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Active-Based Combo in Fortifying Students Performance in Measures of Quantile

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ABSTRACT

This study determined the effectiveness of the Active-Based Learning (ABL) approach in fortifying Grade 10 students' performance in measures of position, particularly quartiles, deciles, and percentiles. A true experimental pretest-posttest control group design was employed among 46 Grade 10 students of Don Alipio Fernandez, Sr. Integrated School during School Year 2025-2026. Two heterogeneous sections were purposively selected because of their low prior performance, after which one section was randomly designated as the experimental group and the other as the control group. Each group consisted of 23 students. The experimental group received three weeks of ABL instruction involving hands-on data manipulation, collaborative problem solving, guided discovery, and real-life applications, whereas the control group received conventional lecture-based instruction. A researcher-made 30-item multiple-choice test served as both pretest and posttest. The instrument obtained an overall expert-validation mean of 4.43, interpreted as very highly valid, and a Cronbach's alpha coefficient of 0.849, indicating high reliability. Descriptive statistics, independent-samples t tests, and paired-samples t tests were used. The groups did not differ significantly at pretest, $t = 0.488$, $p = .628$. At posttest, the experimental group obtained a higher mean score ($M = 23.0870$) than the control group ($M = 17.4348$), with a statistically significant difference, $t = 6.238$, $p < .001$. The experimental group's mean gain of 10.52174 was nearly twice the control group's mean gain of 5.30435. The results demonstrate that ABL was more effective than lecture-based instruction in strengthening students' conceptual understanding and computational performance in measures of position. The study recommends the integration of structured active-learning tasks in secondary mathematics instruction.

Keywords: *Active-Based Learning, Mathematics Education, Measures of Position, Quartiles, Deciles, Percentiles, Experimental Research, Grade 10 Students*

INTRODUCTION

Statistics is central to contemporary life because decisions in education, government, science, business, health, and technology increasingly depend on the collection, organization, interpretation, and communication of data. Statistical competence enables learners to distinguish meaningful evidence from unsupported claims and to make reasoned judgments under uncertainty. Frost (2024) emphasized that statistical practice supports scientific discovery, prediction, and evidence-based decision making, while Sirisilla (2023) described statistics as a systematic means of transforming data into usable knowledge. The continuing expansion of data-intensive occupations further illustrates why schools must develop statistical literacy early and deliberately.

Educational systems have consequently increased the place of probability and statistics in school curricula. Weiland and Sundrani (2022) noted that opportunities for students to learn statistics have expanded across K-12 education, although the quality and depth of those opportunities remain uneven. In the Philippines, mathematics curricula likewise aim to develop reasoning, problem solving, and the ability to interpret quantitative information. Measures of position, including quartiles, deciles, and percentiles, are especially important because they allow learners to locate observations within a distribution and interpret relative standing in academic, social, and practical contexts.

Despite this curricular emphasis, statistics remains difficult for many students. Learners may memorize a formula yet fail to recognize which positional measure is appropriate, arrange data correctly, determine a target location, interpolate when necessary, or explain what the computed value means. Garfield and Ben-Zvi (2008) distinguished conceptual statistical understanding from the mechanical substitution of numbers into formulas. This distinction is important because procedural success alone does not ensure that students can reason with data. Weak foundations, mathematics anxiety, limited contextualization, and insufficient opportunities to discuss reasoning can further restrict achievement.

Conventional instruction frequently places the teacher at the center of classroom activity. Explanations, demonstrations, and individual exercises can communicate procedures efficiently, but they may provide few opportunities for students to test ideas, explain solutions, compare strategies, and connect statistical measures to authentic data. Abedi et al. (2019) observed that traditional one-pace instruction can limit interaction and learner agency. When statistical topics are presented primarily as formula-driven exercises, students may perceive them as abstract and disconnected from daily experience.

Active learning offers an alternative. Felder and Brent (2009) defined active learning as instruction that requires students to do meaningful learning tasks and think about what they are doing. Rather than remaining passive recipients, students discuss, investigate, calculate, interpret, and defend their reasoning. Freeman et al. (2014) found that active learning improves achievement in science, technology, engineering, and mathematics, while Theobald et al. (2020) reported that well-designed active instruction can also reduce achievement gaps. In mathematics, these approaches create opportunities for learners to construct meaning through exploration and feedback.

The Active-Based Learning approach used in this study was grounded in constructivist principles. Piaget's view of knowledge construction emphasizes active intellectual engagement, while Vygotsky's social constructivism highlights learning through interaction, language, scaffolding, and guided participation. In the present intervention, students manipulated data sets, worked collaboratively, solved contextualized problems, presented solutions, and received immediate guidance. These activities were intended to strengthen both procedural fluency and conceptual interpretation.

Related research supports the use of contextualized and participatory strategies in statistics. Fernandez et al. (2020) showed that activity-based workshops using real data can strengthen statistical teaching and reasoning. Funny et al. (2019) found that structured learning activities can elicit reflective thinking in statistics, and Wijaya and Doorman (2021) demonstrated that game-based contexts may support the progressive development of probabilistic understanding. Across these studies, a common principle is that students learn statistical ideas more effectively when they actively engage with representations, situations, and explanations rather than merely copy procedures.

At Don Alipio Fernandez, Sr. Integrated School, assessment records indicated that measures of position were among the least-mastered Grade 10 competencies. This local need justified an intervention focused on quartiles, deciles, and percentiles. The study therefore sought to determine the performance of experimental and control groups in the pretest and posttest and to test differences between groups, within each group, and in their mean gains. It was hypothesized that no significant differences would exist. The study contributes classroom-based evidence on whether ABL can strengthen statistical learning under actual secondary-school conditions.

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METHODS

Research Design

The study used a true experimental pretest-posttest control group design. Both groups completed the same 30-item pretest before instruction and the same form of assessment as a posttest after the three-week intervention. Grade 10-Jade was randomly designated as the experimental group and received ABL instruction, whereas Grade 10-Sapphire served as the control group and received lecture-based instruction. The pretest established baseline comparability, while the posttest and gain scores measured the effect of the instructional approaches.

Research Locale

The research was conducted at Don Alipio Fernandez, Sr. Integrated School in Sitio Isla, Pinmaludpod, Urdaneta City, Pangasinan, during School Year 2025-2026. The school was selected because Grade 10 assessment results identified persistent difficulty in measures of position. The intervention was implemented during regular mathematics instruction, allowing the study to examine the approach under authentic classroom conditions.

Sampling Technique

Purposive sampling was used to identify two Grade 10 sections with similar learning needs and low previous performance in the target competency. One section was then randomly assigned as the experimental group and the other as the control group. Each group included 23 students, for a total of 46 participants. School sectioning practices produced heterogeneous groups in terms of academic ability and learning readiness.

Table 1. *Distribution of Respondents*

Group	Instruction	n	Percentage
Experimental	Active-Based Learning	23	50.00%
Control	Lecture Method	23	50.00%
Total		**46**	**100.00%**

Research Instrument

A researcher-made 30-item multiple-choice achievement test measured competencies in quartiles, deciles, and percentiles. A table of specifications guided item distribution across recall, conceptual interpretation, computation, and analysis. Three Master Teachers specializing in mathematics evaluated the test for clarity, relevance, appropriateness, and alignment. The overall mean rating was 4.43, interpreted as very highly valid. A pilot test among 10 Grade 10 students from another school yielded a Cronbach's alpha coefficient of 0.849, indicating high internal consistency.

Intervention and Data-Gathering Procedure

After securing approval from the school principal and consent from participants and their parents or guardians, the researcher administered the pretest. The experimental group then participated in structured ABL sessions for three weeks. Activities included ordering and manipulating authentic data, locating positional measures, solving problems in pairs or groups, explaining solution pathways, comparing interpretations, and applying quartiles, deciles, and percentiles to grades, sports scores, and survey results. The teacher facilitated learning through questions, prompts, examples, feedback, and corrective scaffolding. The control group received direct explanations, teacher demonstrations, and individual practice exercises covering the same competencies and instructional period. At the end of the intervention, both groups completed the posttest.

Statistical Treatment and Ethical Considerations

Mean, median, standard deviation, variance, skewness, kurtosis, range, and the 75th percentile were used to describe performance. Independent-samples t tests compared the two groups at pretest and posttest, while paired-samples t tests assessed change within each group. Statistical analyses were processed using SPSS Version 25. Participation was voluntary; informed consent and parental or guardian permission were obtained; student identities and scores were treated confidentially; and both groups were provided equitable instructional opportunities.

RESULTS AND DISCUSSION

Performance of the Grade 10 in Pre-Test

The experimental and control groups began with nearly identical mean scores. The experimental group obtained M = 12.5652, while the control group obtained M = 12.1304. Medians were also close to their respective means, and skewness values were near zero, indicating fairly symmetrical distributions. The 75th-percentile values of 15 and 14 showed that most students answered no more than about half of the 30 items correctly. The pretest therefore established a low and comparable baseline.

Table 2. *Descriptive Statistics for Pretest Performance*

Statistic	Experimental	Control
Mean	12.5652	12.1304
Median	13.0000	12.0000
Standard deviation	2.92056	3.12329
Variance	8.530	9.755
Skewness	-0.067	-0.123
Kurtosis	-0.635	-0.456
Range	11.00	12.00
75th percentile	15.0000	14.0000

The relatively similar variance and standard deviation values indicate comparable score dispersion before instruction. This baseline similarity was important because it reduced the likelihood that later differences were caused by initial achievement disparities. The generally low scores also confirmed the instructional need identified in the school's assessment records. As Garfield and Ben-Zvi (2008) explained, students' difficulties in statistics often involve meaning and reasoning, not only calculation, supporting the need for instruction that makes positional concepts visible and discussable.

Performance of the Grade 10 in Post-Test

After the intervention, the experimental group achieved M = 23.0870, compared with M = 17.4348 for the control group. The 5.6522-point posttest gap favored ABL. The experimental group also had a narrower range and lower variance, suggesting that improvement was not limited to a few high-performing students. Its 75th percentile increased to 25, compared with 19 for the control group.

Table 3. *Descriptive Statistics for Posttest Performance*

Statistic	Experimental	Control
Mean	23.0870	17.4348
Median	23.0000	18.0000
Standard deviation	2.79469	3.32793
Variance	7.810	11.075
Skewness	-0.180	0.141
Kurtosis	-0.543	-0.550

Range	10.00	12.00
75th percentile	25.0000	19.0000

These results suggest that hands-on and collaborative tasks enabled students to connect formulas with the ordered position and interpretation of data. The finding is consistent with Felder and Brent (2009), who emphasized purposeful learner activity, and with Theobald et al. (2020), who demonstrated the achievement benefits of active instruction. The lower posttest variability in the experimental group further suggests that the approach supported more consistent learning across participants.

Table 4. *Independent-Samples Comparison of Pretest Means*

Group	n	Mean	t	p	Decision
Experimental	23	23.0870	6.238	<.001	Reject H0
Control	23	17.4348			

The posttest comparison produced t = 6.238 and p < .001; therefore, the null hypothesis was rejected. Students exposed to ABL significantly outperformed those who received lecture-based instruction. The result supports the argument that active participation, collaborative explanation, and contextual application can deepen understanding beyond what is typically achieved through demonstration and individual practice alone. Fernandez et al. (2020) similarly emphasized the usefulness of activity-based work with meaningful statistical tasks.

Within-Group Improvement

Table 6. *Paired Comparisons Within the Experimental and Control Groups*

Group	Pretest M	Posttest M	Mean gain	t	p	Decision
Experimental	12.5652	23.0870	10.52174	98.796	<.001	Reject H0
Control	12.1304	17.4348	5.30435	54.071	<.001	Reject H0

Both groups improved significantly. The control group's gain indicates that structured lecture and practice can increase achievement, particularly when learners receive focused instruction over time. However, the experimental group's gain was almost double that of the control group. This magnitude suggests that ABL added instructional value through opportunities to manipulate data, discuss alternative procedures, receive peer and teacher feedback, and articulate interpretations.

Comparison of Mean Gains

Table 7. *Summary of Learning Gains*

Group	Pretest M	Posttest M	Gain	Relative result
Experimental	12.5652	23.0870	10.52174	Larger gain
Control	12.1304	17.4348	5.30435	Smaller gain

The experimental group's gain of 10.52174 points was 5.21739 points greater than the control group's gain. In practical terms, ABL students improved by about one third of the full 30-point scale beyond the baseline, while the control group improved by about one sixth. The pattern across descriptive and inferential results consistently favors ABL. It also supports constructivist explanations of learning: conceptual understanding becomes more durable when learners actively organize information, test procedures, explain ideas, and connect representations to practical situations.

The findings have direct implications for mathematics instruction. Measures of position should not be taught only as formulas. Teachers can use class scores, household data, sports results, or survey responses to let students order observations, locate target positions, compare computational conventions, and explain the meaning of the resulting quartile, decile, or percentile. Collaborative tasks should include explicit roles and teacher scaffolding so that participation remains purposeful. Short formative checks can then verify individual understanding after group work.

The study is limited to two Grade 10 sections in one school, a three-week intervention, and achievement measured by a 30-item test. Attitudes, motivation, long-term retention, and transfer to other statistics topics were not measured. The unusually large paired t values reported in the thesis should also be rechecked against the original SPSS output before external publication to ensure that the correct test statistics and decimal values were transcribed. Nevertheless, the consistent mean pattern, the nonsignificant baseline difference, and the significant posttest advantage provide classroom-level evidence supporting ABL.

CONCLUSION

Active-Based Learning significantly strengthened Grade 10 students' performance in measures of position. The experimental and control groups began at comparable and generally low achievement levels, but after three weeks the experimental group obtained a substantially higher posttest mean and nearly twice the learning gain of the control group. The combination of hands-on data manipulation, collaborative problem solving, guided discovery, discussion, and contextual application appears to have supported both computational proficiency and conceptual understanding.

The results do not imply that direct instruction has no value, because the control group also improved significantly. Rather, the evidence indicates that lecture-based explanation becomes more effective when complemented or replaced, where appropriate, by structured opportunities for learners to do mathematics, explain reasoning, and apply statistical ideas. Mathematics teachers are encouraged to integrate ABL tasks when teaching quartiles, deciles, and percentiles. School leaders may support implementation through Learning Action Cell sessions, in-service training, shared activity banks, and instructional resources. Further research may replicate the intervention in other schools and grade levels, examine additional mathematics topics, and include measures of retention, attitudes, engagement, and effect size.

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