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Calculating Measures of Position with the Aid of Technology-Driven Problem-Based Learning in Mathematics

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Index Terms:

measures of position, technology-driven problem-based learning, quartiles, deciles, percentiles, mathematics competency

Abstract. This study determined the effectiveness of Technology-Driven Problem-Based Learning (TDPBL) in enhancing Grade 10 learners' competency in calculating measures of position in Mathematics. It focused on quartiles, deciles, and percentiles among learners at Munguia National High School, Dupax del Norte, Nueva Vizcaya. The study was conducted to address learners' low performance in the Data and Probability, particularly in arranging data, locating positional values, applying correct procedures, and interpreting statistical results. TDPBL was used as an intervention because it combines real-life problem situations, guided inquiry, and teacher-made mobile-based video lessons that learners can review at their own pace.The study employed a one-group quasi-experimental design and pretest-posttest evaluations. Thirty-three Grade 10 learners were selected through cluster sampling and total enumeration after the reviewing the Rapid Mathematics Assessment results. A validated 30-item teacher-made test served as the pretest and posttest instrument. The instrument yielded a KR-20 reliability coefficient of 0.72, which indicated acceptable internal consistency. Data were analyzed using mean, standard deviation, and paired sample t-test at the 0.05 level of significance.Results showed that the learners' pretest mean score of 11.15 increased to 19.36 after exposure to TDPBL. Although the overall competency level remained under Did Not Meet Expectations, the increase showed clear improvement in learners' performance. The difference between the pretest and posttest scores was statistically significant, with a computed t-value of -11.44 and a p-value below 0.05. The findings indicate that TDPBL significantly improved learners' competency in calculating measures of position. However, continued guided practice remains necessary, especially in deciles, percentiles, procedural accuracy, and interpretation of results.

Introduction

Mathematics develops logical thinking, analytical reasoning, and problem-solving skills needed in academic and real-life situations. At the secondary level, learners are expected not only to compute but also to interpret mathematical results and apply them meaningfully. However, many learners continue to struggle with mathematical concepts that require reasoning, interpretation, and data-based decision-making.

Statistics and Probability is one of the strands where learners commonly encounter difficulty. In Grade 10 Mathematics, calculating measures of position requires learners to arrange data, locate positional values, apply correct procedures, and interpret results. These competencies include quartiles, deciles, and percentiles, which help describe the relative standing of values within a data set. When learners focus only on formulas, they may compute without understanding what the values represent.

International assessments show that many learners struggle to use mathematics in real-life situations. The Programme for International Student Assessment reported weak performance in tasks that require learners to interpret, reason, and solve problems. In the Philippines, results from national and international assessments also indicate that learners have difficulty in advanced mathematics, especially in Statistics and Probability.

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At Munguia National High School, the Rapid Mathematics Assessment given to Grade 10 learners during the first quarter of School Year 2025–2026 showed serious learning gaps. Out of 110 learners, 109 or 99.09% were classified under the Emerging or Not Proficient level. Only one learner, or 0.91%, reached the Emerging Low Proficient level. None of the learners reached the Developing, Transitioning, Proficient, or Highly Proficient levels. The results also showed zero mastery in the Data and Probability domain, including the competency on calculating measures of position.

Classroom observations and school-based assessments showed the same concern. Learners had difficulty arranging data, finding the correct positional values, and explaining what their answers meant. These difficulties affected their confidence and overall performance in Mathematics. Since the school is located in a rural area and has limited instructional resources, there was a clear need for a practical and focused intervention.

Technology-Driven Problem-Based Learning (TDPBL) was chosen to help address these gaps. It uses real-life problem situations, guided activities, and digital learning materials. Through teacher-made mobile-based video lessons, learners can review the lesson at their own pace and follow the procedures step by step. They can also work on statistical problems that are connected to real situations. This approach follows Polya's problem-solving stages: understanding the problem, devising a plan, carrying out the plan, and looking back.

Although several studies support technology integration and problem-based learning in Mathematics, fewer local studies focus specifically on TDPBL for Grade 10 measures of position in a rural public secondary school. This study addressed that gap by examining whether TDPBL could improve learners' competency in calculating and interpreting quartiles, deciles, and percentiles.

Statement of the Problem

This study determined the effectiveness of Technology-Driven Problem-Based Learning (TDPBL) in enhancing Grade 10 learners' competency in calculating measures of position of a set of data in Mathematics at Munguia National High School. Specifically, it answered the following questions:

1. What is the level of competency of Grade 10 learners in calculating measures of position of a data set before and after exposure to TDPBL intervention?

2. Is there a significant difference between the learners' competency in calculating measures of position before and after the implementation of TDPBL?

Methodology

This study used a quantitative research approach with a one-group quasi-experimental design and pretest-posttest evaluations. This design was appropriate because the study measured the competency of the same group of learners before and after exposure to the intervention.

The study was conducted at Munguia National High School in Dupax del Norte, Nueva Vizcaya during School Year 2025-2026. The respondents were 33 who are Grade 10 learners from the section identified through the Rapid Mathematics Assessment as having the highest concentration of low performance in Data and Probability. Cluster sampling was used to select the class. All learners in the selected section were included. However, participation remained voluntary. Moreover, parental consent was secured.

The research test was a teacher-made 30-item test focused on calculating measures of position, specifically quartiles, deciles, and percentiles. It was aligned with the Grade 10 Mathematics Curriculum Guide and the Table of Specifications. It was validated by experts and pilot-tested with a comparable Grade 10 class. Since the items were scored as correct or incorrect, the Kuder-Richardson Formula 20 was used to determine internal consistency. The computed KR-20 coefficient was 0.72, which indicated acceptable reliability.

The intervention was implemented for two weeks during the fourth quarter. It used mobile-based video lessons and problem-based learning activities. The lessons covered arranging and organizing data, finding quartiles, finding deciles and percentiles, and interpreting measures of position in real-life situations. The activities followed Polya's problem-solving framework. In this framework, learners understand the problem, devise a plan, carry out the plan, and look back at their answers.

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A pretest was administered before the intervention to determine the learners' baseline competency. After the implementation of TDPBL, the same validated test was administered as the posttest. Data were analyzed using mean and standard deviation to describe competency levels, while the paired sample t-test was used to determine whether the difference between pretest and posttest scores was statistically significant at the 0.05 level.

Results and Discussion

The learners' competency in calculating measures of position before and after exposure to TDPBL was analyzed. The results are presented in Table 1.

Measures of Position	Pretest Mean	Pretest SD	Pretest Interpretation	Posttest Mean	Posttest SD	Posttest Interpretation
Quartiles	7.70	2.91	Did Not Meet Expectations	12.55	2.58	Fairly Satisfactory
Deciles	1.58	1.41	Did Not Meet Expectations	3.42	1.62	Did Not Meet Expectations
Percentiles	1.88	1.60	Did Not Meet Expectations	3.39	1.58	Did Not Meet Expectations
Overall	11.15	4.41	Did Not Meet Expectations	19.36	4.94	Did Not Meet Expectations

Table 1. Level of Competency of Grade 10 Learners Before and After Exposure to TDPBL

Table 1 shows the scores of learners before the intervention of TDPBL. Attained mean score is 11.15, which fell under Did Not Meet Expectations. The results indicate that learners had limited competency in calculating measures of position. They performed better in quartiles than in deciles and percentiles, but all areas remained below the expected mastery level.

After the intervention, the overall mean score increased to 19.36. This shows a clear improvement in learners' performance. Quartiles improved to a posttest mean of 12.55 and a qualitative equivalent of Fairly Satisfactory level. However, deciles and percentiles competencies remained under the level of Did Not Meet Expectations. With these results, learners still need support in these areas.

The results suggest that TDPBL helped learners improve their skills in organizing data, following solution steps, and computing measures of position. The lessons enhanced with technology may have helped learners review the procedures at their own pace, while the problem-based activities allowed them to connect computations with real-life situations. Still, the low performance in deciles and percentiles shows that learners require more guidance and practice.

Learners' performance was also analyzed based on Polya's problem-solving framework to determine where improvement occurred. The results are presented in Table 2.

Specific Skill	Pretest Mean	Pretest SD	Pretest Interpretation	Posttest Mean	Posttest SD	Posttest Interpretation
Understand the Problem	5.03	1.81	Did Not Meet Expectations	7.00	1.44	Fairly Satisfactory
Devise a Plan	1.52	1.28	Did Not Meet Expectations	3.85	1.21	Fairly Satisfactory
Carry Out the Plan	0.73	0.94	Did Not Meet Expectations	1.17	1.10	Did Not Meet Expectations
Look Back	3.88	2.22	Did Not Meet Expectations	7.34	2.68	Did Not Meet Expectations
Overall	11.15	4.41	Did Not Meet Expectations	19.36	4.94	Did Not Meet Expectations

Table 2. Learners' Competency Based on Problem-Solving Skills Before and After TDPBL

Table 2 shows that learners improved in all problem-solving skills after the intervention. The highest improvement was observed in the aspects of understanding the problem and devising a plan. Both skills reached the Fairly Satisfactory level

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in the posttest. This indicates that learners can identify a given information correctly, determining what was asked, and selecting appropriate strategies.

However, the stages on carrying out the plan and looking back remained under the level of Did Not Meet Expectations. This means that learners still had difficulty executing computations accurately and interpreting final answers. With these scores, learners' competency between understanding the problem and completing the solution correctly has a noticeable gap. They need more practice to connect procedural fluency and result interpretation.

These findings support the use of Polya's framework in Mathematics instruction. TDPBL helped learners begin the problem-solving process more effectively, but additional guidance is needed to help them complete and evaluate solutions independently.

To determine whether the improvement between the pretest and posttest was statistically significant, a paired sample t-test was conducted. The results are shown in Table 3.

Test	Mean	Mean Difference	t-value	df	p-value / Remark
Pretest	11.15	-8.21	-11.44	32	$p < 0.05$ / Significant
Posttest	19.36				

Table 3. Test of Difference Between Pretest and Posttest Scores

Table 3 shows that the learners' posttest scores were significantly higher than their pretest scores. The computed t-value of -11.44 with 32 degrees of freedom yielded a p-value below 0.05. Therefore, the null hypothesis was rejected.

The result indicates that TDPBL significantly improved the learners' competency in calculating measures of position. The increase from 11.15 to 19.36 shows that the intervention had a positive effect on learners' performance. However, since the overall posttest level remained below the expected standard, the intervention should be strengthened through longer exposure, repeated practice, and support focused in improving performance for difficult subtopics.

Conclusion and Implications

The findings show that Grade 10 learners initially had low competency in calculating measures of position. Their pretest scores indicated limited understanding of quartiles, deciles, and percentiles and showed the need for constant instructional guidance.

After the implementation of Technology-Driven Problem-Based Learning (TDPBL), learners' performance improved in all areas. The improvement was statistically significant. Thus, TDPBL was effective in enhancing learners' competency in calculating measures of position.

Despite the significant improvement, the overall competency level remained under the level of Did Not Meet Expectations. This means that TDPBL can address learning gaps, but it should be supported by guided practice, immediate feedback, and additional activities that strengthen procedural accuracy and interpretation. Longer exposure to TDPBL could also be beneficial to learners having such difficulties.

The study implies that TDPBL instruction can make Statistics lessons more meaningful. Mobile-based video lessons and contextualized problem tasks can help learners review concepts, follow procedures, and connect statistical results to real-life situations.

Recommendations

1. Mathematics teachers are encouraged to integrate Technology-Driven Problem-Based Learning in teaching quartiles, deciles, and percentiles.

2. Teachers may provide more guided practice in carrying out procedures and interpreting results. Step-by-step demonstrations with visual presentations, worked examples, and immediate feedback can help learners improve accuracy and confidence.

3. Lessons may be designed using Polya's problem-solving framework so learners can consistently practice in calculating measures of position.

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4. School administrators may support the implementation of TDPL intervention by providing digital resources, stable internet access where possible, and training opportunities for teachers.

5. Future researchers may conduct similar studies using larger samples, longer intervention periods, or experimental and mixed-method designs. They may also examine other factors such as motivation, attitude toward Mathematics, access to technology, and challenges during implementation.

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Competing Interests Statement

The researcher declares no known competing financial interests or personal relationships that could have influenced the conduct or reporting of this study.

Data Availability Statement

The data that support the findings of this study are available from the researcher upon reasonable request, subject to school approval and confidentiality requirements.

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Appendices

No appendices are attached to this study.

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