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Instructional use of Scientific Calculators in Algebra Learning

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Abstract
Algebra remains a key challenge for secondary students, often hindered by misconceptions, low engagement, and limited use of technological tools. This study examines how scientific calculators support algebra learning by enhancing problem-solving, motivation, and conceptual understanding. Using a mixed-method approach with surveys (n=173) and interviews, findings show that purposeful calculator use improves confidence, reduces anxiety, and fosters positive attitudes toward mathematics. The study concludes that when strategically integrated, calculators are practical pedagogical tools beyond computation, helping address misconceptions, promote engagement, and create more meaningful learning experiences.

Keywords: Scientific Calculators; Algebraic skills; Instructional activities; Mathematics misconceptions

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1.0 Introduction

Recent decades have witnessed significant advancements in technology. Students can utilise various tools and services designed to enhance their academic experience. Studies indicate that incorporating technology into educational settings improves students' academic progress, learning outcomes, and overall performance (Radzuan et al., 2021). LaCour et al. (2019) propose that the integration of scientific calculators and various digital devices by students during exams has transformed the field of mathematics. The current educational framework may present students with only minor challenges when engaging with new arithmetic concepts, such as algebra. During the early years of secondary education, students frequently select algebra as a fundamental mathematics course (Retnawati & Pramesti, 2019). Various studies have employed descriptive research methods to evaluate students' abilities in mathematics learning (Garinganao & Bearneza, 2021). The scientific calculator represents a significant advancement in mathematics, offering enhanced educational opportunities. This study focuses on teaching secondary students the effective use of scientific calculators to enhance their algebra skills and progress in mathematics courses. Given the significance of algebra within mathematics, students must acknowledge its importance.

Algebra plays a vital role in numerous areas of mathematics, encompassing problem-solving, critical thinking, and more advanced mathematical concepts. Nonetheless, some students might struggle to grasp algebraic concepts when using technological tools such as scientific calculators. Pramesti and Retnawati (2019) identified that a lack of student engagement in educational events organised by educators may contribute to specific challenges students face in mathematics. Setiawan (2022) indicates that contemporary students might perceive mathematics as a complex discipline, yet their disinterest in it could lead to diminished engagement in mathematics education. This investigation seeks to analyse secondary students' algebraic abilities and engagement in educational activities that incorporate scientific calculators.

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Problem Statement: This study evaluates secondary mathematics students' lack of class involvement while using scientific calculators to learn algebra. This issue extends beyond transient boredom and may compromise study findings and instructional endeavors (Radzuan et al., 2021). This topic must be thoroughly examined to determine its connection to the problem statement. The main goals are students' engagement and participation in learning (Pramesti & Retnawati, 2019). Complexity originates from several factors, including relevance and utility evaluations. Students typically struggle to understand how scientific calculators are used in real life. According to Young et al. (2018), students view these devices as portable computers and do not realise their potential to improve algebraic comprehension. If no benefit occurs, students may lose interest.

Confusion, difficulties, disputes, shortcomings, conceptions, practices, and policies drive the investigation. These challenges arise due to principles, guidelines, and practices in mathematics education, according to Setiawan (2022). The concerns mentioned indicate the need for a comprehensive study of the use of scientific calculators in secondary mathematics algebra pedagogy.

Research Objectives

This study seeks to explore the integration of scientific calculators into algebraic instructional activities to enhance students' learning experiences and the resulting outcomes. The study's purpose determined its research objectives:

a) To examine the usage of a scientific calculator in algebraic instructional activities among secondary school students.
b) To determine the students' perception of using scientific calculators in algebraic instructional activities among secondary school students.
c) To determine student engagement in instructional activities using scientific calculators in algebraic skills among secondary school students.

2.0 Literature Review

A review of related literature is essential to frame this study within the broader scholarship on mathematics education, algebraic learning, and technology integration. Prior investigations indicated that students may encounter a rewarding and fulfilling experience with it. It is widely recognised that knowledge varies based on individual perspectives. The consistency of the collected data raised concerns. In the classroom, learners can showcase their understanding through input and output (Özcan, 2024). Recent investigations have examined the potential of integrating scientific calculators into classroom practices to tackle these challenges. This section reviews literature on instructional activities, algebraic skills, calculator roles and gaps in current research.

2.1 Relation of Current Research to Previous Studies

For instance, Radzuan et al (2021) reported that calculators reduce students' mathematics anxiety by providing a reliable means to check answers. This finding is consistent with the present study, in which students reported frequent use and positive perceptions of calculators in algebraic tasks.

Other studies also found that positive attitudes toward calculator use are linked to improved learning outcomes. As per the findings of Radzuan et al. (2021), children facing difficulties in mathematics must conquer their arithmetic anxiety to enhance their performance. Instead, it ought to be incorporated in a manner that serves to reinforce the concepts that are being taught, making it easier to effectively apply these mathematical procedures to situations that occur in the real world, as Song pointed out in 2023. (Song,2023)

2.2 Algebraic Skills and Student Challenges

Legesse & Luneta (2023) define "algebra skill" in math education as the ability to comprehend and apply mathematical concepts and methods. In mathematics, symbols resolve issues and elucidate the relationships between variables. Research on discourse-based mathematics education investigates the use of language acts and behaviors to teach algebraic concepts and methodologies. The study assessed the impact of discourse-based training on enhancing the proficiency of grade 11 students in algebraic, quadratic, and linear skills, using the collected data. For instance, students registered in advanced mathematics courses must possess a high level of proficiency in algebra, a solid understanding of algebraic ideas, and the ability to complete assignments expeditiously. Garinganao and Bearneza (2021) reported that Chinese seventh-grade high school pupils exhibit advanced mathematics knowledge and exceptional algebraic skills. The person possesses proficiency in several mathematical principles, such as arithmetic, factors, fractions, and exponents. These involved evaluating the children's proficiency in algebra and mathematics.

2.3 Scientific Calculators in Mathematics Education

The existing literature highlights the effectiveness of scientific calculators as valuable instruments in mathematics education. Although calculators are recognized as valuable instruments, various concerns arise from existing studies. An electronic device known as a "scientific calculator" can perform exponential, logarithmic, geometric, statistical, and trigonometric calculations, as indicated in the study by Radzuan et al. (2021). Throughout the course, students engaged with intricate problems in geometry and statistics, employing scientific calculators as essential tools. In 2024, Suglo noted that scientific calculators can perform complex mathematical operations, including logarithms, trigonometry, and statistical functions. Their design minimizes the likelihood of calculation errors by simplifying complex mathematical problems and delivering accurate outcomes. Zulfiani et al. (2023) observed that students utilising advanced calculators exhibited greater confidence and achieved higher levels of success than their peers using basic models. The current investigation delves into these issues, analysing usage patterns and perceptions among various demographic groups.

2.4 Summary of Literature Review

The reviewed literature underscores the dual challenges of algebraic learning difficulties and the underutilization of calculators in instruction. Evidence shows that calculators can reduce anxiety, enhance accuracy, and support problem-solving when embedded in well-structured activities. However, unresolved issues persist concerning conceptual learning, student perceptions, and the role of teacher practices. This positions the current study to make a valuable contribution by empirically examining calculator usage, perceptions, and engagement in Malaysian secondary schools.

3.0 Methodology

This study utilized a mixed-methods approach to thoroughly examine students' utilization and perceptions of scientific calculators in algebraic learning, integrating quantitative survey data with qualitative interview responses. The mixed-methods approach offered both breadth via statistical analysis of survey data and depth by integrating students' direct perspectives via interviews.

3.1 Research Design

The qualitative component utilized semi-structured interviews, whereas the quantitative component involved a standardized questionnaire distributed. This methodology was selected since interview responses provide a deeper understanding of students' perceptions than survey data, which might not truly capture their real experiences.

3.2 Population and Sample

The sample comprised secondary school students from Malaysia. Three hundred seventeen children, representing various races and educational backgrounds, participated in the survey. A group of students was chosen for additional interviews.

Table 1. Sample Distribution of Survey Participants (n=317)

Category	Frequency (*f*)	Percentage (%)
Secondary Lower Student	147	46.4
Secondary Upper student	170	53.6

**Secondary Lower: students aged 12 to 15 years old & Secondary Upper: students aged 16 to 18.*

3.3 Research Instruments

Two instruments were utilized:

The survey questionnaire is organized into three sections: (i) demographic information, (ii) the utilization of calculators in algebraic teaching methods, and (iii) students' perceptions of calculators. A Likert scale was employed to assess the items. An evaluation of reliability through Cronbach's Alpha indicated satisfactory internal consistency ($\alpha > 0.80$). Chosen students engaged in semi-structured interviews to gain deeper insights into their perspectives. To showcase students perspectives, excerpts from the verbatim transcriptions of the interviews are included.

3.4 Data Collection Procedures

The data collection occurred in two separate phases. Initially, surveys were spread by student associations and educational networks. Thereafter, five volunteers were solicited for follow-up interviews. All participants granted informed consent, and ethical approval was obtained from the Faculty of Education. These methods were employed to guarantee authenticity (by employing the genuine voices of the students) and accessibility (via an online survey Google form). Data was analyzed using thematic analysis, identifying recurring patterns aligned with the study's objectives.

3.5 Data Analysis.

Quantitative data were analyzed using SPSS, employing one-way and two-way ANOVA, independent t-tests, and descriptive statistics to accomplish the study's objectives. The appropriateness for parametric analysis was validated via normality assessments. Student quotations were selected to augment the survey results, and qualitative interview material was transcribed and presented descriptively.

4.0 Findings

4.1 Calculator Usage in Algebraic Activities

Survey data reveal that most students use scientific calculators in their algebra classes. A small percentage of students utilized calculators for factorization tasks; however, over two-thirds of participants reported using them for solving equations, simplification, and substitution. The descriptive analysis indicated higher mean scores ($M > 3.5$) for using calculators in basic algebra skills, implying that calculators are considered essential for everyday educational activities.

Table 2: Calculator Usage in Algebraic Activities

items	Mean	SD
A scientific calculator helps me solve mathematics problems	7.57	2.369

more effectively in the algebra topic.		
A scientific calculator makes solving mathematical algebra problems as easy as I wish.	7.74	2.415
A scientific calculator saves me time when I use it to solve algebra problems in instructional activities.	7.34	2.445

The responses gathered during the interviews supported these conclusions. A student in Form 2, for instance, explained: "I always use the calculator to check my answers in simplification; it saves time and makes me more confident.". These results address Objective 1, demonstrating that calculators are widely used in algebraic instructional activities, primarily for verification and simplification tasks. The high mean scores confirm that students view calculators as integral to their algebra learning process.

4.2 Students' Perception of Scientific Calculators

The findings indicate generally positive perceptions of calculators. Items with the highest means included "The calculator is easy to bring everywhere" (M = 8.25) and "A Scientific calculator can be used without written instructions" (M = 7.27).

Table 3: Students' Perceptions of Using a Scientific Calculator.

items	Mean	SD
Scientific calculators are easy to bring everywhere.	8.25	1.939
A Scientific calculator can be used without written instructions.	7.27	2.533
I can use a scientific calculator successfully to solve algebra mathematic problem every time.	7.25	2.799

Interview responses reinforced these findings. One Form 3 student stated: *"I feel less anxious when using calculators because I know I can verify my answers.".* This supports Objective 2, indicating positive perceptions of calculator use, particularly regarding convenience and confidence enhancement. The qualitative responses affirm that calculators reduce anxiety and increase motivation.

4.3 Engagement and Learning Outcomes

There was no significant difference in calculator usage between urban (M = 6.10) and rural (M = 5.96) students, as determined by an independent samples t-test (p = 0.697). One-way ANOVA indicated a significant perception variation based on the employed calculator model (p < .001). In comparison to students utilizing older models, those employing the Casio fx-570EX expressed the most favorable sentiments (M = 7.87). ANOVA revealed substantial school level differences, with older students expressing more favorable judgments. The inferential results correspond to Objective 3, showing that while overall usage patterns are consistent across demographics, differences in model types and levels suggest that experience and device quality affect engagement.

Table 4:. Inferential Test results for Calculator Usage and Perceptions

Test	Factor	Result/Mean Difference	p- value	Interpretation
Independent T-test	Urban vs. Rural	No significant different	0.697	Usage consistent across areas
One Way ANOVA	Type of Scientific Calculator	Casio fx-570EX highest	<.001	Significant difference found
One Way ANOVA	School Level	Older > Younger	<.05	Significant difference found
Two Way ANOVA	Type of Scientific Calculator x School Level	Significant interaction	<.001	Form 5 + Casio fx-570EX most positive

4.4 Summary of Findings

The findings indicate that students utilised calculators extensively in algebra classes, held positive views regarding their usefulness, and displayed differing perspectives based on the type of calculator employed and their grade level. This study's findings demonstrate that the use of calculators enhances accuracy, confidence, and motivation, particularly when integrated with structured classroom activities.

5.0 Discussion

The findings of this study provide strong evidence that the use of scientific calculators enhances students' precision, confidence, and involvement when integrated with algebraic teaching methods. This section analyses the findings in relation to previous studies, existing hypotheses, and broader implications for education.

5.1 Integration of Scientific Calculators

The extensive use of calculators in algebraic problems is evidenced by the high utilization scores (M = 6.04, SD = 0.96) suggests that calculators were frequently employed to assist with algebraic tasks. The participants in this study emphasized that calculators enabled them to verify their answers, consequently enhancing their confidence and precision, aligning with the studied by Arfa Afzal in 2023 that addressing the digital divide enables the creation of an inclusive and empowering educational environment, allowing all students to benefit from technology. The findings indicate that calculators serve dual purposes, acting both as computational instruments and as frameworks that assist students in their problem-solving endeavours.

5.2 Students' Perceptions

Students' perceptions were also found to be positive with the highest ratings related to portability and the ability to make algebra easier to understand. This study's findings align with Vygotsky's concept of the Zone of Proximal Development (ZPD), indicating that learners can be supported in accomplishing tasks that exceed their current abilities using suitable tools. Similarly, Closing the digital divide is essential for fostering a more just and equitable society, as well as enhancing educational opportunities. (Afzal et al., 2023). It indicates that merely equipping children with advanced calculators does not suffice. The interviews in this study confirmed these quantitative results, as students reported feeling more motivated to attempt questions when calculators were available.

5.3 Demographic Factors

The absence of significant differences in usage between urban and rural students ($p = 0.697$) suggests that calculators may reduce disparities in access to learning tools, supporting Zulfiani et al. (2023), who argued that technology can act as an equalizer in education. However, significant differences by calculator model and school level show that access to more advanced calculators, such as the Casio fx-570EX, may provide additional advantages. Also, this aligns with the study by Arfa Afzal in 2023 that addressing the digital divide enables the creation of an inclusive and empowering educational environment, allowing all students to benefit from technology. Finding underscores the need to consider equity not only in terms of access to calculators but also in terms of the quality of devices available to students.

5.4 Implications for Teaching and Learning

At the classroom level, teachers should design lessons that integrate calculators for exploration and verification purposes rather than as shortcuts. At the curriculum level, embedding calculator-supported tasks can help students engage with algebra meaningfully. At the policy level, attention must be given to ensuring equitable access to updated calculator models across schools. Based on Eleje recent study in 2024, They expressed concerns that excessive dependence on calculators might hinder the development of essential computational skills in children. (Eleje et al., 2024). The "errors" encountered prompted students to reflect on their manual procedures, thereby improving their metacognitive skills. For instance, Participant 2 acknowledged that she acquired additional insights from incorrect results, as they compelled her to pinpoint specific mistakes in her work.

5.5 Broader Implications for Teaching Policy

Beyond the immediate scope of this study, the findings carry important implications. At the classroom level, teachers should not regard calculators as shortcuts but as pedagogical tools that facilitate conceptual learning, verification, and exploration. At the curriculum level, embedding calculator-integrated tasks can align with 21st-century learning goals, encouraging students to think critically rather than memorise mechanically. This study's findings align with Vygotsky's concept of the Zone of Proximal Development (ZPD), indicating that learners can be supported in accomplishing tasks that exceed their current abilities using suitable tools. Calculators function as a supportive tool for advanced learners, facilitating the development of higher-order skills like answer verification, pattern exploration, and solution validation. This, consequently, contributes to the development of more favorable perspectives regarding the integration of technology in mathematical education.

5.6 Contribution to Educational Practice

The findings also contribute to broader sociological discussions in education by showing how access to technology intersects with learning equity**.** Constructivist Theory of Learning is founded on Jean Piaget's and Lev Vygotsky's research, which posits that students might learn by their understanding and knowledge of the world throughout the experience thing and reflect on the surrounding experience. Ginga & Zakariya, (2020) said that these methods work to help students learn new information by connecting it to things they already know, enabling them to make modifications in their existing intelligence to accommodate the new information. This is related to his research on cognitive development in children**.** This theoretical framing extends the impact of the study beyond mathematics pedagogy into wider educational debates.

6.0 Conclusion& Recommendations

This investigation focused on the teaching of algebra in secondary schools using scientific calculators. When utilized effectively, calculators enhance precision, foster assurance, increase involvement, and reduce anxiety related to mathematics. Students indicated significant usage (M = 6.04, SD = 0.96) and favourable views (M = 7.23, SD = 1.99), highlighting the instructional value of calculators beyond mere calculation. The notable differences observed based on calculator type and educational level indicate that the quality of tools and the maturity of learners influence the process of integration.

It is important to acknowledge certain limitations. The study focused exclusively on selected schools, which restricts its generalizability. The data collected through self-reported surveys may have been subject to bias, and the qualitative insights were derived from a limited number of interviews. These characteristics indicate that, although valuable, the results warrant careful interpretation.The results indicate numerous potential actions. Educators ought to design organized calculator tasks that promote exploration and validation rather than reliance. The use of calculators must be explicitly outlined in algebra classes to align with contemporary educational objectives. Educator preparation should include instruction on the effective use of calculators within the classroom setting.

Future studies should employ longitudinal approaches to investigate the enduring impacts on achievement and motivation, while also incorporating larger and more diverse samples from various regions. Comparative studies on calculators, graphing software, and mobile apps could uncover valuable insights into their integration. It is essential to address equity concerns, particularly the disparities in student outcomes associated with advanced versus basic calculator models.

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Paper Contribution to Related Field of Study

This study adds valuable insights to mathematics education by offering empirical data on the role of scientific calculators in improving algebraic learning for secondary school students. This study demonstrates that calculators, often seen solely as computing tools, offer a more extensive educational benefit. Calculators possess capabilities that extend beyond mere mathematical computations. They can also assist children in developing greater confidence, reducing their fear of mathematics, and increasing their likelihood of engaging in problem-solving activities. The findings enhance the existing body of work by concentrating on the Malaysian context, which is underexplored in terms of the incorporation of calculators into organised educational activities. The findings provide valuable insights for educators, curriculum developers, and policymakers aiming to utilise accessible technologies to enhance the teaching and learning of mathematics.

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