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The Impact of a Scientific Calculator Workshop on Form 5 Students' Performance

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Abstract

Despite the widespread availability of scientific calculators in secondary schools, many students struggle to fully utilize these tools to their advantage in mathematics education. This study investigates the efficacy of a specialized workshop designed to enhance Form 5 students' proficiency in using scientific calculators for pre-calculus and calculus problems. Conducted at Sekolah Menengah Sains Kepala Batas, Pulau Pinang, Malaysia, the research employed a pre-test and post-test methodology to assess the workshop's impact. A total of 147 students participated in the pre-test, with 144 completing the post-test at the end of the workshop. The intervention focused on comprehensive instruction in calculator usage, covering basic to advanced functions. Results demonstrated a significant improvement in students' performance, with the average score increasing from 6.2 in the pre-test to 7.9 in the post-test. Notably, substantial gains were observed in areas such as quadratic equations, trigonometry, and number bases. The study also revealed a student preference for more advanced calculator models, particularly the Classwiz fx-570ex. While acknowledging limitations such as sample size and immediate post-test focus, this research underscores the importance of structured interventions in bridging the gap between calculator availability and effective utilization in mathematics education. The findings suggest potential implications for educational policies and practices in enhancing students' mathematical proficiency through targeted technology-based interventions.

Keywords: Scientific Calculator, Mathematics Education, Technology In Learning.

Introduction

The progress and innovation of nations are closely tied to the field of mathematics. This is because a solid understanding of mathematics is essential for grasping other disciplines, including engineering, physics, social sciences, and even the arts (Patena & Dinglasan, 2013). Mathematics studies the logic behind shapes, quantities, and orders, making it integral to nearly every aspect of daily life. However, many students find mathematics to be one of the most challenging and difficult subjects. Mastering mathematics is crucial for students as it

equips them with the skills needed to become valuable contributors to society (Nofriyandi & Andrian, 2022). Ashaari et al. (2011) noted that most students struggle with mathematics due to a lack of understanding of its concepts, techniques, and underlying principles. Additionally, Omar et al. (2022) found that for high-achieving students, emotions significantly influence their levels of mathematics anxiety. In this context, the effective use of scientific calculators in secondary schools can greatly aid students in overcoming these challenges by simplifying complex calculations and enhancing their overall understanding of mathematical concepts.

Calculators are used as a learning aid by teachers and students in mathematics education (Leng, 2011). Using scientific calculators in secondary education has become essential in mathematics classrooms in Malaysia. These devices are powerful tools that enable students to perform complex calculations quickly and accurately, enhancing their ability to solve problems in topics such as algebra, trigonometry, and calculus. One of the primary benefits of using calculators is their ability to facilitate problem-solving skills. For instance, emphasizes that technology, including graphing calculators, plays a crucial role in mathematics education by enabling students to engage with complex problems more effectively (Phillips, 2010). This aligns with findings from those who argue that calculators can help foster mathematical understanding and a sense of numbers, provided they are used appropriately (Chamoso & Cáceres, 2018). However, despite their widespread availability, many students struggle to fully utilize the features and functions of scientific calculators. This often leads to a dependency on basic functions, leaving more advanced capabilities untapped and hindering their overall mathematical development. Moreover, the relationship between math anxiety and the use of calculators is particularly noteworthy. Math anxiety can hinder students' performance and willingness to engage with mathematical tasks. Research by suggests that managing math anxiety is essential for improving students' communication abilities in mathematics (Haniyah & Khusna, 2023). Similarly, Omika's study indicates that students experiencing high levels of math anxiety may struggle with online learning environments, which could be mitigated by using calculators that simplify calculations and reduce cognitive load (Omika, 2022) This suggests that calculators can serve as a supportive tool in alleviating anxiety and improving learning outcomes.

The challenges students face in mastering scientific calculators are often attributed to a lack of formal instruction. In many cases, students are expected to learn how to operate these devices independently without comprehensive guidance from educators. This gap in knowledge can result in inefficient calculator use, errors in computations, and a general lack of confidence in handling mathematical tasks that require the use of these tools. The integration of calculators must be accompanied by appropriate pedagogical strategies considering students' backgrounds and attitudes towards mathematics. Emphasizes the importance of fostering a positive attitude towards mathematics, which is correlated with higher achievement (Abdul Rahman et al., 2022; Darmiyati, 2017). As a result, there is a pressing need for structured educational interventions that can bridge this gap and empower students to harness the full potential of scientific calculators in their studies.

The motivation for this study stems from the need to address a critical gap in mathematics education: the underutilization of scientific calculators by secondary school students. While these tools are readily available, many students cannot leverage their full capabilities, affecting their overall mathematical proficiency and confidence. By investigating

the impact of a specialized workshop on calculator usage, this study contributes to the broader discourse on effective educational interventions in mathematics.

In response to these challenges, a specialized workshop was conducted for Form 5 students in a secondary school in Malaysia. The workshop aimed to provide detailed instructions on using scientific calculators, covering all the devices' buttons, modes, and options available. By offering both theoretical and practical guidance, the workshop sought to enhance students' proficiency in using scientific calculators for pre-calculus and calculus topics. This study aims to evaluate the workshop's effectiveness in improving students' understanding and usage of scientific calculators and its impact on their mathematical performance.

Methodology

Participants

The study was conducted with a group of Form 5 students from Sekolah Menengah Sains Kepala Batas, Pulau Pinang, Malaysia, who volunteered to participate in the workshop on empowering the use of scientific calculators.

Workshop Design

The workshop was meticulously crafted to address the challenges students commonly face when using scientific calculators, particularly in the context of solving pre-calculus and calculus problems. It began with an introduction to the scientific calculator's layout, offering students a historical overview of these devices and discussing the different models and brands commonly used in Malaysian schools.

This initial segment covered the basic functions and operations of the calculator, including arithmetic calculations, trigonometric functions, and logarithms. Following the introduction, the workshop provided a detailed explanation of each button and mode on the calculator. Students were guided through the calculator's keypad, with the purpose and use of each button carefully explained. Special attention was given to modes such as DEG (degree) and RAD (radian), with practical examples illustrating their application in solving trigonometric problems. Additionally, the workshop covered more advanced functions, including statistical operations, equation solving, and memory functions, ensuring that students were equipped with a comprehensive understanding of the calculator's capabilities.

To reinforce the theoretical knowledge imparted during the workshop, students engaged in hands-on activities where they were tasked with solving a series of mathematical problems. These problems ranged from basic calculations to more complex pre-calculus and calculus questions, designed to allow students to practice and become proficient in using their calculators. The workshop concluded with an interactive Q&A session, allowing students to ask questions and clarify doubts. During this session, common errors and misconceptions were addressed, and strategies for efficient calculator use were shared.

Pre-Test and Post-Test Design

A pre-test and a post-test were administered to the students to assess the workshop's effectiveness. Each test comprised 10 questions covering topics from the pre-calculus and calculus syllabus, focusing on areas where using scientific calculators would be most

beneficial. The questions evaluated students' ability to perform calculations, solve equations, and interpret results using scientific calculators.

The pre-test was conducted before the workshop to gauge the students' initial competency in using scientific calculators. After the workshop, the post-test was administered to measure any improvement in their abilities. Both tests were timed, with students given 30 minutes to complete each test. The tests consist of ten questions adapted from the Secondary School Mathematics syllabus given to the students. The details of each question given to the students are shown in Table 1. The differences between the pre-test and post-test scores were analyzed to determine the workshop's effectiveness. Statistical methods, including paired t-tests, were used to evaluate the significance of the improvements observed in the post-test results.

Table 1
Description of Questions

Question Number	Topic	Description
1	Arithmetic	Evaluate the given value.
2	Logarithms	Find the value of logarithmic.
3	Quadratic Equations	Determine the roots of quadratic equation.
4	Standard Form	Change the given number to standard form.
5	Trigonometry	Find the value of sin.
6	Derivative	Evaluate the derivative at point *x*.
7	Integration	Find the value of the definite integral.
8	Number Bases	Operation on number bases.
9	Linear Equations	Solve the linear equation.
10	Quadratic Functions	Find the value of *f(x)*.

Limitations

While the study aimed to comprehensively evaluate the workshop's effectiveness, certain limitations were acknowledged. The relatively small sample size, while representative of a typical classroom, may limit the generalizability of the findings. Additionally, the study was conducted in a single school, which may mean that results could vary in different educational contexts. Furthermore, the immediate post-test responses might not fully capture the long-term retention and application of the skills learned during the workshop. Despite these limitations, the study provides valuable insights into the effectiveness of structured educational interventions in enhancing students' use of scientific calculators.

Results and Discussions

A total of 147 students aged 17 years were involved in the study. Form 5 students will be taking a national examination called Sijil Pelajaran Malaysia (SPM), where mathematics and additional mathematics are the subjects that they will be taking in 2024. The sample included a mix of male and female students (see Table 2), and their mathematical abilities varied, providing a comprehensive representation of the typical student demographic at this educational level. There were 72 male students (49.0%) and 75 female students (51.0%) sat for pre-test. Meanwhile, there were 69 male students (47.9%) and 75 female students (52.1%) for the post-test.

Table 2
Number of participants according to gender

Gender	Pre-test		Post-test	
	Frequency	Percentage	Frequency	Percentage
Male	72	49.0	69	47.9
Female	75	51.0	75	52.1
Total	147	100.0	144	100.0

The bar chart in Figure 1 illustrates the distribution of calculator usage among students, highlighting three categories: 'Other', 'fx-570ms', and 'Classwiz fx-570ex'. The 'Classwiz fx-570ex' by Casio is the most popular model, used by 66 students, followed by the 'fx-570ms' also by Casio with 55 students. The 'Other' category includes all other models and brands, such as Canon, SHARP and GAINTECH, and is the least popular, with only 26 students. This data suggests a clear preference for the Classwiz fx-570ex among the students surveyed, possibly due to its advanced features or user-friendly design compared to other models. The Classwiz fx-570ex is more user-friendly because it can display mathematical expressions in a natural textbook display. The significant difference in usage numbers indicates that the Classwiz fx-570ex might better suit the student's needs or preferences.

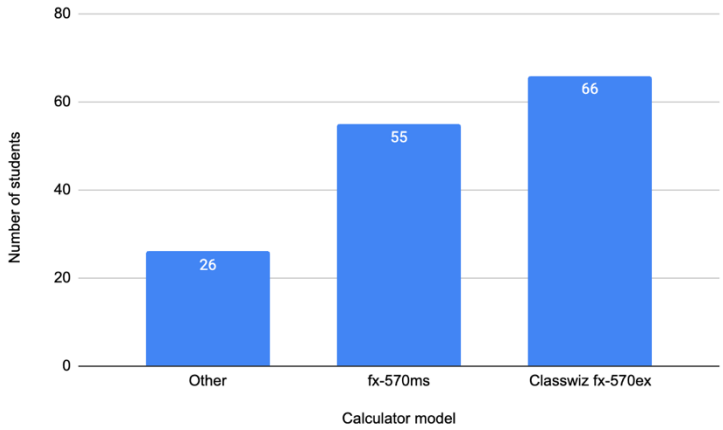

Figure 1. Model calculators used by students

All of 147 students took the pre-test. However, only 144 students stayed in the workshop until the end. Hence, the number of students who took the post-test was 144 only. The data from students' pre-test and post-test performance indicate a significant improvement in their mathematical skills following the workshop on the effective use of scientific calculators. The pre-test results revealed that students had an average score of 6.2. This suggests that while the students understood pre-calculus and calculus concepts, they were not fully proficient in applying them using scientific calculators. However, the post-test results showed a marked improvement, with the average score rising to 7.9. Figure 2 shows the chart of the average score of pre-test versus post-test. This chart clearly illustrates the overall student performance improvement, highlighting the workshop's effectiveness.

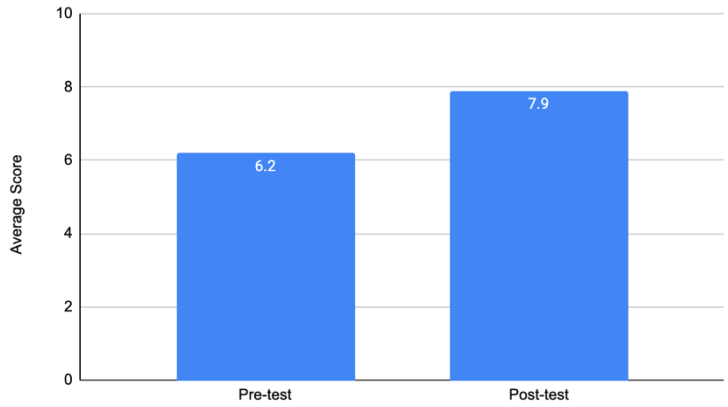

Figure 2. Average score: Pre-test vs post-test

Figure 3 presents the marks obtained by students in a pre-test and post-test. The result reveals a general trend of improvement, with post-test scores consistently higher than pre-test scores across all ten questions (Q1 to Q10). This shows that the workshop effectively enhanced the students' understanding and application of the scientific calculator in solving mathematical problems.

Significant improvements are observed in questions Q3 (Quadratic Equations), Q5 (Trigonometry), and Q8 (Number Bases). These gains indicate that the instructional methods or practice exercises related to these topics were particularly effective. Conversely, questions Q2 (Logarithms) and Q6 (Derivative) show relatively modest gains, highlighting areas where students may need additional support or more focused instruction.

The consistent performance in questions Q1 (Arithmetic) and Q7 (Integration), with only slight improvements, suggests that students had a relatively good grasp of these topics initially, but there is still potential for further enhancement.

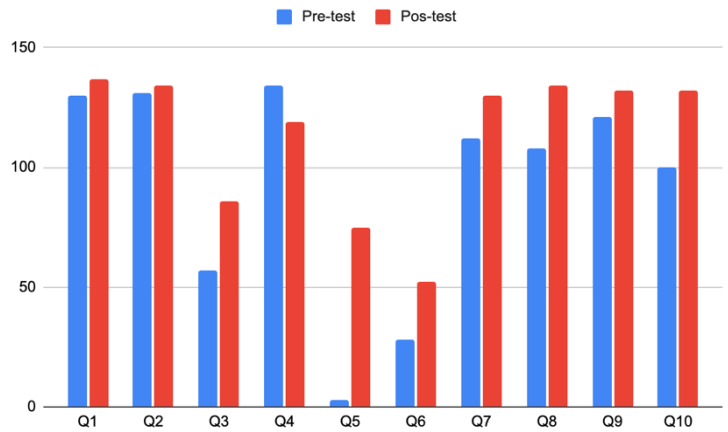

Figure 3. The comparative performance of in pre-test and post-test

Conclusion

The study conducted at Sekolah Menengah Sains Kepala Batas, Pulau Pinang, Malaysia, demonstrates the significant positive impact of structured educational interventions on students' proficiency in using scientific calculators for mathematical problem-solving. The

workshop, which focused on comprehensive instruction in calculator usage, resulted in a marked improvement in students' performance, with the average score increasing from 6.2 in the pre-test to 7.9 in the post-test. This improvement was consistent across various mathematical topics, particularly in areas such as quadratic equations, trigonometry, and number bases, indicating the workshop's effectiveness in enhancing students' ability to apply calculator functions to diverse mathematical concepts.

The research highlights the importance of formal instruction in calculator usage, addressing a critical gap in mathematics education where students are often expected to learn these skills independently. The study's findings suggest that targeted interventions can significantly enhance students' confidence and proficiency in utilizing advanced calculator features, potentially alleviating math anxiety and improving overall mathematical performance. The preference for more advanced calculator models, such as the Classwiz fx-570ex, among students further underscores the need for comprehensive training to maximize the benefits of these technological tools in mathematics education.

While the study provides valuable insights into the effectiveness of calculator workshops, it also acknowledges certain limitations, including the relatively small sample size and the focus on immediate post-test results. Future research could benefit from longitudinal studies to assess the long-term retention and application of skills learned during such workshops. Additionally, expanding the study to multiple schools and diverse educational contexts could enhance the generalizability of the findings. Nevertheless, this research contributes significantly to the understanding of how structured interventions can bridge the gap between calculator availability and effective utilization, potentially informing educational policies and practices in mathematics instruction.

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