PROBLEM SITUATION 2: STUDENT ALLOWANCE DISTRIBUTION

A class adviser recorded weekly allowances: 100, 120, 130, 150, 160, 170, 180, 200, 220, 240

- B 4. What does P25 represent in this situation?
- | |
|---|
| A. Students who receive the highest allowance |
| B. Students below the lowest 25% spending level |
| C. Students at the median allowance level |
| D. Students above 75% allowance level |
- C 5. If a student's allowance is at P75, what can be concluded?
- | |
|--|
| A. They are among the lowest earners |
| B. They are in the middle group |
| C. They belong to higher allowance group |
| D. They are the lowest spender |
- B 6. Why is knowing P50 useful to the adviser?

Learners' Engagement and Problem-Solving Motivation Questionnaire (PBL)

Directions: The following statements describe how you approach engagement, motivation, and problem-solving in a Problem-Based Learning (PBL) environment. Please indicate the extent to which each statement applies to you by selecting the most appropriate response. Use the following scale:

Use the following scale: 7 – Strongly Agree | 6 – Agree | 5 – Slightly Agree | 4 – Neutral | 3 – Slightly Disagree | 2 – Disagree | 1 – Strongly Disagree

Constructor/Indicators	5	4	3	2	1
A. Cognitive Engagement					
1. I actively participate in PBL problem-solving activities.	✓				
2. I try different strategies to solve math problems in a gamified setting.	✓				
3. I focus on improving my mathematical problem-solving skills through PBL.	✓				
4. I analyze my mistakes and adjust my approach when working on PBL problems.	✓				
5. I apply what I learn from PBL activities to real-world mathematical problems.	✓				
B. Affective Engagement					
6. I feel more motivated to solve math problems when engaged in PBL.		✓			
7. I enjoy learning mathematics more when it involves real-life problem-solving.		✓			
8. I feel a sense of accomplishment when I complete a PBL math challenge.		✓			
9. I am excited to participate in math activities that involve collaborative problem-solving.		✓			
10. I feel more confident in solving mathematical problems after PBL activities.		✓			
C. Behavioral Engagement					
11. I actively work with my group to complete PBL tasks successfully.		✓			
12. I willingly engage in extra problem-solving challenges during PBL sessions.		✓			
13. I spend more time practicing math when solving real-world problems in PBL.		✓			
14. I remain persistent even when I struggle with a math problem in PBL activities.		✓			
15. I collaborate with classmates to improve our performance in PBL tasks.		✓			
D. Motivation in Problem-Solving					

16. I challenge myself to solve more difficult problems during PBL activities.		/			
17. I set goals for improving my problem-solving skills in PBL tasks.		/			
18. I feel motivated to keep trying when I don't succeed in solving a problem immediately.		/			
19. I believe PBL helps me develop better problem-solving strategies in mathematics.		/			
20. I prefer using PBL over traditional methods for improving my mathematical problem-solving skills.		/			

Alzabut

Learners' Engagement and Problem-Solving Motivation Questionnaire (PBL)

Directions: The following statements describe how you approach engagement, motivation, and problem-solving in a Problem-Based Learning (PBL) environment. Please indicate the extent to which each statement applies to you by selecting the most appropriate response. Use the following scale:

Use the following scale: 7 – Strongly Agree | 6 – Agree | 5 – Slightly Agree | 4 – Neutral | 3 – Slightly Disagree | 2 – Disagree | 1 – Strongly Disagree

Constructor/Indicators	5	4	3	2	1
A. Cognitive Engagement					
1. I actively participate in PBL problem-solving activities.		/			
2. I try different strategies to solve math problems in a gamified setting.	/				
3. I focus on improving my mathematical problem-solving skills through PBL.	/				
4. I analyze my mistakes and adjust my approach when working on PBL problems.		/			
5. I apply what I learn from PBL activities to real-world mathematical problems.	/				
B. Affective Engagement					
6. I feel more motivated to solve math problems when engaged in PBL.		/			
7. I enjoy learning mathematics more when it involves real-life problem-solving.		/			
8. I feel a sense of accomplishment when I complete a PBL math challenge.		/			
9. I am excited to participate in math activities that involve collaborative problem-solving.		/			
10. I feel more confident in solving mathematical problems after PBL activities.		/			
C. Behavioral Engagement					
11. I actively work with my group to complete PBL tasks successfully.		/			
12. I willingly engage in extra problem-solving challenges during PBL sessions.		/			
13. I spend more time practicing math when solving real-world problems in PBL.		/			
14. I remain persistent even when I struggle with a math problem in PBL activities.		/			
15. I collaborate with classmates to improve our performance in PBL tasks.	/				
D. Motivation in Problem-Solving					

16. I challenge myself to solve more difficult problems during PBL activities.		/			
17. I set goals for improving my problem-solving skills in PBL tasks.		/			
18. I feel motivated to keep trying when I don't succeed in solving a problem immediately.	/				
19. I believe PBL helps me develop better problem-solving strategies in mathematics.			/		
20. I prefer using PBL over traditional methods for improving my mathematical problem-solving skills.		/			

AP-APD

Learners' Engagement and Problem-Solving Motivation Questionnaire (PBL)

Directions: The following statements describe how you approach engagement, motivation, and problem-solving in a Problem-Based Learning (PBL) environment. Please indicate the extent to which each statement applies to you by selecting the most appropriate response. Use the following scale:

Use the following scale: 7 – Strongly Agree | 6 – Agree | 5 – Slightly Agree | 4 – Neutral | 3 – Slightly Disagree | 2 – Disagree | 1 – Strongly Disagree

Constructor/Indicators	5	4	3	2	1
A. Cognitive Engagement					
1. I actively participate in PBL problem-solving activities.				/	
2. I try different strategies to solve math problems in a gamified setting.	/				
3. I focus on improving my mathematical problem-solving skills through PBL.			/		
4. I analyze my mistakes and adjust my approach when working on PBL problems.		/			
5. I apply what I learn from PBL activities to real-world mathematical problems.	/				
B. Affective Engagement		/			
6. I feel more motivated to solve math problems when engaged in PBL.			/		
7. I enjoy learning mathematics more when it involves real-life problem-solving.		/			
8. I feel a sense of accomplishment when I complete a PBL math challenge.	/				
9. I am excited to participate in math activities that involve collaborative problem-solving.	/		/		
10. I feel more confident in solving mathematical problems after PBL activities.					/
C. Behavioral Engagement					
11. I actively work with my group to complete PBL tasks successfully.		/			
12. I willingly engage in extra problem-solving challenges during PBL sessions.	/				
13. I spend more time practicing math when solving real-world problems in PBL.			/		
14. I remain persistent even when I struggle with a math problem in PBL activities.			/		
15. I collaborate with classmates to improve our performance in PBL tasks.	/				
D. Motivation in Problem-Solving					

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Directions: The following statements describe how you approach engagement, motivation, and problem-solving in a Problem-Based Learning (PBL) environment. Please indicate the extent to which each statement applies to you by selecting the most appropriate response. Use the following scale:

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A. Cognitive Engagement					
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2. I try different strategies to solve math problems in a gamified setting.	✓				
3. I focus on improving my mathematical problem-solving skills through PBL.	✓				
4. I analyze my mistakes and adjust my approach when working on PBL problems.	✓				
5. I apply what I learn from PBL activities to real-world mathematical problems.	✓				
B. Affective Engagement					
6. I feel more motivated to solve math problems when engaged in PBL.		✓			
7. I enjoy learning mathematics more when it involves real-life problem-solving.		✓			
8. I feel a sense of accomplishment when I complete a PBL math challenge.		✓			
9. I am excited to participate in math activities that involve collaborative problem-solving.		✓			
10. I feel more confident in solving mathematical problems after PBL activities.		✓			
C. Behavioral Engagement					
11. I actively work with my group to complete PBL tasks successfully.		✓			
12. I willingly engage in extra problem-solving challenges during PBL sessions.		✓			
13. I spend more time practicing math when solving real-world problems in PBL.		✓			
14. I remain persistent even when I struggle with a math problem in PBL activities.		✓			
15. I collaborate with classmates to improve our performance in PBL tasks.		✓			
D. Motivation in Problem-Solving					

Arslan

Learners' Engagement and Problem-Solving Motivation Questionnaire (PBL)

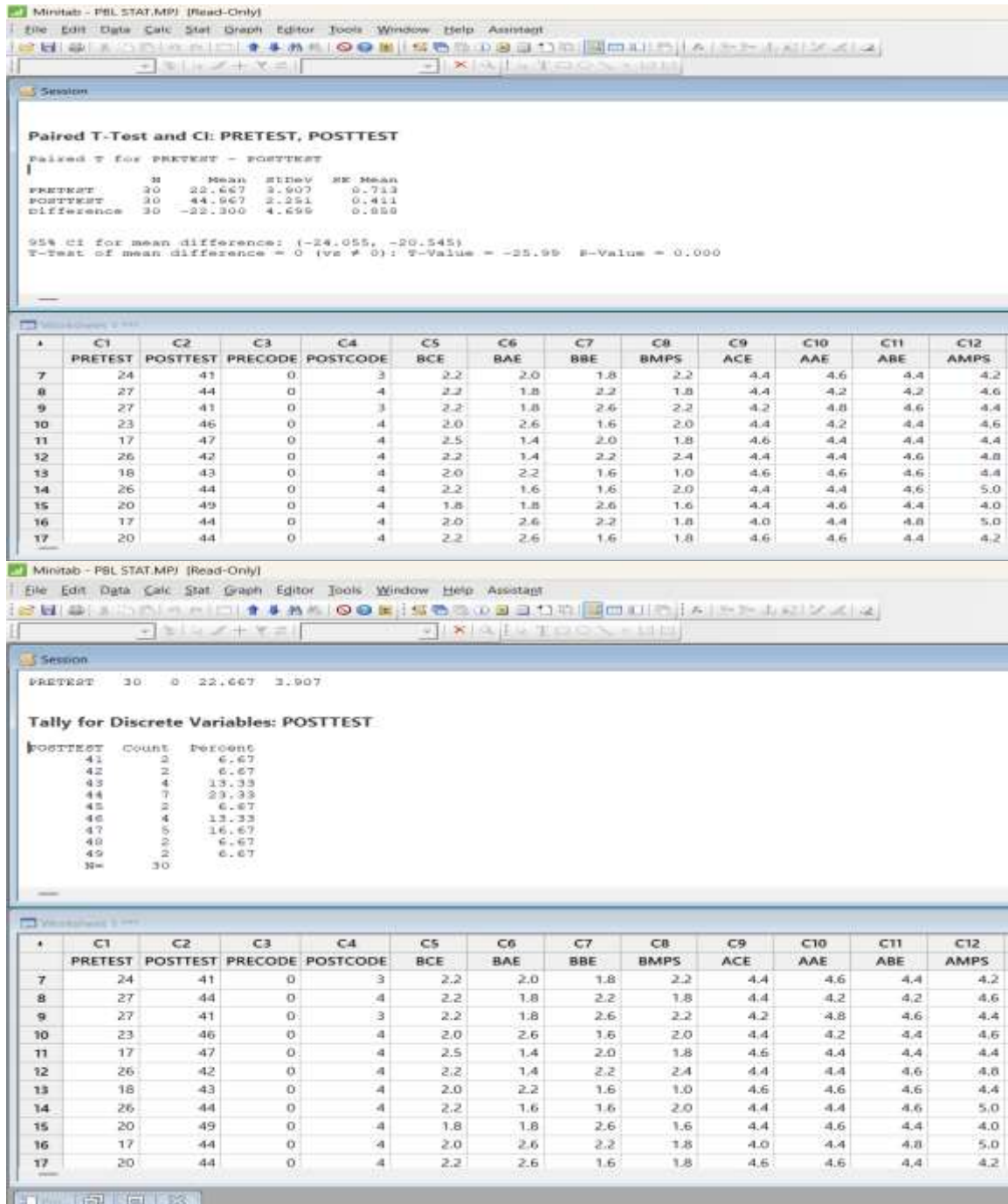
Directions: The following statements describe how you approach engagement, motivation, and problem-solving in a Problem-Based Learning (PBL) environment. Please indicate the extent to which each statement applies to you by selecting the most appropriate response. Use the following scale.

Use the following scale: 7 – Strongly Agree | 6 – Agree | 5 – Slightly Agree | 4 – Neutral | 3 – Slightly Disagree | 2 – Disagree | 1 – Strongly Disagree

Constructor/Indicators	5	4	3	2	1
A. Cognitive Engagement					
1. I actively participate in PBL problem-solving activities.		/			
2. I try different strategies to solve math problems in a gamified setting.			/		
3. I focus on improving my mathematical problem-solving skills through PBL.				/	
4. I analyze my mistakes and adjust my approach when working on PBL problems.		/			
5. I apply what I learn from PBL activities to real-world mathematical problems.		/			
B. Affective Engagement					
6. I feel more motivated to solve math problems when engaged in PBL.		/			
7. I enjoy learning mathematics more when it involves real-life problem-solving.			/		
8. I feel a sense of accomplishment when I complete a PBL math challenge.		/			
9. I am excited to participate in math activities that involve collaborative problem-solving.		/			
10. I feel more confident in solving mathematical problems after PBL activities.		/			
C. Behavioral Engagement					
11. I actively work with my group to complete PBL tasks successfully.			/		
12. I willingly engage in extra problem-solving challenges during PBL sessions.			/		
13. I spend more time practicing math when solving real-world problems in PBL.				/	
14. I remain persistent even when I struggle with a math problem in PBL activities.			/		
15. I collaborate with classmates to improve our performance in PBL tasks.			/		
D. Motivation in Problem-Solving					

Appendix D

SAMPLING COMPUTATION



Minitab - PBL STAT.MPJ (Read-Only)

File Edit Data Calc Stat Graph Editor Tools Window Help Assistant

Session

Paired T-Test and CI: PRETEST, POSTTEST

Paired T for PRETEST - POSTTEST

	N	Mean	StDev	SE Mean
PRETEST	30	22.667	3.907	0.713
POSTTEST	30	44.967	2.281	0.411
Difference	30	-22.300	4.699	0.858

95% CI for mean difference: (-24.055, -20.545)
T-Test of mean difference = 0 (vs ≠ 0): T-Value = -25.99 P-Value = 0.000

Worksheet 1

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
	PRETEST	POSTTEST	PRECODE	POSTCODE	BCE	BAE	BBE	BMPS	ACE	AAE	ABE	AMPS
7	24	41	0	3	2.2	2.0	1.8	2.2	4.4	4.6	4.4	4.2
8	27	44	0	4	2.2	1.8	2.2	1.8	4.4	4.2	4.2	4.6
9	27	41	0	3	2.2	1.8	2.6	2.2	4.2	4.8	4.6	4.4
10	23	46	0	4	2.0	2.6	1.6	2.0	4.4	4.2	4.4	4.6
11	17	47	0	4	2.5	1.4	2.0	1.8	4.6	4.4	4.4	4.4
12	26	42	0	4	2.2	1.4	2.2	2.4	4.4	4.4	4.6	4.8
13	18	43	0	4	2.0	2.2	1.6	1.0	4.6	4.6	4.6	4.4
14	26	44	0	4	2.2	1.6	1.6	2.0	4.4	4.4	4.6	5.0
15	20	49	0	4	1.8	1.8	2.6	1.6	4.4	4.6	4.4	4.0
16	17	44	0	4	2.0	2.6	2.2	1.8	4.0	4.4	4.8	5.0
17	20	44	0	4	2.2	2.6	1.6	1.8	4.6	4.6	4.4	4.2

Minitab - PBL STAT.MPJ (Read-Only)

File Edit Data Calc Stat Graph Editor Tools Window Help Assistant

Session

Descriptive Statistics: BCE, BAE, BBE, BMPS

Variable	N	N*	Mean	StDev
BCE	30	0	2.1167	0.2135
BAE	30	0	1.9733	0.3956
BBE	30	0	2.0667	0.3457
BMPS	30	0	1.8633	0.3285

Descriptive Statistics: ACE, AAE, ABE, AMPS

Variable	N	N*	Mean	StDev
ACE	30	0	4.2867	0.2713
AAE	30	0	4.4200	0.2124

Worksheet 3

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
	PRETEST	POSTTEST	PRECODE	POSTCODE	BCE	BAE	BBE	BMPS	ACE	AAE	ABE	AMPS
7	24	41	0	3	2.2	2.0	1.8	2.2	4.4	4.6	4.4	4.2
8	27	44	0	4	2.2	1.8	2.2	1.8	4.4	4.2	4.2	4.6
9	27	41	0	3	2.2	1.8	2.6	2.2	4.2	4.8	4.6	4.4
10	23	46	0	4	2.0	2.6	1.6	2.0	4.4	4.2	4.4	4.6
11	17	47	0	4	2.5	1.4	2.0	1.8	4.6	4.4	4.4	4.4
12	26	42	0	4	2.2	1.4	2.2	2.4	4.4	4.4	4.6	4.8
13	18	43	0	4	2.0	2.2	1.6	1.0	4.6	4.6	4.6	4.4
14	26	44	0	4	2.2	1.6	1.6	2.0	4.4	4.4	4.6	5.0
15	20	49	0	4	1.8	1.8	2.6	1.6	4.4	4.6	4.4	4.0
16	17	44	0	4	2.0	2.6	2.2	1.8	4.0	4.4	4.8	5.0
17	20	44	0	4	2.2	2.6	1.6	1.8	4.6	4.6	4.4	4.2



14/04/2026 9:26:44 pm

Welcome to Minitab, press F1 for help.

Tally for Discrete Variables: PRECODE, POSTCODE

PRECODE	Count	Percent	POSTCODE	Count	Percent
0	30	100.00	3	2	6.67
N=	30		4	28	93.33
			N=	30	

Descriptive Statistics: PRETEST, POSTTEST

Worksheet 1 ***												
	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12
	PRETEST	POSTTEST	PRECODE	POSTCODE	BCE	BAE	BBE	BMPS	ACE	AAE	ABE	AMPS
7	24	41	0	3	2.2	2.0	1.8	2.2	4.4	4.6	4.4	4.2
8	27	44	0	4	2.2	1.8	2.2	1.8	4.4	4.2	4.2	4.6
9	27	41	0	3	2.2	1.8	2.6	2.2	4.2	4.8	4.6	4.4
10	23	46	0	4	2.0	2.6	1.6	2.0	4.4	4.2	4.4	4.6
11	17	47	0	4	2.5	1.4	2.0	1.8	4.6	4.4	4.4	4.4
12	26	42	0	4	2.2	1.4	2.2	2.4	4.4	4.4	4.6	4.8
13	18	43	0	4	2.0	2.2	1.6	1.0	4.6	4.6	4.6	4.4
14	26	44	0	4	2.2	1.6	1.6	2.0	4.4	4.4	4.6	5.0
15	20	49	0	4	1.8	1.8	2.6	1.6	4.4	4.6	4.4	4.0
16	17	44	0	4	2.0	2.6	2.2	1.8	4.0	4.4	4.8	5.0
17	20	44	0	4	2.2	2.6	1.6	1.8	4.6	4.6	4.4	4.2

Appendix E

6-Week Mathematics Lesson Plan Outline (Grade 10)

Grade Level: 10

Strategy: Problem-Based Learning (PBL)

Focus Topics: Measures of Position (Quartiles, Deciles, Percentiles) & Basic Probability

Framework: 4-Phase PBL Cycle (Problem Presentation, Inquiry/Investigation, Solution Development, Reflection)

Week 1 – Introduction to Measures of Position (Quartiles)

Objectives (SMART):

- Specific: Identify Q1, Q2, and Q3 of a given ungrouped data set.
- Measurable: Correctly solve at least 3 out of 5 quartile problems.
- Achievable: Using structured PBL tasks and data sets.
- Relevant: Understand how quartiles describe real-world data (e.g., test scores).
- Time-bound: Complete tasks within a 60-minute session.

Activities:

1. PBL Problem Presentation: Students analyze a set of mock exam scores to determine who qualifies for honors.
2. Inquiry Task: Students work in groups to identify Q1, Q2, Q3.
3. Guided Discussion: Teacher facilitates steps for calculating quartiles.
4. Independent PBL Task: Students solve 5 quartile-based scenarios.
5. Mini-Assessment: 5-item check for understanding.
6. Reflection: “How did quartiles help me interpret the data?”

Week 2 – Measures of Position (Deciles)

Objectives (SMART):

- Solve for selected deciles (D1–D10) in ungrouped data using PBL activities.

Activities:

1. PBL Starter: "A teacher wants to identify the bottom 10% and top 10% performers—how can she use deciles?"
2. Group Inquiry: Students compute specific deciles from class-provided data.
3. Guided Practice: Teacher models decile formula and application.

4. Independent Work: Students answer 5 PBL problem cards involving deciles.
5. Exit Ticket: 5 quick decile questions.

Week 3 – Measures of Position (Percentiles)

Objectives (SMART):

- Compute percentiles in ungrouped data and interpret meaning in real-life contexts.

Activities:

1. AMS/PBL Scenario: Students interpret percentile ranks from an entrance test.
2. Group Investigation: Compute P25, P50, P90 from sample data.
3. Guided Modeling: Teacher explains percentile computation.
4. Independent PBL Exercises: 5 real-life percentile problems (e.g., height percentile charts).
5. Reflection: “How can percentiles guide decision-making?”

Week 4 – Introduction to Probability (Simple Events)

Objectives (SMART):

- Compute simple probabilities of events using real-life PBL tasks.

Activities:

1. PBL Scenario: “A school club is organizing a raffle. What is the chance of winning?”
2. Group Task: Students compute probabilities using coins, dice, or cards.
3. Guided Practice: Teacher demonstrates probability formula.
4. Independent PBL Task: Solve 5 probability-based situations.
5. Exit Ticket: 5 items on probability of simple events.

Week 5 – Probability of Compound Events

Objectives (SMART):

- Solve compound probability problems using PBL challenges.

Activities:

1. Problem Scenario: Determine chances of drawing two specific prizes from a school event.
2. Group Investigation: Use tree diagrams, lists, or probability rules.
3. Teacher Guidance: Clarify dependent and independent events.
4. Independent Work: Answer 5 compound-probability PBL challenges.
5. Exit Ticket: 5 quick problems.

Week 6 – Application of Measures of Position and Probability (Culminating PBL Task)

Objectives (SMART):

- Apply measures of position and probability in a real-life PBL project.

Activities:

1. PBL Culminating Project:
Students analyze a *school-related dataset* (scores, attendance, or survey results) and apply quartiles, deciles, percentiles, and probability.
2. Group Work: Students compute required statistical measures and probability outcomes.
3. Creation of Output: Infographic or mini-report showing interpretations and conclusions.
4. Presentation: Group sharing of solutions and reasoning.
5. Reflection: “How did PBL help me understand statistics and probability better?”

Appendix F

ACTION RESEARCH WORK PLAN AND TIMELINE **(Grade 10 – Problem-Based Learning on Measures of Position and Probability)**

Week	Focus / Activity	Procedure / Implementation
Week 1	Introduction & Pre-Assessment	- Introduce the research, classroom procedures, and purpose of Problem-Based Learning (PBL). - Present a simple real-life scenario involving test scores to introduce measures of position (quartiles, deciles, percentiles). - Conduct pre-assessment to determine students' baseline mastery in measures of position and probability.
Week 2	PBL Session 1: Quartiles	- Present a problem scenario involving classification of student performance using quartiles. - Guide learners through group-based inquiry and computation of Q1, Q2, and Q3. - Facilitate discussion and reflection on results. - Administer short post-activity assessment to measure progress.

Week 3	PBL Session 2: Deciles and Percentiles	- Provide a real-life scenario involving ranking, scholarships, or selection based on deciles and percentiles. - Students work in pairs/groups to compute required positions and interpret results. - Teacher supports through targeted questioning and feedback. - Administer post-activity assessment to monitor understanding.
Week 4	PBL Session 3: Basic Probability	- Present a problem such as raffle draws or school event chances. - Students conduct guided inquiry on simple probability using real-life contexts. - Group tasks involve listing sample spaces and solving probability questions. - Short assessment administered to assess mastery.
Week 5	PBL Session 4: Compound Probability	- Provide a scenario such as drawing two items, winning multiple events, or selecting multiple outcomes. - Students collaborate to analyze independent and dependent events using tree diagrams or listing methods. - Teacher facilitates solution sharing and error analysis. - Administer quick check for understanding.

Week 6	Culminating Task & Post-Assessment	- Conduct a culminating PBL activity integrating measures of position and probability using real or simulated data (e.g., class scores, survey results, event outcomes). - Students prepare solutions, interpretations, and short presentations. - Administer post-assessment to measure improvement in mastery and problem-solving performance. - Gather student reflections for qualitative insights.
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Appendix G

Greetings!

I, a student researcher of _____ under the program of _____, respectfully request your permission for your child/children, who are under 18 years of age, to participate in our study.

This study aims to determine the effect of Problem-Based Learning (PBL) on students' mastery and problem-solving skills in measures of position and probability. As part of this research, the participants will be asked to answer short activity related to the topic with the use of Problem- Based Strategy. These activities will help your child improve their focus, participation, and ability to remember the lesson, supporting better learning outcomes in Mathematics.

Your participation will be a great help for the success of our study.

Thank you very much!

Respectfully yours,

Researcher

Noted:

ACKNOWLEDGMENT

I have read this consent form and give my consent for my child/children to participate in this study.

Guardian's name: _____

Date: _____

Contact no.: _____

Signature: _____

Approved:

Name: _____

Ethics Review Board Chair

Contact no.: _____

PARENTAL CONSENT

Maayong Adlaw!

Ako, usa ka estudyante-researcher sa _____ ubos sa programa sa _____, mapailubon nga nangayo sa inyong pagtugot aron ang inyong anak/anak nga wala pa moabot sa 18 anyos moapil sa among pagtuon.

Ang pagtuon nagtumong sa pagtuki sa epekto sa Problem-Based Learning (PBL) sa kahibalo ug kahanas sa paghusay og problema sa mga estudyante, ilabi na sa measures of position ug probability. Isip kabahin sa pag-research, ang mga partisipante pangayuan og gamayng mga aktibidad nga may kalabutan sa maong hilisgutan gamit ang Problem-Based Strategy. Kini nga mga aktibidad makatabang sa imong anak nga mapaayo ang ilang konsentrasyon, partisipasyon, ug paghinumdom sa leksyon, ug makatabang usab sa mas maayo nga pagkat-on sa Math.

Ang inyong pagtugot dako kaayong tabang alang sa kalampusan sa among pagtuon.

Daghang Salamat!

Respectfully yours,

Researcher

Noted:

ACKNOWLEDGMENT

Nasabtan nako kini nga porma ug naghatag ko og pagtugot nga moapil ang akong anak/anak sa pagtuon.

Ngalan sa Ginikanan: _____

Contact no.: _____

Petsa: _____

Pirma: _____

Giaprobahan:

Ngalan: _____

Ethics Review Board Chair

Contact no.: _____

Appendix H

KASABUTAN SA PAGTUGOT SA BATA

Ako, si _____, tibuok kasingkasing nga mosugot nga mahimong bahin sa pagtuon nga gitawag nga **“Problem-Based Learning as an Instructional Strategy or Strengthening Grade 10 Students’ Mastery of Measures of Position and Probability”**. Apil sa pamaagi ang pag-observer sa akong partisipasyon sa klase ug ang paggamit sa exit pass aron masuta ang akong pokus ug pagka hinumdoman sa leksyon. Wala kini makadaot ug dili kini makahatag ug sakit o peligro sa akong lawas. Kini nga pamaagi himuon sulod sa takdang oras sa klase ug dili molapas sa kasagaran nga kalihokan sa eskwelahan.

Wala ko gipugos, gikulbaan, o giingnan sa bisan unsang paagi aron moapil niini nga pagtuon.

Pirma sa Estudyante

Petsa

Saksi:

Ngalan ug Pirma sa Ginikanan

Petsa

ASSENT FORM

I, _____, willingly agree to take part in the study titled **Problem-Based Learning as an Instructional Strategy or Strengthening Grade 10 Students' Mastery of Measures of Position and Probability**". Part of the procedure includes observing my participation in class and using an exit pass to check my focus and how well I remember the lesson. This activity is safe and will not cause any harm or discomfort. This procedure will be done only during regular class hours and will not go beyond our usual school activities.

I understand that I am not forced, threatened, or pressured in any way to join this study.

Signature of Student

Date

Witness:

Name and Signature of Parent/Guardian

Date

Ruel Angelo T. Salaranga

Greetings!

I, a student researcher of College of Education under the program of Bachelor of Secondary Education Major in Mathematics, respectfully request your permission for your child/children, who are under 18 years of age, to participate in our study.

This study aims to determine the effect of Problem-Based Learning (PBL) on students' mastery and problem-solving skills in measures of position and probability. As part of this research, the participants will be asked to answer short activity related to the topic with the use of Problem-Based Strategy. These activities will help your child improve their focus, participation, and ability to remember the lesson, supporting better learning outcomes in Mathematics.

Your participation will be a great help for the success of our study.

Thank you very much!

Respectfully yours,

Darife S. Bahoy
Researcher

Noted:

ACKNOWLEDGMENT

I have read this consent form and give my consent for my child/children to participate in this study.

Guardian's name: Ruel Thomas Salaranga
Contact no.: 0909 7873963

Date: 02-02-20
Signature: [Signature]

Ruel Angelo T. Salaranga

Greetings!

I, a student researcher of College of Education under the program of Bachelor of Secondary Education Major in Mathematics, respectfully request your permission for your child/children, who are under 18 years of age, to participate in our study.

This study aims to determine the effect of Problem-Based Learning (PBL) on students' mastery and problem-solving skills in measures of position and probability. As part of this research, the participants will be asked to answer short activity related to the topic with the use of Problem-Based Strategy. These activities will help your child improve their focus, participation, and ability to remember the lesson, supporting better learning outcomes in Mathematics.

Your participation will be a great help for the success of our study.

Thank you very much!

Respectfully yours,

Darife S. Bahoy
Researcher

Noted:

ACKNOWLEDGMENT

I have read this consent form and give my consent for my child/children to participate in this study.

Guardian's name: Ruel Thomas Salaranga
Contact no.: 0909 7873963

Date: 02-02-20
Signature: [Signature]

PARENTAL CONSENT

Maayong Adlaw!

Ako, usa ka estudyante-researcher sa DCNHS ubos sa programa sa STE, mapailubon nga nangayo sa inyong pagtugot aron ang inyong anak/anak nga wala pa moabot sa 18 anyos moapil sa among pagtuon.

Ang pagtuon nagtumong sa pagtuki sa epekto sa Problem-Based Learning (PBL) sa kahibalo ug kahanas sa paghusay og problema sa mga estudyante, ilabi na sa measures of position ug probability. Isip kabahin sa pag-research, ang mga partisipante pangayuan og gamayng mga aktibidad nga may kalabutan sa maong hilisgutan gamit ang Problem-Based Strategy. Kini nga mga aktibidad makatabang sa imong anak nga mapaayo ang ilang konsentrasyon, partisipasyon, ug paghinumdom sa leksyon, ug makatabang usab sa mas maayo nga pagkat-on sa Math.

Ang inyong pagtugot dako kaayong tabang alang sa kalampanan sa among pagtuon.

Daghang Salamat!

Respectfully yours,

David S. Bataj
Researcher

Noted:

ACKNOWLEDGMENT

Nasabtan nako kini nga porma ug naghatag ko og pagtugot nga moapil ang akong anak/anak sa pagtuon.

Ngalan sa Ginikanan: Paul Thomas Soladiego
Contact no.: 0909 2973963

Petsa: 02-2-2020
Pirma: [Signature]

PARENTAL CONSENT

Maayong Adlaw!

Ako, usa ka estudyante-researcher sa College of Education ubos sa programa sa BSED- Mathematics, mapailubon nga nangayo sa inyong pagtugot aron ang inyong anak/anak nga wala pa moabot sa 18 anyos moapil sa among pagtuon.

Ang pagtuon nagtumong sa pagtuki sa epekto sa Problem-Based Learning (PBL) sa kahibalo ug kahanas sa paghusay og problema sa mga estudyante, ilabi na sa measures of position ug probability. Isip kabahin sa pag-research, ang mga partisipante pangayuan og gamayng mga aktibidad nga may kalabutan sa maong hilisgutan gamit ang Problem-Based Strategy. Kini nga mga aktibidad makatabang sa imong anak nga mapaayo ang ilang konsentrasyon, partisipasyon, ug paghinumdom sa leksyon, ug makatabang usab sa mas maayo nga pagkat-on sa Math.

Ang inyong pagtugot dako kaayong tabang alang sa kalampusan sa among pagtuon.

Daghang Salamat!

Respectfully yours,

Dante S. Balmor
Researcher

Noted:

ACKNOWLEDGMENT

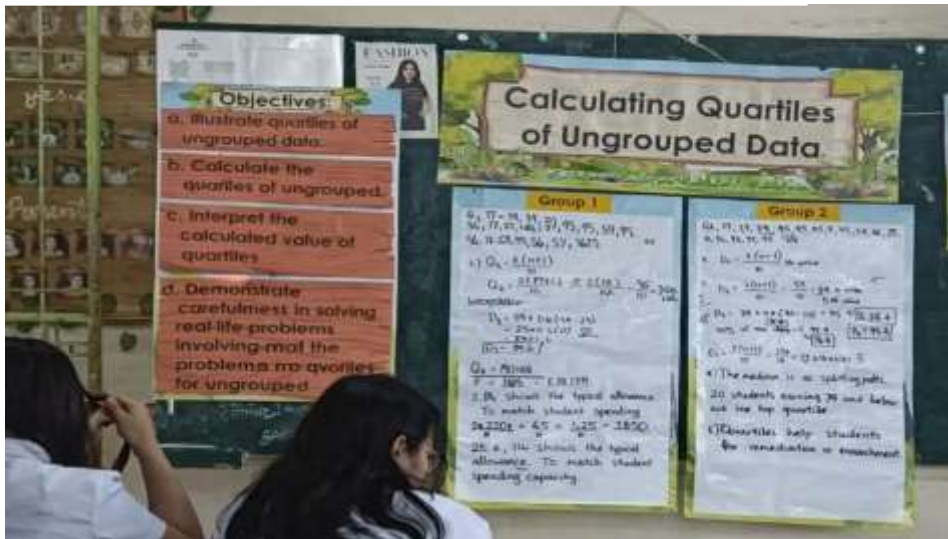
Nasabtan nako kini nga porma ug naghatag ko og pagtugot nga moapil ang akong anak/anak sa pagtuon.

Ngalan sa Ginikanan: _____
Contact no.: _____

Petsa: Dec-02-20
Pirma: _____

Documentation

1st Conduct of Problem Based Learning



3rd Conduct of Problem Based Learning



4th Conduct of Problem Based Learning



Reflections

Reflection 1: Calculating Quartiles of Ungrouped Data

In my action research titled Using Problem-Based Learning to Enhance Students' Problem-Solving Skills, I introduced the concept of calculating quartiles of ungrouped data. This topic is essential in helping students understand how data is divided into four equal parts. I aimed to make the lesson more meaningful by applying problem-based learning strategies. Instead of focusing only on procedures, I wanted students to develop deeper understanding. This approach allowed students to see the relevance of quartiles in real-life situations.

During the lesson, I provided real-life problems where students needed to arrange data and determine quartiles. At first, some students had difficulty organizing the data in ascending order. However, through guided instruction and group collaboration, they were able to overcome these challenges. I noticed that students became more active when solving problems with their peers. They were able to explain their answers and justify their solutions clearly. This showed that problem-based learning improved both their understanding and communication skills.

Overall, the use of problem-based learning made the lesson more engaging and effective. Students were able to understand quartiles beyond simple computation. They developed confidence in solving problems and interpreting data. I also learned that active participation enhances learning outcomes. This experience strengthened my belief in using interactive teaching strategies.

Reflection 2: Calculating Deciles of Ungrouped Data

In this part of my action research, I focused on teaching deciles of ungrouped data. Deciles help divide data into ten equal parts, which is useful in data analysis. I applied problem-based learning to encourage active student participation. My goal was to help students understand the concept through real-life problem situations. I wanted them to move from memorization to meaningful learning.

I presented problem scenarios that required students to compute and interpret deciles. Initially, students found it confusing to determine the correct position of each decile. However, through step-by-step guidance and group discussions, they gradually understood the process. Students became more engaged as they worked together to solve problems. They started asking questions and sharing their ideas confidently. This showed that problem-based learning supported their critical thinking and collaboration skills.

Through this lesson, I observed significant improvement in student participation. Students were able to understand deciles more clearly and apply them correctly. They also developed patience and perseverance in solving complex problems. I realized that learning becomes more effective when students are actively involved. This experience helped me grow as a future mathematics teacher.

Reflection 3: Calculating Percentiles of Ungrouped Data

In teaching percentiles of ungrouped data, I continued to apply problem-based learning in my action research. Percentiles are important in interpreting data and understanding rankings. I aimed to make the lesson relevant by connecting it to real-life situations. This approach helped students see the value of learning percentiles. I wanted them to understand not only the process but also its application.

In teaching percentiles of ungrouped data, I continued to apply problem-based learning in my action research. Percentiles are important in interpreting data and understanding rankings. I aimed to make the lesson relevant by connecting it to real-life situations. This approach helped students see the value of learning percentiles. I wanted them to understand not only the process but also its application.

This lesson showed that real-life connections improve student learning. Problem-based learning helped students understand percentiles in a deeper way. They became more confident in solving and explaining problems. I learned that students learn better when they find meaning in the lesson. This experience inspired me to continue using engaging teaching strategies.

Reflection 4: Calculating Quartiles of Grouped Data

In this lesson, I taught the concept of calculating quartiles of grouped data. This topic is more complex because it involves class intervals and additional formulas. As part of my action research, I used problem-based learning to guide students. My goal was to help them understand the process step by step. I wanted to develop both their computational and analytical skills.

Students were given grouped data and asked to find quartiles using appropriate formulas. Many students initially found the lesson difficult and confusing. However, through guided instruction and group work, they were able to follow the steps correctly. I observed that students became more focused and determined to solve the problems. They helped each other understand the process and clarified misunderstandings. Problem-based learning encouraged them to think critically and persist despite challenges.

Overall, this lesson showed that complex topics can be learned with proper guidance. Students were able to improve their understanding and problem-solving skills. They became more confident in handling grouped data. I realized the importance of patience and support in teaching difficult concepts. This experience strengthened my skills and confidence as a future educator.

		Interpretation (WH-Questions – Sample Answers): • Which score represents the median? The median score is 82, meaning half of the class scored below and above this value. • Who are above Q_3? Students who scored 90 and above are in the top 25%. • Why are quartiles useful? Quartiles help identify students who may need remedial help or advanced activities.
		Interpretation (WH-Questions – Sample Answers): • What allowance range represents most students? Most students receive between P1,525 and P2,175. • Which quartile shows higher allowance earners? Students above Q_3 receive the highest allowances. • Why is Q_2 important? Q_2 represents the typical student allowance. • How can this help planning programs? Programs can be designed based on the spending capacity of most students.

OZAMIZ CITY NATIONAL HIGH SCHOOL

		• $D_3 = 4$ hours $\rightarrow$ students studying 4 hours or below may need guidance to improve study habits • $D_5 = 5$ hours $\rightarrow$ represents the average study time • $D_7 = 7$ hours $\rightarrow$ students studying 7 hours or more are highly disciplined learners or 20% of the students studying 7 hours or more are highly disciplined learners.
IV. EVALUATION	Assessment	

Guide Questions (PBL) • Which students study less than the 3rd decile? • What study time represents the average among students? • Which students belong to the high study-time group?	✓ $D_3 = 4$ hours ◆ D_5 $D_5 = 1.7 \times 5$ $= 8.5$th position • Interpolate between 8th and 9th values (8th = 5, 9th = 5) $D_5 = 5 + 0.5 \times (5 - 5)$ $= 5 + 0$ $= 5$ ✓ $D_5 = 5$ hours ◆ D_8 $D_8 = 1.6 \times 8$ $= 13.6$th position • Interpolate between 13th and 14th values (13th = 7, 14th = 7) $D_8 = 7 + 0.6 \times (7 - 7)$ $= 7 + 0$ $= 7$ ✓ $D_8 = 7$ hours Step 5: Interpretation
--	---

Interpolate between 16th and 17th values (16th = 87, 17th = 99)

$$D_9 = 87 + 0.2(99 - 87)$$

$$\begin{aligned} D_9 &= 87 + 0.2(12) \\ &= 87 + 2.4 \\ &= 89.4 \end{aligned}$$

Step 5: Interpretation

- $D_3 = 34 \rightarrow$ 30% of the students scored 34 or below.
- $D_8 = 81 \rightarrow$ 80% of the students scored 81 or below. Conversely, 20% of the students scored 81 or above 81.
- $D_9 = 87 \rightarrow$ students scoring 87 or above are the top performers or 10% of the students scored 87 or above are considered as the top performers.

Group 2

Problem Situation

A school guidance counselor wants to understand the **study habits of students** to help improve academic performance. The following data show the **number of hours spent studying in one week** by 15 students.

Study Hours:

2, 3, 4, 5, 6, 7, 8, 4, 5, 6, 3, 2, 7, 6, 5

Group Tasks

1. Arrange the data from **lowest to highest**.
2. Determine the **positions** of the following deciles (do not use interpolation):
 - D_3 (low study time)
 - D_5 (average study time)
 - D_9 (high study time)
3. Identify the **hour values** corresponding to each decile.
4. Answer the guide questions below.

Group 2

Step 1: Arrange the data (lowest to highest)

2, 2, 3, 3, 4, 4, 5, 5, 5, 6, 6, 6, 7, 7, 8

Step 2: Number of observations

$$n = 15$$

Step 3: Decile positions formula

$$D_k = \frac{k(n+1)}{10}$$

Step 4: Find the deciles

• D_3

$$D_3 = \frac{3(15+1)}{10}$$

$$\begin{aligned} D_3 &= 1.7 \times 3 \\ &= 5.1 \text{th position} \end{aligned}$$

- Interpolate between 5th and 6th values (5th = 4, 6th = 4)

$$\begin{aligned} D_3 &= 4 + 0.1(-4) \\ &= 4 + 0 \\ &= 4 \end{aligned}$$

You will be rated based on this rubric

Criteria	Excellent (4)	Good (3)	Fair (2)	Needs Improvement (1)	Points
Data Arrangement	All scores are correctly arranged from lowest to highest	Most scores arranged correctly (1-2 errors)	Some scores arranged correctly (3-4 errors)	Scores are mostly unsorted or incorrect	/4
Decile Identification	D ₁ , D ₅ , and D ₉ correctly identified, no interpolation	2 deciles correct, minor mistakes in 1	Only 1 decile correct	None of the deciles correctly identified	/4
Interpretation of Deciles	Correctly explains each decile's meaning and how to lower, upper	Mostly correct explanations, minor details missing	Partially correct explanations, missing some connections	Explanation missing or incorrect	/4
Guide Questions	All guide questions answered clearly, with logical reasoning	Most guide questions answered, minor errors	Some guide questions answered, lacks reasoning	Guide questions unanswered or illogical	/4
Presentation / Neatness	Work is neat, organized, easy to read, and clearly labeled	Work mostly neat, minor organization issues	Work somewhat messy, hard to read	Work messy, disorganized, difficult to read	/4

Group 1

Problem Situation

A teacher recorded the scores of 17 students in a major test. The teacher wants to identify students who belong to the **lower group**, **upper group**, and **top performers** for academic planning.

Scores:

45, 50, 23, 34, 67, 81, 45, 11, 99, 86, 78, 17, 45, 34, 87, 56, 45

Group Tasks

1. Arrange the scores from **lowest to highest**.

Group 1

Step 1: Arrange the data (lowest to highest)

11, 17, 23, 34, 34, 45, 45, 45, 45, 50, 56, 67, 78, 81, 86, 87, 99

Step 2: Number of observations

$$n = 17$$

Step 3: Determine decile positions (NO interpolation)

$$D_k = \frac{k(n+1)}{10}$$

2. Determine the **positions** of the following deciles (do not use interpolation):

- o **D₃** (lower group)
- o **D₈** (upper group)
- o **D₉** (top performers)

3. Identify the **score values** corresponding to each decile.
4. Answer the guide questions below.

Guide Questions (PBL)

- Which students belong to the **lower 30% of the class**?
- Which students belong to the **upper 20%**?
- Who are considered the **top performers** based on D₉?

Expected Group Output

- Ordered list of scores
- Values of **D₃**, **D₈**, and **D₉**
- A short explanation showing how deciles help in **real-life decision-making**

Step 4: Find the required deciles

• **D₃**
 $D_3 = 1.8 \times 3$
 $= 5.4\text{th position}$

Interpolate between 5th and 6th values (5th = 34, 6th = 45)
 $D_3 = 34 + 0.4(45 - 34)$
 $D_3 = 34 + 0.4(11)$
 $= 34 + 4.4$
 $= 38.4$

• **D₈**
 $D_8 = 1.8 \times 8$
 $= 14.4\text{th position}$

Interpolate between 14th and 15th values (14th = 81, 15th = 86)
 $D_8 = 81 + 0.4 \times (86 - 81)$
 $D_8 = 81 + 0.4(5)$
 $= 81 + 2$
 $= 83$

• **D₉**
 $D_9 = 1.8 \times 9$
 $= 16.2\text{th position}$

	Misamis University <i>Ozamiz City</i> MISAMIS UNIVERSITY RESEARCH CENTER CERTIFIED: ISO 21001: 2018 Educational Organizations Management System by DNV ACCREDITED: Philippine Association of Colleges and Universities Commission on Accreditation (PACUCOA)		
MU-RC-042/13 November 2024			
Thesis/Research Data Gathering Approval Form			
Date: _____			
Name of Authors: _____			
College/Department: _____			
Research Title: _____			
Data Gathering Procedure:			
<i>a. Type of Research: (Kindly check)</i>			
☐ Quantitative	☐ Qualitative	☐ Experimental	
☐ Approved Research Title & Problem/Objectives	☐ Approved Data Gathering Procedure	☐ Approved Data Gathering Instrument/Data Sheets	
<i>b. Respondents/Participants/Subject/Samples to be Collected:</i> _____			
<i>c. Procedure:</i>			
☐ Survey	☐ Interview	☐ Experimentation	☐ Laboratory Testing
<i>d. Place of Implementation/Study Area:</i> _____			
<i>If to be conducted outside the school campus, indicate the nature of transportation to be used:</i>			
☐ Own private vehicle	☐ public utility vehicle	☐ rental	☐ Others, please indicate _____
<i>e. Date/s of Implementation/Sampling:</i> _____			
Attachments:			
☐ Approved Letter of Consent from the designated authority in the area/place where the study is to be conducted			
☐ Signed Parents' Consent			
The thesis proposal mentioned above is hereby recommended for the commencement of data gathering implementation.			
Recommended by:			
_____ Thesis/Research Adviser	_____ Thesis/Research Instructor		
Approved by: _____ College Dean			
CONTROLLED DOCUMENT			

Appendix J

INFORMED CONSENT FORM

1. I volunteer to participate in the research undertaken by Darife S. Bahoy from the College of Education, Misamis University. I understand that the research is designed to gather information about using exit pass to strengthen grade 1 pupils' focus and learning retention in mathematics. I will be one of the participants who will be surveyed for this research.
2. My participation in this research is voluntary. I understand that I will not be paid for my participation. I may withdraw and discontinue participation at any time without penalty. If I decline to participate or withdraw from the study, no one will be told.
3. This research will involve my participation. I understand that most questions will find the discussion interesting and thought-provoking. If, however, I feel uncomfortable in any way during the survey session, I have the right to decline to answer any question or to end the survey.
4. The survey will last approximately 3-5 minutes.
5. I understand that the information to be gathered will be treated with confidentiality. I will not be identified in the paper. Only the researchers and their adviser will have access to the data of the research.
6. I understand that this research has been reviewed and approved by the DSAS Head of Misamis University.
7. I have read and understood the explanation provided to me. I have had all my questions answered to my satisfaction, and I voluntarily agree to participate in this study.
8. I have been given a copy of this consent form.

Participant's Signature

Date

For further information, please contact:

Darife S. Bahoy (09562063739/ darife.bahoy2004@gmail.com)

INFORMED CONSENT FORM

1. I volunteer to participate in the research undertaken by Darife S. Bahoy from the College of Education, Misamis University. I understand that the research is designed to gather information about using exit pass to strengthen grade 1 pupils' focus and learning retention in mathematics. I will be one of the participants who will be surveyed for this research.

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8. I have been given a copy of this consent form.



Participant's Signature

February 07, 2026

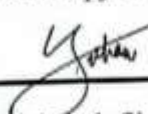
Date

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8. I have been given a copy of this consent form.



 Participant's Signature

02-06-26

 Date

For further information, please contact:

Darife S. Bahoy (09562063739/ darife.bahoy2004@gmail.com)

CURRICULUM VITAE



PERSONAL DATA

Name : Darife S. Bahoy

Address : P-1 Talisay Malauabang, Ozamiz City
Misamis Occidental

Date of Birth : February 27, 2004

Place of Birth : Dulop, Dumingag Zamboanga del Sur

Sex : Female

Civil Status : Single

Parents : Mr. & Mrs. Felipa Bahoy

EDUCATION

College : Bachelor of Secondary Education Major in Mathematics
Misamis University
H.T. Feliciano St., Ozamiz City, Misamis Occidental
2022-2026

Secondary : Senior High School
Misamis University
Ozamiz City, Misamis Occidental
2020-2022

Junior High School
Misamis Annex Integrated School
Ozamis City Carmen, Ozamiz City, Gov. Angel Medina
2015-2020

Elementary : Misamis Annex Integrated School
Ozamis City Carmen, Ozamiz City, Gov. Angel Medina
2009-2015