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CALTECH SEMINAR: ENHANCING GRADE 10 STUDENTS' COMPUTATIONAL THINKING SKILLS IN STATISTICAL MEASURES

Prince Charles T. Cantalejo[1], Alvin D. Libre[2]
[1]*Researcher, Institute of Teacher Education, Kapalong College of Agriculture, Sciences and Technology, Kapalong, Davao del Norte, Philippines*
[2]*Researcher, Institute of Teacher Education, Kapalong College of Agriculture, Sciences and Technology, Kapalong, Davao del Norte, Philippines*

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ABSTRACT

This study examined the effectiveness of CALTECH Seminar in enhancing the computational thinking skills of Junior High School Students under Grade 10 students in statistical measures at Sto. Niño National High School. The researchers proposed an intervention plan named the CALTECH (Scientific Calculator) Seminar. In this seminar, the researchers identified learning competencies related to statistical measures from the Department of Education's K-12 curriculum guide for Junior High School – Mathematics – 10. The researchers implemented CALTECH Seminar intervention in the subject, Mathematics – 10, which deals with statistical measures. Employing a quantitative-descriptive method supplemented with interviews, the study provided a comprehensive understanding of the computational thinking skills and the effectiveness of the CALTECH Seminar intervention. Twenty-Nine Grade-10 Banahaw students purposefully and categorizing them into instructional and frustration groups based on their pretest scores. The intervention included using the Survey Questionnaire to evaluate computational thinking skills before and after implementing CALTECH Seminar. Findings revealed a substantial difference in the scores before and after the intervention. The mean pre-test score was 23.28% (needs improvement), while the mean post-test score was 79.48% (highly satisfactory. Moreover, results showed that students performed better in the post-test than the pre-test, implying a significant difference between the two test scores, t (28) =17.5, p<.001, with a standardized effect size of Cohen's d=3.23. To provide a comprehensive understanding of the students' experiences, the researchers conducted in-depth interviews with selected participants. From their responses, five (5) themes were identified from the insights of students: 1) difficulties in applying statistical concepts pre-intervention; 2) enhancing problem-solving skills; 3) improving computational thinking; 4) building confidence in solving statistical problems; and 5) incorporating real-world applications enhance learning. In conclusion, the CALTECH Seminar was effective in enhancing the computational thinking skills in statistical measures of the students.

KEYWORDS: *CALTECH Seminar, Computational Thinking Skills, İnteractive Learning Approaches, Quantitative-Descriptive, Philippines*

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INTRODUCTION

Many students struggle to apply Computational Thinking (CT) skills when faced with complex, data-driven problems. This often stems from a lack of critical thinking specifically, the inability to analyze situations, question assumptions, recognize biases, and consider multiple perspectives (Nurmalasari et al., 2024). Consequently, their approach to statistical measures becomes unstructured, lacking the logical reasoning and precision needed for accurate data interpretation. Moreover, low student acceptance of CT and the absence of effective assessment tools hinder the proper evaluation and development of these essential skills (Huda & Rohaeti, 2024). Studies further revealed that students' thinking skills are not being adequately developed or applied in educational settings, limiting their ability to engage with and understand statistical content (Salwadila & Hapizah, 2024).

In Universiti Teknologi MARA, Malaysia, according to Han et al. (2024), reveals that about 6.55% of students struggle academically due to the limited focus on computational thinking (CT) skills in the national education system. This gap not only affects their academic progress but also puts their future careers at risk in an increasingly digital world. Similarly, Universitas Swadaya Gunung Jati, Indonesia, as reported by Aminah et al. (2023), shares a similar concern, with around 36% of students facing difficulties in mathematical problem-solving linked to weak CT skills. Many of these students find it hard to break down complex problems, apply abstract ideas to real-life situations, and confidently use computational tools,

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challenges that diminish their overall learning experience. Meanwhile, the University of Birmingham, United Kingdom, as discussed by Kang (2024), points to broader systemic issues such as a lack of awareness among teachers and policymakers, insufficient training, and the absence of structured CT curricula. Together, these studies paint a picture of students across different countries facing real, everyday struggles in adapting to the demands of a digital era, largely because their educational environments have yet to fully embrace the teaching of computational thinking.

In Central Mindanao University, Bukidnon, Philippines, students continue to struggle with computational thinking skills despite 63.0% (75) coming from private schools and 37.0% (44) from public schools; while they manage basic operations, they lack the ability to derive formulas and solve problems involving plane and solid figures (Panagdato et al., 2024). Similarly, in Alubijid National Comprehensive High School, Cagayan de Oro, Philippines, 66.66% of Grade 9 students showed low math performance, with a pretest mean of 10.2 (SD = 3.35), revealing a lack of foundational learning in mathematics; although the Personalized Worksheet and Friends Tutorial (PWAFT) strategy helped improve results, the gap remains evident (Ocor, 2024). Meanwhile, in a public high school in southern Negros Occidental, Grade 11 students showed only developing-level performance in General Mathematics, with notable gaps in both verbal and nonverbal math skills across strands and sexes indicating a continued lack of computational thinking that hampers overall academic achievement (Parcon & Bearneza, 2024).

In the Division of Davao del Norte, particularly in Sto. Niño National High School, it was noticed that some Junior High School students are struggling with computational thinking skills, particularly in their Statistical Measures subject. Because of this, the researchers anticipated that students will also have poor skills in Measures of Central Tendency, Measures of Variability, and Measures of Position during their class in Mathematics-10 in the third and fourth grading. The school has limited resources and doesn't have early intervention programs to help solve this issue. To support a positive and inclusive learning environment, it's important to understand and address these students' specific learning needs by creating targeted interventions.

The purpose of this study was to determine the improvement of the students' computational thinking skills in statistical measures upon the implementation of the intervention called the CALTECH Seminar that was planned by the researchers. It highlighted the diagnosis of students' knowledge and skills on the competencies of Mathematics – 10 based on the Department of Education' curriculum guide. Also, an assessment was be made after giving support or intervention to the students on the competencies that were found difficult for the students after overseeing the diagnostic test results. This study aimed to apply CALTECH Seminar in the core subject, Mathematics-10, of the Junior High School students under the Grade 10 – Banahaw. Moreover, this study wanted to solidify the computational thinking skills of the students' competencies as foundation in order to succeed in Mathematics – 10. The researchers utilized the most essential learning competencies for Mathematics – 10 based on the Department of Education's K-12 curriculum guide that becames in crafting diagnostic test and post-test.

In review, Peteros et al. (2021), in *"Attitudes and Computational Thinking Skills Validation of Grade Ten Pupils at Don Vicente Rama Memorial National High School in Cebu City, Philippines Through Calculator Utilization"*, found that anxiety in using calculators negatively affected students' computational thinking. Another research study conducted by Balacuit et al. (2024), in *"Incorporating Computational Thinking in Mathematics through Block-Based Programming"*, showed that home, teacher, and learner factors significantly influenced Grade 10 students' skills. Furthermore, a study of Rafli et al. (2024), in *"Implementation of Computational Thinking in Data Structure Subject Using Problem-based Learning Models"*, without proper use of SHM methodology, which relies on statistical measures, students struggled to develop computational thinking effectively. Despite the existence of the aforementioned studies, the researchers proposed a new way to integrate a seminar in enhancing the computational thinking skills of the students. Specifically, the researchers wanted to integrate CALTECH (Scientific Calculator) Seminar as a tool to enhance the computational thinking skills in statistical measures among the Junior High School students. The researchers found it as a new and specific approach in incorporating a tool in education.

Research Questions

The research questions below were to investigate on enhancing students' computational thinking skills in statistical measures in order to succeed in Mathematics – 10. The CALTECH Seminar was an intervention for the learners to address this problem. The research questions that guide this study use the following:

1. What is the level of the enhancing the computational thinking skills demonstrated by grade 10 students on the pre-test?
2. What is the level of the enhancing the computational thinking skills demonstrated by grade 10 students on the post-test?
3. What is the significant difference between pre-test and post-test employing the CALTECH Seminar intervention?
4. What are the insights of the students on the effectiveness and areas for improvement of CALTECH Seminar in enhancing statistical measures?

PROPOSED INTERVENTION/PLAN

The researchers implemented the CALTECH (Scientific Calculator) Seminar as a three-week intervention aligned with the K-12 Mathematics Curriculum Guide for Grade 10, focusing on statistical measures of central tendency, variability, and position. Conducted at Sto. Niño National High School, the intervention began with a 20-item pre-test to assess students' baseline knowledge. Designed and facilitated by pre-service teachers, the CALTECH Seminar used active learning, real-life

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data applications, and collaborative strategies to enhance the computational thinking skills of Grade 10-Banahaw students.

In Week 1, the CALTECH Seminar introduced Measures of Central Tendency—mean, median, and mode, through real-life examples like class scores and household data. Visual aids such as graphs and infographics made the concepts more accessible. Students worked in groups to compute averages and create their own problems, while peer-led discussions and interactive questioning encouraged logical and systematic thinking.

In Week 2, the focus shifted to Measures of Variability, including range, variance, standard deviation, and interquartile range. A refresher on integers and absolute values laid the groundwork. CALTECH methods like number lines, visual aids, and scaffolded worksheets supported understanding. Students analyzed real data sets and received feedback from peers and facilitators, strengthening their grasp of data dispersion.

In Week 3, the Measures of Position, including quartiles, deciles, and percentiles—were taught using relatable examples like test rankings and sports stats. Digital tools and games helped students visualize and interpret data. Activities included creating cumulative frequency tables and box plots, encouraging collaboration and analytical thinking through inquiry-based learning.

The three-week CALTECH Seminar effectively combined visuals, collaboration, real-world applications, and reflective learning. At Sto. Niño National High School, even non-developer students showed progress. Post-tests and interviews with participants confirmed significant improvements in computational thinking and confidence in solving statistical problems.

Table 1. Matrix of the Intervention

The CALTECH Seminar		
Phase		**Duration**
Week 1	A 20-item pre-test was administered to assess students' baseline knowledge of statistical measures. After the pre-test, the researchers able to Introduce the Measures of Central Tendency, the mean, median, and mode in a CALTECH Seminar.	5 days
Week 2	The researchers will have a lesson on Measures of Variability, including range, variance, standard deviation, and interquartile range, in a CALTECH seminar.	5 days
Week 3	The researcher gave a discussion on measures of position, including quartiles, deciles, and percentiles, in a CALTECH seminar. After the seminar, the researcher was able to administer a 20-item post-test parallel to the pre-test, along with student interviews.	5 days

Research Hypothesis

The null hypothesis, which was tested at the 0.05 level of significance, stated that there is no significant difference between the pre-test and post-test results of the students. Likewise, it is stated that the intervention, CALTECH Seminar, cannot significantly influence the scores of the students on computational thinking skills in statistical measures.

RESEARCH METHODOLOGY

Research Design

This study employed mixed methods incorporating both quantitative and qualitative design. A quantitative research was employed through a one-group pretest-posttest design, a type of pre-experimental approach. It assessed changes resulting from an intervention or project by comparing values before (baseline) and after the intervention (end-line evaluation). Unlike experimental designs, pre-experimental designs lack a control group for comparison; instead, they focus on changes within a single group over time. The observed differences between baseline and end-line values are attributed to the project, suggesting its impact on the outcomes (Wamunyima & Nyirenda, 2023). Alongside, qualitative data were gathered to explore students' learning behaviors, reactions, and challenges throughout the intervention. Employing this combined approach strengthens the research's ability to capture not only what works but also why it works within the specific classroom context (Onwuegbuzie & Hitchcock, 2021).

In the context of this study, the students underwent a pre-test and a post-test. The intervention was implemented between the interval of the two tests. Also, an in-depth interview to selected participants was conducted to reveal their insights about the implementation of the CALTECH Seminar. Merging both quantitative and qualitative perspectives proved valuable in addressing the diverse and real-world nature of classroom settings. The CALTECH Seminar was not only evaluated through numerical gains in test performance but also through observational data and student reflections, which revealed insights into their conceptual development and engagement.

Research Respondents

Purposive sampling, a non-random selection technique, empowers researchers to delve into specific populations by choosing individuals, cases, or events with key characteristics aligned with the research aims. This approach, also known as judgmental sampling, leverages the researcher's expertise to identify participants who can offer the most valuable insights, unlike random selection where chance dictates participant selection (Memon et al., 2025).

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The respondents of this study were Junior High School students from Sto. Niño National High School. Specifically, the study involved 29 purposively selected Grade 10 Banahaw students (aged 15–16) from Sto. Niño National High School in Talaingod, Davao del Norte, during the 2024–2025 school year. The participants were chosen with the assistance of the Mathematics Department Head based on set criteria. They took part in a CALTECH Seminar intervention aimed at enhancing their computational thinking skills in statistical measures.

Research Instrument

The study had a survey questionnaire on enhancing computational thinking skills in mathematics. This questionnaire aims to assess students' proficiency in performing calculations, understanding of statistical measures, problem-solving abilities, and overall confidence in applying mathematical procedures. The questions were carefully designed to align with the study's objectives and underwent validation by a panel of experts before implementation. Additionally, the survey questionnaire was validated by the research panel and pilot-tested to ensure the reliability and accuracy of the results obtained from the instrument. Moreover, the researchers provided pre-test and post-test to measure and identify the status of computational skills in mathematics of the students involved in the study.

Furthermore, the range of percentage score below is used to assess the level of performance of the students in statistical measures during pre-test and post-test. This range was adopted from the study of Marliasari (2017) which was used to measure the computational thinking skills of the students.

Table 2. Range of Mean Percentage

Range of Percentage Score	Descriptive Level	Interpretation
90 – 100%	Outstanding	If the level of performance of the students in statistical measures is outstanding.
72 – 89%	Highly Satisfactory	If the level of performance of the students in statistical measures is very satisfactory
54 – 71%	Satisfactory	If the level of performance of the students in statistical measures is satisfactory.
36 – 53%	Fairly Satisfactory	If the level of performance of the students in statistical measures is fairly satisfactory.
18 – 35%	Needs Improvement	If the level of performance of the students in statistical measures is needs improvement.
0 – 17%	Poor	If students did not perform well in statistical measures.

Additionally, a difficulty index is used to determine the least mastered learning competencies based on the corresponding items in the pre-test and post-test. Difficulty index corresponds the proportion of students who correctly answered the item (Mahjabeen et al., 2018; Mukherjee & Lahiri, 2015).

Range of Difficulty Index	Interpretation
0% – 25%	Difficult
26% - 75%	Right Difficulty
76% - 100%	Easy

Procedure

To begin the study, the researchers first sought formal approval from the principal of Sto. Niño National High School to ensure ethical compliance and institutional support. After receiving approval, they identified participants from Grade 10-Banahaw, specifically selecting students considered non-developing in their understanding of statistical and mathematical concepts based on academic performance and teacher recommendations. The next step involved developing a 20-item pre-test questionnaire focused on Measures of Central Tendency, Measures of Variability, and Measures of Position, designed to assess the students' baseline knowledge and computational skills. After administering the pre-test, the researchers implemented the CALTECH Seminar—a three-week scientific and interactive teaching approach facilitated by pre-service teachers that utilized visual aids, collaborative activities, real-life data applications, and reflective discussions. Each week addressed a specific statistical topic, progressively strengthening students' computational thinking through active participation and practical problem-solving. Upon completing the intervention, a 20-item post-test, parallel in format and difficulty to the pre-test, was administered to evaluate improvements in statistical knowledge, computational accuracy, and problem-solving skills. The researchers then gathered the completed pre- and post-tests, transferred the data to Microsoft Excel, and assigned a licensed statistician to compute results, generate summary tables, and analyze the findings using descriptive statistical methods to assess the intervention's effectiveness. Lastly, to gain qualitative insights, the researchers conducted interviews with selected students via Messenger to explore their experiences and reflections, followed by a thematic analysis to identify recurring themes and evaluate the overall impact of the CALTECH Seminar on enhancing students' computational thinking skills

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Table 3. Intervention Schedule

Week	Content	Task	Platform
Week 1	Pre-Test Administration & Seminar Start	Pre-Test on baseline knowledge about statistical measures. Measures of Central Tendency.	Face-to-face (school setting) Scientific Calculator
Week 2	Seminar Continuation	Measures of Variability	Face-to-face (school setting) Scientific Calculator
Week 3	Seminar Completion & Post-Test	Measures of Position Post-Test (parallel to pre-test)	Face-to-face (school setting) Scientific Calculator
Week 4	Data Compilation and Analysis	Data recording and statistical analysis using descriptive statistics	Microsoft Excel, Licensed statistician support
Week 5	Student Interviews	Student feedback and reflections on CALTECH Seminar	Messenger (online interviews)
Week 6	Thematic Analysis	Extraction of themes and patterns from interview responses	Manual/thematic coding

Statistical Treatment of Data

In analyzing the data, the researchers tabulated the raw scores of the students from both pre-test and post-test. The following statistical tools were used to compute the data and testing the results between the two tests.

Mean. This was used to determine the level of enhancing their computational thinking skills in statistical measures demonstrated by Grade 10 students.

Standard Deviation. This was used to measure the consistency of the students' performance in computational thinking skills in statistical measures.

Paired T-Test. This was used to compare the pre-test and post-test scores of the students to evaluate the effectiveness of the CALTECH Seminar in enhancing their computational thinking skills in statistical measures.

Cohen's d. This was used to measure the effect size of the difference between the pre-test and post-test scores of the students to evaluate the practical significance of the CALTECH Seminar in enhancing their computational thinking skills in statistical measures.

Data Analysis

In addition to quantitative analysis, qualitative data from in-depth interviews were analyzed to provide a nuanced understanding of the intervention's impact. Thematic analysis of interview transcripts highlighted students' perspectives on the CALTECH Seminar, uncovering insights into its effectiveness, perceived benefits, and challenges faced during implementation.

Ethical Considerations

Observing ethical standards in research is essential. At the core, this helped shape the true aims of the study, such as knowledge, truth, and avoidance of error and promoted values essential to collaborative work, such as trust, accountability, mutual respect, and fairness. To ensure ethical research, this study followed and respected the principles of research ethics from the Belmont Report. These principles respect a person's autonomy, beneficence and non-maleficence, justice, informed consent, confidentiality and data protection, integrity, and conflict of interest (Barrow et al., 2022).

RESULTS AND DISCUSSION

This section presents the findings and elaboration of results of CALTECH Seminar as a strategy in enhancing the computational thinking skills of Grade 10-Banahaw students of Sto. Niño National High School. This section of the study presents the data gathered by the researchers, which was meticulously organized, presented, analyzed, and interpreted to achieve a comprehensive understanding of the collected information.

Research Question No. 1: What is the level of the enhancing the computational thinking skills demonstrated by grade 10 students on the pre-test?

Presented in Table 4 presents the pre-test results indicating the level of computational thinking skills among 29 Grade 10 students prior to the implementation of the CALTECH Seminar intervention. The scores ranged from a low of 1 to a high of 10. The most frequent score recorded was 4, attained by 8 students or 27.59% of the class. Despite a few students reaching relatively higher scores, the majority of scores clustered at the lower end of the range. The computed overall mean score is 23.28%, with a standard deviation (SD) of 2.24, which falls under the Needs Improvement proficiency level. Overall, the data reflect a general lack of computational thinking skills related in Measures of Central Tendency, Measures of Variability, and Measures of Positions among the students prior to the intervention, highlighting the need for targeted instructional support.

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Table 4. Level of Computational Thinking Skills in Measures of Central Tendency, Measure of Variability, and Measures of positions of the Grade 10 Banahaw in Pre-Test

Pre-Test Scores	Frequency	Percentage
1	2	6.9%
2	4	13.79%
3	1	3.44%
4	8	27.59%
5	6	20.69%
6	2	6.9%
7	3	10.34%
8	1	3.44%
9	1	3.44%
10	1	3.44%
Total	**29**	**100.00%**
Overall Mean		**23.28%**
Standard Deviation		**2.24**
Description		**Needs Improvement**

To support the findings, Del Rosario et al. (2024) found that using real-world data sets in teaching statistical measures significantly improved junior high school students' data interpretation skills. Likewise, Xiong et al. (2020) showed that scaffolding and formative assessment led to better student performance in applying statistical concepts compared to lecture-based instruction. Meanwhile, Chan et al. (2021) revealed gender and grade-level differences in critical thinking (CT) skills among Singaporean students, with males and ninth-graders outperforming others. Taken together, these studies highlight the importance of contextualized tasks, guided instruction, and targeted interventions to enhance students' understanding and application of statistical measures.

Table 5. Summary on the Level of Computational Thinking Skills Among Grade 10 Students before the CALTECH Seminar Intervention

Pre-test	Mean	Interpretation
Measures of Central Tendency	12.99%	Difficult
Measures of Variability	24.63%	Difficult
Measures of Position	21.67	Difficult
Total Mean	**23.28**	**Difficult**

The table 5 presents the mean scores for various computational thinking skills indicators, all described as "Difficult." The mean score for Measure Central Tendency is 12.99%, indicating that students perform difficult in developing measures of central tendency for their computational thinking skills. Similarly, Measures of Variability has a mean score of 24.63%, reflecting a significant struggle with computing measures of variability. The Measures of Position indicator scores 21.67%, revealing struggles of computational thinking skills. The overall mean score of 23.28% further emphasizes the pervasive issue of low computational thinking skills across all indicators. These results highlight the urgent need for targeted interventions to improve students' computational thinking skills, particularly in the statistical measures.

The current results are supported by the study of Novianti and Dewi (2024), who found that using a Scientific Calculator app can enhance students' learning and computational thinking key skills for 21st-century education. Their findings show that digital tools help students better understand abstract concepts and perform complex calculations with confidence. Similarly, Hartawan et al. (2024) noted that junior high students show moderate computational thinking skills but struggle with problem-solving in statistics, stressing the need for improved teaching strategies. Sulastri et al. (2021) also found that while students demonstrated all aspects of computational thinking, they had the most difficulty with decomposition due to unstructured problem-solving habits, highlighting common cognitive challenges in learning mathematics.

Given the ongoing struggles students face with statistical concepts, it is clear that a personalized and targeted instructional approach is necessary. By identifying the specific indicators where students show low performance such as measures of central tendency, variability, and position educators can implement focused support to strengthen both conceptual understanding and computational fluency. This type of intervention would help students grasp key statistical ideas more clearly, enhance their problem-solving abilities, and build greater confidence in applying these skills to real-world

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Research Question No. 2: What is the level of the enhancing the computational thinking skills demonstrated by grade 10 students on the post-test?

Table 6 presents the post-test results indicating the level of computational thinking skills among 29 Grade 10 students after the implementation of the CALTECH Seminar intervention. The post-test scores range from 10 to 20, with the most frequently occurring scores being 14 and 16, each achieved by 10 students or 17.24% of the class. The computed overall mean score is 79.48%, with a standard deviation (SD) of 2.69, which falls under the Highly Satisfactory proficiency level. Compared to the pre-test results, there is a marked improvement in both the average score and the distribution of performance levels.

Table 6. Level of Computational Thinking Skills in Measures of Central Tendency, Measure of Variability, and Measures of positions of the Grade 10 Banahaw in Post-Test

Post-Test Scores	Frequency	Percentage
10	1	3.44%
11	1	3.44%
12	2	6.9%
13	2	6.9%
14	5	17.24%
15	2	6.5%
16	5	17.24%
17	3	10.34%
18	3	10.34%
19	3	10.34%
20	2	6.9%
Total	**29**	**100.00%**
Overall Mean		**79.48%**
Standard Deviation		**2.69**
Description		**Highly Satisfactory**

To support the findings, Lopez et al. (2023) implemented a differentiated instruction strategy in teaching statistical concepts to 95 Grade 10 students in Batangas. Their quasi-experimental research revealed that students who received tailored activities for measures of central tendency, variability, and position, such as grouped exercises on mean, standard deviation, and percentile rank performed significantly better than those in the control group. Likewise, Singh and Morales (2021) found that incorporating technology, particularly statistical software and graphing tools, helped enhance students' comprehension of data dispersion and relative standing. Students reported higher levels of engagement and retention when visualizing concepts like quartiles and z-scores through interactive simulations. These findings emphasize the importance of using adaptive and technology-driven approaches to improve student understanding of core statistical topics.

To support the findings, Nordby et al. (2022) conducted a scoping review of empirical studies focusing on the integration of computational thinking (CT) and mathematics. Their research highlights that incorporating CT into mathematics education enhances students' problem-solving abilities, particularly in understanding concepts like measures of central tendency. The study emphasizes that tools and approaches facilitating CT can lead to improved mathematical reasoning and data analysis skills among students. This underscores the potential benefits of integrating CT into mathematics curricula to foster deeper comprehension of statistical concepts. In addition, a study by Horton and Hardin (2020) discusses the integration of computing in the statistics and data science curriculum. They argue that embedding CT into statistical education equips students with novel skills and habits essential for data analysis. Their findings suggest that teaching CT within the context of statistics enhances students' ability to interpret and analyze data effectively, which is crucial for understanding measures of central tendency. This reinforces the importance of CT in developing students' analytical skills in statistical contexts.

Table 7. Summary on the Level of Computational Thinking Skills Among Grade 10 Students after the CALTECH Seminar Intervention

Post-Test	Mean	Description
Measures of Central Tendency	78.74%	Easy
Measures of Varıabılıty	80.30%	Easy
Measures of Posıtıon	79.31%	Easy
Total Mean	79.48%	Easy

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The table 7 presents the post-test results on the level of computational thinking skills among Grade 10 students following the implementation of the CALTECH Seminar intervention. The average percentage scores across the three statistical measure indicators demonstrates marked improvement. The highest score was observed in the Measures of Variability category with 80.30%, described as Easy, Measures of Central Tendency followed with 78.74%, also falling under the High category and Measures of Position with 79.31%, described as Easy, suggesting that while students improved in these areas, further support may still be needed to refine their computational thinking skills. The overall average percentage score of 79.48% places students' general computational thinking skills in the Easy category. This substantial improvement from the pre-test results highlights the effectiveness of the CALTECH Seminar intervention in strengthening various aspects of computational thinking skills among Grade 10 learners.

These findings are supported by Karaca and Ay (2024), who emphasized the importance of developing students' ability to understand and interpret statistical data, particularly measures of central tendency. Moreover, Barrón et al. (2024) study of 445 university students in Fresnillo, Zacatecas, Mexico, high internal consistency was found in a career choice survey instrument ($\alpha = 0.968$), and measures of central tendency were used to describe students' opinions across six career decision-making dimensions. While students showed procedural knowledge in calculating mean, median, and mode, many struggled with conceptual understanding and interpretation, underscoring the need for instructional strategies that foster deeper statistical thinking.

These findings are supported by research emphasizing that measures of variability such as range, variance, and especially standard deviation are crucial for understanding data dispersion beyond averages. Standard deviation in particular is valuable for assessing variability in normally distributed data, aligning with the empirical rule (Rakrak, 2025). Similarly, De la Rubia (2024) for qualitative data , newer methods like Kvalseth's standard deviation from the mode and Moral's universal variation ratio have proven especially effective due to their sensitivity and reliability in capturing variation among non-numeric responses, allowing for more nuanced insights into qualitative patterns.

These findings are supported by the study of Mandal and Morados (2023), which showed that integrating gamification in teaching measures of position in Mathematics enhanced student performance, even if it did not significantly impact motivation. Similarly, research in a private school in Bogo City, Cebu confirmed that game-based elements positively influence academic achievement in this topic. In the same vein, Isnawati et al. (2025) developed a statistics module based on the Realistic Mathematics Education approach, infused with Islamic values, which proved to be valid and practical. This highlights how contextualized and culturally relevant materials can effectively enhance students' understanding and engagement in statistical concepts like measures of position.

Research Question No. 3: What is the significant difference between pre-test and post-test employing the CALTECH Seminar intervention?

Presented in Table 8 were the results of the paired sample t-test conducted to determine whether there was a statistically significant difference between the pre-test and post-test scores of Grade 10-Banahaw students following the implementation of CALTECH Seminar, $t(28.0) = 17.5$, $p < .001$. Since the p-value was less than .001, which is well below the 0.05 significance level, the null hypothesis was rejected. The results confirm that the CALTECH Seminar intervention was effective in enhancing students' performance in measures of central tendency, measures of position and measures of position. Moreover, the effect size, represented by Cohen's $d = 3.25$, falls within the medium to large range. This means that the impact of the intervention was moderately strong, indicating not only a statistical significance but also a meaningful improvement in student learning outcomes.

Table 8. Significance Difference Between the Pre-test and Post-test Scores

Paired Sample T-test								
		t	**df**	**p**	**Mean difference**	**SE difference**		**Effect Size**
Post-test	Pre-test	17.5	28.0	<.001	56.2	3.21	Cohen's d	3.25

These findings are strongly supported by Astuti et al. (2025), who found that junior high students with higher cognitive abilities showed strong computational thinking skills like decomposition, pattern recognition, abstraction, and algorithmic thinking when solving statistical problems, while those with lower abilities struggled. This shows the value of embedding CT skills in statistics lessons to support all learners. Likewise, Choi and Choi (2024) reported that using Code.org's block-based coding improved students' computational thinking, motivation, attitudes, and academic performance. Their study emphasizes how CT can help students better understand and apply statistical concepts, especially in challenging areas like measures of central tendency, variability, and position.

Research Question No. 4: What are the insights of the students on the effectiveness and areas for improvement of CALTECH Seminar in enhancing statistical measures?

To answer this research question, in-depth interviews were conducted with the participants. probing questions were asked to elicit their concept regarding the insights about CALTECH Seminar in enhancing statistical measures. The major themes and supporting statements for research question number 4 were presented in Table 9. Participants had their responses to their

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own experiences and observation. From the answers of the participants, nine major themes emerged: (1) difficulties in applying statistical concepts pre-intervention; (2) enhancing problem-solving skills; (3) improving computational thinking; (4) building confidence in solving statistical problems; and (5) incorporating real-world applications enhance learning.

Table 9. Themes and Supporting Statements on the Insights that the Grade 10 Students Share about the CALTECH Seminar in enhancing statistical measures

Emerging Themes	Supporting Statements
Difficulties in Applying Statistical Concepts Pre-Intervention	• "I struggled to understand how to apply statistical formulas and coding concepts to real-world problems." (IDI-02) • "I had difficulty analyzing data and applying statistical concepts." (IDI-03) • "Limited understanding of data analysis and visualization and also challenges in choosing the right statistical method." (IDI-01) • "It is hard for me to identify symbols and how to use it appropriately." (IDI-04) • "I encounter numerous obstacles…unsure how to start and what tools or techniques to use." (IDI-06) • "I face a difficulty in managing my time and staying focus on problem-solving which is very overwhelming for me." (IDI-09)
Enhancing Problem-Solving Skills	• "Hands-on experience with real-world dataset and learning practical applications of statistical concepts." (IDI-01) • "The CALTECH Seminar helped me by providing clear explanations, examples and hands-on practice." (IDI-02) • "Helped me to see process to follow… taught me how to think step-by-step and look for patterns." (IDI-05) • "Showed me how to approach a problem in stages, starting with determining the data required then selecting tools." (IDI-06) • "Practical exercises and projects improved ability to solve statistical problems." (IDI-08)
Improving Computational Thinking	• "The seminar greatly improved my ability to think computationally and apply statistical concepts to solve problems." (IDI-02) • It greatly helped me develop my computational thinking skills." (IDI-03) • "The seminar really enhances computational thinking skills to quantify and describe statistical problems." (IDI-08)
Building Confidence in Solving Statistical Problems	• "I feel more confident and organized in how I solve problems." (IDI-05) • "Working with data made me more practical and improved my confidence in computation." (IDI-09) • "The seminar greatly improved my ability to think computationally and apply statistical concepts to solve problems." (IDI-02)
Incorporating Real-World Applications Enhance Learning	• "If more Future seminars should include more interactive coding sessions and real-world examples." (IDI-02) • "It would be good to have more activities that apply concepts to real-life situations." (IDI-07) • "More advanced topics including more challenging statistical concepts and computational methods." (IDI-08) • "Encourage students to work with real-life problems using computational thinking and statistics." (IDI-09) • "Include more real-life examples." (IDI-05) • "For me, sir, the most important part of the CALTECH seminar was applying statistical thinking to real-world scenarios and problem-based learning, rather than tackling numerical problems. Genuine case studies and datasets required truthful and creative application of statistical measures." (IDI-06)

The study revealed that, students faced significant difficulties in applying statistical concepts prior to the intervention, particularly when dealing with real-world data containing inconsistencies or gaps Yu et al. (2024). Consequently, confusion and misconceptions often led to inaccurate conclusions. Moreover, research by Kadusale et al. (2024) highlights the urgent need to address these foundational gaps, as they hinder students' ability to analyze data and make informed decisions. Thus, these challenges emphasize the importance of structured interventions and instructional

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strategies that strengthen both theoretical understanding and practical problem-solving skills in statistics.

The study revealed that enhancing problem-solving skills is essential in 21st-century education, especially in applying statistical measures to real-world problems. Consequently, it aligns to the study of Fadwa et al. (2024) where educational strategies need to prioritize inquiry-based learning, experimentation, and reflection to address this need. Likewise, Guerra and Huesca (2024) found that many students initially struggle with understanding statistical procedures and applying them confidently, often feeling anxious in evaluative settings. Breaking down complex problems into smaller parts is particularly challenging. However, with regular practice, group work, and hands-on experience, students gradually improve their ability to think clearly, solve problems step-by-step, and confidently interpret data. This highlights that developing problem-solving skills is a necessary response to the real challenges students face in mastering statistics.

The study revealed that improving computational thinking helped students better understand and apply statistical measures in solving problems. As Xu et al. (2022) observed, students became more confident in analyzing data, reasoning logically, and explaining their results more clearly. Similarly, Kumar and Mohd (2024) highlighted how computational thinking taught students to break down complex problems, organize information, and draw thoughtful conclusions. As a result, students not only became more skilled but also felt more capable when tackling statistical tasks, showing that structured thinking can truly make learning statistics more manageable and meaningful.

The study revealed that building students' confidence in solving statistical measures was crucial for improving their overall performance. Specifically, Brown (2022) found that students gained confidence and accuracy by learning best practices, avoiding common mistakes, and working hands-on with data, which helped them develop a more practical and organized approach. Moreover, Marshall et al. (2024) emphasized that personalized statistics support, particularly through face-to-face interactions, significantly reduced students' anxiety, especially for those who initially felt overwhelmed. Consequently, both studies highlight that when learners feel supported and engaged, they are more likely to strengthen their computational thinking, approach problems with clarity, and interpret statistical data with greater confidence.

The study revealed that incorporating real-world applications enhance learning into lessons significantly enhances students' confidence and understanding in solving statistical measures. Consequently, students became more engaged when lessons connected to practical, relatable scenarios, as highlighted by Kumar et al. (2024), who emphasized that applying statistical concepts to real-life problems fosters deeper comprehension and creative problem-solving. Likewise, Perdana et al. (2024) found that even in online learning environments, integrating real-world elements boosts both engagement and understanding. Moreover, students expressed a genuine interest in interactive sessions and hands-on activities, noting that using computational thinking in real contexts made statistics feel more meaningful and easier to grasp.

The study revealed that incorporating real-world applications into learning statistical measures enhances students' ability to make meaningful decisions through experience-based learning. Similar to how reinforcement learning enables an agent to improve through trial and error, students develop deeper understanding by interacting with real-life data, observing outcomes, and refining their approaches over time. Rather than relying solely on direct instruction, learners benefit from hands-on exploration and feedback, which helps them grasp the practical value of statistical concepts and strengthens their ability to apply these measures in varied, authentic contexts.

Findings from the study indicate that incorporating real-world applications into the learning of statistical measures greatly enhances student engagement and understanding. Similar to how Reinforcement Learning (RL) relies on an agent's interaction with its environment to learn optimal actions through trial and error, Memarian & Doleck (2024) emphasize that learners develop better problem-solving skills when they actively apply concepts in practical, real-life contexts. This approach helps students internalize statistical concepts by connecting theory with meaningful experiences, thereby improving their ability to make informed decisions and solve problems effectively.

CONCLUSION

The research study aimed to enhance the skills in statistical measures among Grade 10 learners through the implementation of the CALTECH (Scientific Calculator) Seminar within the subject, Mathematics – 10 of the Junior High School. Before the intervention, the students exhibited very low proficiency, as indicated by their scores ranging from 1 to 10 out of 20, with an overall mean percentage score of 23.28. They struggled particularly with computing for measures of central tendency, measures of variability, and measures of position. Following the CALTECH Seminar implementation, significant improvement was observed in their performance in statistical measures. The scores showed a marked increase, with scores ranging from 10 to 20 and an overall mean of 79.48%, indicating an easy proficiency. Statistical analysis using a paired t-test confirmed a significant difference between pre-test and post-test scores ($t = 28$, $p < 0.001$), highlighting the effectiveness of the CALTECH Seminar in enhancing computational thinking skills in statistical measures.

Also, qualitative insights from student feedback further supported these findings, showing that the CALTECH Seminar sessions helped boost engagement, confidence, and appreciation for collaborative learning. Students highlighted how interactive activities and real-life applications made statistical concepts easier to grasp. While they noted some challenges, such as unclear instructions, limited visual aids, and the need for better organization in game-based tasks, these concerns were outweighed by the overall positive learning experience. The intervention not only deepened their

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understanding of the lessons but also increased their motivation and interest in learning statistical measures through meaningful and student-centered approaches.

Overall, the results from the quantitative and qualitative aspects of the study showed that CALTECH Seminar is an effective way to enhance the computational thinking skills in statistical measures of the Junior High School students. The quantitative phase demonstrated the significant increase in the test scores of the students after the conduct of the intervention. Meanwhile, the qualitiative phase through interviews revealed the significance and contributory factor of the CALTECH Seminar towards learning statistical measures.

RECOMMENDATION

Based on the results of the study, it is recommended that the CALTECH Seminar intervention be implemented more broadly across Grade 10 statistics curricula to enhance students' computational thinking skills. The program's interactive sessions, guided instruction, and collaborative activities proved effective in improving students' understanding and application of statistical measures. To further optimize learning, clearer instructions, more visual aids, and well-managed game-based activities should be incorporated. Educators are encouraged to adopt and adapt student-centered, hands-on strategies like CALTECH to foster engagement, build confidence, and promote deeper comprehension in mathematics specifically in statistical measures, ultimately supporting students' long-term academic success.

Furthermore, consistent with student feedback, it is vital to sustain the momentum of the CALTECH Seminar by embedding real-world applications into the learning process, as this approach not only deepens understanding but also makes statistical concepts more relatable and engaging. Consequently, when students see how data analysis connects to everyday situations, they become more motivated and confident in their abilities. In addition, encouraging peer collaboration and allowing room for reflection can create a more supportive environment where learners feel safe to explore, make mistakes, and grow. Thus, by nurturing both cognitive and emotional engagement, educators can further elevate the impact of the intervention on students' statistical thinking.

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