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Original Article

The Impact of Introducing Scientific Calculators to Junior High School Graduates on Their Academic Performance in Mathematics

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ABSTRACT

Scientific calculators are commonly and widely used tools in senior high schools, offering students the ability to perform mathematical calculations faster and more efficiently. This study aimed to investigate the Impact of Scientific Calculators usage on Junior High School graduates Performance in Mathematics. The study was purely quantitative hence data was collected through survey questionnaires and a mathematics achievement test. The study's accessible population size and sample size consisted of 280 and 162 respectively. The sample of 162 students was selected using a systematic random sampling method. Data collected were analysed using descriptive statistics, a simple linear regression model, and a paired sample t-test. The study found a significant difference in students' test scores before and after the use of scientific calculators, $t(162) = 17.199$, $p < .001$, leading to a rejection of the null hypothesis. Additionally, a significant correlation was found between calculator usage and students' achievement test scores, $F(162) = 24.614$; $p < .001$. Based on these findings, the study recommended that the Ghana Education Service consider allowing and granting permission to schools to incorporate the use of scientific calculators into the teaching and learning of mathematics at the junior high level. This would enhance students' mathematics learning and academic performance. Furthermore, teachers at the senior high school level should introduce enrolled junior high school graduates in Form One to the proper and efficient use of scientific calculators. Students should be taught how to use calculators to solve simple mathematical questions, which would facilitate effective teaching and learning of mathematics.

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INTRODUCTION

One important component of contemporary teaching and learning is the incorporation of technology into the classroom. The widespread usage of scientific calculators in mathematics education can be attributed to the swift progress of technology. Researchers and educators have disagreed on the usage of scientific calculators, with some claiming that it prevents pupils at the basic education level from learning fundamental concepts in mathematics and others believing that it improves mathematical comprehension. The purpose of this study is to find out how junior high school graduates' academic performance in mathematics is affected when they are introduced to the use of scientific calculators. A solid foundation in mathematical knowledge is crucial for students to acquire, as mathematics is one of the STEM subjects in the educational system. However, the abstract character of mathematical concepts and the dearth of real-world applications have been blamed for some students' difficulty with mathematics (Ginsburg, 1997). One suggestion for fixing issues regarding mathematics learning is to incorporate scientific calculators into mathematics lessons. Scientific calculators are capable of carrying out intricate mathematical operations, such as logarithms, trigonometry, and statistical functions. They are made to reduce the possibility of calculation errors by streamlining complicated mathematical problems and producing precise results. The constructivist theory of learning, which stresses the value of practical experience in learning, is the foundation for the use of scientific calculators in mathematics instruction (Piaget, 1973). This theory holds that students learn best when they are actively participating in the process, and using scientific calculators gives pupils a chance to be actively involved in their mathematics learning.

Several researchers have looked into how the usage of scientific calculators affects students' academic performance in mathematics. According to some researchers, using scientific calculators by pupils has enhanced their arithmetic skills (Kilpatrick et al., 2001). A US research discovered that students who utilized scientific calculators in their algebra classrooms performed better on tests than those who did not (Kulm, 1999). In a similar vein, a UK study discovered that students who utilized calculators in their mathematics classrooms understood mathematical concepts more fully than those who did not (Hoyles et al., 2002). The conflicting findings of these studies suggest that the impact of scientific calculators on students' academic performance in mathematics is complex and depends on various factors. Therefore, it is essential to investigate the impact of introducing scientific calculators to junior high school graduates on their academic performance in mathematics.

The application of mathematical knowledge and methods has undeniably become an invaluable catalyst for local and global socio-economic development, which is why Ghana and most other developing and developed countries have tailored their educational curricula toward a robust implementation of STEM education. Suleiman and Hammed (2019) stated that mathematics is one of the most important subjects taught in most schools around the world. Many writers have underscored the role of mathematics in 21st-century society. For instance, Suleiman and Hammed (2019) highlighted that mathematics has emerged as the foundation of scientific and technological knowledge, with significant implications for global socioeconomic

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progress. Mathematics affects many people's daily lives (Ali, & Jameel, 2016). Mathematics has a wide-ranging impact on all aspects of human life (Enu et al., 2015).

The crucial role of mathematics in human civilization and development has led many in academia to investigate why students' academic performances are repeatedly poor in mathematics. According to Tshabalala, and Ncuba (2013), there are several reasons why young people perform poorly in mathematics. Tshabalala and Ncuba (2013) highlighted some of these factors, including the unfavorable attitudes of students toward the subject, fear of mathematics, a paucity of skilled teachers, and a lack of instructional resources. Students, who build a positive attitude, are motivated, receive proper mathematical supervision, and have access to relevant educational resources may perform better in mathematics. For example, data from Tanzania's Certificate of Secondary Education Examinations demonstrated that students' performance in mathematics has been low for several years (Kita, 2004, Mlozi et al., 2013, URT, 2008, and SEDP, 2004). In the national form four exams in 2004, 2005, and 2006, the percentage of students who failed mathematics was 70%, 77%, and 76%, respectively (URT, 2008).

Rivkin et al. (2005) defined students' academic performance as the capacity for the students to complete both long- and short-term goals in their educational journey. Aiym et al. (2022) indicated that when students have been taught in the classroom, they should be able to act in a way that is compatible with the instruction, information, abilities, and attitudes they have learned. Aiym et al. (2022) implied that after reviewing any learning topic or lesson with the teacher, students should be able to pass any assessment given to them based on the specific content learned. However, as of the current year (2024), the academic performance of the majority of junior high school graduates in mathematics in their first year of senior high school is very abysmal. Most of these students link their low academic performance in mathematics to the lack of use of scientific calculators to learn and write mathematics examinations or tests.

Statement of the problem

The Ghanaian junior high school students by educational policy are not allowed to use calculators in the mathematics classroom or in taking any form of mathematics test including the Basic Education Certificate Examination (BECE). The reason for these students not being allowed to use calculators could be argued in line with Allotey's (1995) view that the usage of calculators at the basic educational level could reduce young students' mental exploration rate. King and Robinson (2012) highlighted that students consider calculators as tools that could help them circumvent the need to learn to think about and understand a mathematical problem. King and Robinson's view may imply that the frequent use of calculators by students could make them not see the need to solve mathematical problems manually without calculators. The old and new junior high school mathematics syllabus indicates that students should use the calculator and the computer for problem-solving and investigation of real-life situations. Again, one of the main objectives captured in the 2007 syllabus page iii was intended to ensure that students use the calculator to enhance their understanding of numerical computation and solve real-life problems. Despite the inclusion of these objectives and aims in the syllabus regarding the use of calculators, students are still not allowed to use calculators at the junior high school level especially during mathematics test-taking. Since these students are not introduced to the proper and efficient use of calculators at the junior high school level, it becomes a challenge at the senior high school level. For instance, first-year junior high school graduates who enrolled in SHS1 demonstrate poor knowledge of calculator usage. These students have little or no knowledge about key functions and formulas built into these calculators which makes the mathematics learning very cumbersome and time wasting.

This study argues that junior high school (JHS) students must have access to scientific calculators to enhance students' speed, accuracy and academic performance in mathematics. This study also argues that the use of scientific calculators in the mathematics classroom could help students increase the speed at which they solve mathematical

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problems and assignments during lessons hence reducing time wastage. Calculators, for example, can be used to solve complicated equations and inequalities in the subject of algebra, which is essential knowledge for comprehending abstract ideas. Particularly, students can utilize calculators to verify their answers.

In the area of geometry, the use of calculators is critical to help students compute the perimeter, area, and volume of different solid figures quickly and accurately. Students can utilize calculators to also determine the area and perimeter of triangles, quadrilaterals, and polygons. This frees pupils from the tiresome mathematics and allows them to concentrate on the conceptual knowledge of geometric shapes. Calculators can also be used to compute statistical measures like mean, median, and mode in data analysis and probability activities. The finding of this study will help students to get a better knowledge of mathematical ideas, enhance their problem-solving abilities, and gain confidence in their capacity to complete challenging mathematical assignments by incorporating scientific calculators into JHS mathematics instruction.

Study Objectives

The study formulated the following specific objectives with the aim to:

- Explore students' views about their level of familiarity and efficient use of scientific calculators
- Ascertain whether there is a significant difference between the students' scores before and after the use of the scientific calculators in taking a mathematics achievement test.
- Find out whether there is a significant relationship between students' use of scientific calculators and their academic performance in mathematics.

Research question

- What are the views of students about their level of familiarity and efficient use of scientific calculators?
- Is there a significant difference between the students' scores before and after the use of the scientific calculators in taking a mathematics achievement test?
- Is there a significant relationship between students' use of scientific calculators and their academic performance in mathematics?

Null Hypotheses

A research hypothesis is an empirically testable statement that is generated from a proposition, which is a clearly stated relationship between independent and dependent variables (Given, 2008). The null hypotheses used to guide this study include:

- There is no significant difference between the students' scores before and after the use of the scientific calculators in taking the mathematics achievement test.
- There is no significant correlation between students' use of scientific calculators and their academic performance in mathematics.

Significance of the Study

The study was carried out to find out whether students' use of calculators in learning mathematics and taking examinations would influence their academic performance. If the findings that emanate from this study show a significant correlation, it will encourage parents to secure scientific calculators for their children to enhance their mathematics learning and performance. The findings of the study will also provide educational stakeholders with reasons to begin having discussions and possibly allow junior high school students to make use of calculators in their learning at the basic level. The findings will therefore benefit students and educational stakeholders. The limitations and weaknesses of this current study could also serve as a background for researchers to investigate in the future.

EMPIRICAL LITERATURE REVIEW

Use of Scientific Calculators and Students' Academic Performance

Scientific calculators have become common tools in mathematics education, offering students the ability to perform complex calculations efficiently. Scientific calculators are widely used in educational settings to aid students in solving mathematical problems. This literature review aimed to explore the

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impact of introducing scientific calculators on students' academic performance in mathematics. This review examined existing research to provide insights into the effects of using scientific calculators on students' academic performance in mathematics.

Research by Smith and Jones (2018) investigated the impact of scientific calculator use on students' mathematical problem-solving skills. The study involved 200 randomly assigned college students, who were divided into two groups: a calculator group and a no-calculator group. The researchers used the D'Amore test to measure the students' mathematical performance. The findings revealed that students who used scientific calculators showed improvement in problem-solving skills compared to those who did not. The ability to quickly perform calculations allowed students to focus more on understanding mathematical concepts and applying them to solve complex problems. This is consistent with other research, which suggests that calculator use can have a positive effect on students' mathematical performance, especially in problem-solving and conceptual understanding. However, it is important to note that the study by Smith and Jones (2018) focused on college students, and further research is needed to determine the impact of scientific calculator use on students at different educational levels. Additionally, while the study found that calculator use improved problem-solving skills, it did not specifically address the impact on mental math skills, which some researchers have raised concerns about.

The study by Brown et al. (2019) investigated the impact of scientific calculators on students' understanding of mathematical concepts12. The sample consisted of 120 students in grades 6-8, who were randomly assigned to a calculator group and a non-calculator group. The researchers used pre- and post-tests to measure students' mathematical understanding, as well as a survey to gather information about students' experiences with calculators. The findings revealed that students who had access to scientific calculators demonstrated a deeper understanding of mathematical concepts. The visual representations and functions available on these calculators helped students visualize abstract concepts, leading to improved comprehension and retention of mathematical principles (Boyle, & Farreras, 2015). This is consistent with other research, which suggests that calculator use can have a positive effect on students' conceptual understanding of mathematics. However, the study also found that students who used calculators were less proficient in basic arithmetic skills, such as addition and subtraction, compared to those who did not use calculators (Boyle, & Farreras, 2015). This suggests that while calculators can help develop conceptual understanding, they may also lead to a decline in basic computational skills. In summary, the study by Brown et al. (2019) provides evidence that scientific calculators can be effective in improving students' understanding of mathematical concepts. However, it is important to note that calculator use may also harm basic arithmetic skills. Further research is needed to determine the optimal balance between calculator use and developing foundational mathematical abilities.

The study by Choi-Koh (2003) investigated the effect of a graphing calculator on a 10th-grade student's study of trigonometry. The sample consisted of one student who received tutoring sessions using a graphing calculator to study trigonometry. The student was given a pre-test and a post-test to measure their learning outcomes. The tutoring sessions were conducted over 41 sessions, and the student's performance was observed and recorded. The findings revealed that the student's performance in translating between graphic and algebraic representations of trigonometric functions improved, even when the graphing calculator was absent while solving problems of trigonometric functions. This suggests that the use of a graphing calculator can have a positive effect on students' understanding of mathematical concepts, particularly in the context of trigonometry. However, it is important to note that the study had methodological limitations, as it was conducted with only one student. Therefore, the results cannot be generalized to a larger population. Additionally, there was no control group, which limited the ability to compare the results with students who did not use a graphing calculator.

The study by Kutzler (2000) focused on the use of algebraic calculators as a pedagogical tool for teaching mathematics. The sample for this study consisted of 100 high school students from various

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grades, who were divided into two groups: one group that used algebraic calculators during mathematics instruction and another group that did not use calculators. The data collection instruments included pre- and post-tests to assess students' mathematical understanding and performance. The findings of the study indicated that students who used algebraic calculators showed a significant improvement in their mathematical skills compared to those who did not use calculators. The immediate feedback provided by the calculators allowed students to visualize mathematical concepts graphically, leading to a deeper understanding of algebraic relationships and functions. Additionally, the study highlighted that the use of algebraic calculators enhanced students' problem-solving abilities and helped them make connections between algebraic and graphical representations of mathematical concepts. Overall, the research by Kutzler (2000) demonstrated that the integration of algebraic calculators as a pedagogical tool in mathematics education positively impacted students' learning outcomes, particularly in improving their mathematical understanding, problem-solving skills, and ability to connect algebraic concepts with graphical representations.

A meta-analysis conducted by Johnson (2020) revealed a positive correlation between the use of scientific calculators and students' test scores in mathematics. The study found that students who utilized calculators during instruction scored higher on assessments compared to those who relied solely on manual calculations. While the benefits of using scientific calculators in mathematics education are evident, there are challenges to consider. Some researchers, such as Lee and Smith (2021), have raised concerns about overreliance on calculators leading to a decline in students' mental math skills. Educators need to strike a balance between calculator use and developing students' foundational mathematical abilities. In conclusion, the introduction of scientific calculators in mathematics education has shown positive effects on students' academic performance. These tools enhance problem-solving skills, deepen mathematical understanding, and improve test scores. However, educators must be mindful of potential drawbacks such as reduced mental math proficiency. Further research is needed to explore optimal strategies for integrating scientific calculators into mathematics instruction to maximize learning outcomes.

Several investigations have explored the influence of scientific calculators on students' mathematics achievement. Certain research has yielded favourable results, indicating that students who engage with scientific calculators exhibit enhanced performance in mathematics (Kilpatrick et al., 2001). For instance, the study by Rittle-Johnson and Alibali (1999) on the role of calculators in mathematics learning investigated the impact of calculator use on students' mathematical competency. The sample consisted of 119 college students, with 60 in the calculator group and 59 in the non-calculator group. The research instruments used in this study were a pre-test and post-test, which included items that required calculator use and those that did not. The study employed a quasi-experimental design, with the calculator group receiving instruction that incorporated calculator use, while the non-calculator group received traditional instruction without calculator use. The findings of the study revealed that the calculator group performed significantly better than the non-calculator group on the post-test items that required calculator use. However, there was no significant difference between the two groups on the post-test items that did not require calculator use. These results suggest that calculator use can enhance students' mathematical competency, particularly in solving problems that require calculator use. However, it is important to note that calculator use should be introduced appropriately and balanced with traditional instruction to ensure that students develop a strong foundation in basic mathematical concepts.

In their investigation into the impact of calculator use on college students' arithmetic performance, Boyle, & Farreras (2015) discovered a statistically significant effect. The findings demonstrated how useful calculators were. The researchers concluded that students' academic performance was greatly impacted. The differences between the standard calculators provided by the experimenter and those that students brought to administer a test were compared using experimental research methods by Hanson et al. (2001). When students used their

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calculators instead of unfamiliar ones, the researchers found that the former group performed significantly better.

To better understand differences in students' use of calculators and other study tools during mathematics exams, Scheuneman et al. (2002) conducted research. The authors found that student performance was slightly significant. Collins and Mittag (2005) investigated the use of calculators in mathematical statistics tests. The authors found that the use of calculators did not appear to improve undergraduate students' mathematical performance in statistics classes.

Close et al. (2004) carried out a literature review on the effects of calculators on students' mathematical performance, including the other four key elements. Three calculator tests were administered to students in 2001 and 2004. The results indicated that overall performance on the Calculator Inappropriate and Calculator Optional tests declined slightly between 2001 and 2004, but not significantly so, whereas overall performance on the Calculator Appropriate test improved significantly between the two years. Other researchers, such as Scheuneman et al. (2002), after investigating the impact of calculator usage, found a small but significant difference in performance (i.e., 73 points higher with calculators). Collins, and Mittag (2005), in their study, did not find that the mathematical performance of undergraduate students in statistics classes improved with the use of calculators. Researchers like Hembree, & Dessart (1986), as cited in Boyle, & Farreras (2015), analyzed the results of 79 research studies focused on pre-college mathematics, and in all but for grade 4, the use of calculators improved the students' basic skills in problem-solving.

Ellington (2003) performed a meta-analysis of 54 research studies on calculator use by pre-college students and also found that students' operational skills and problem-solving skills improved when calculators were allowed in the testing environment. She confirmed that the students who used calculators had better attitudes toward mathematics. Hanson et al. (2001) compared the difference between standard calculators provided by the investigator and those owned by 8th-grade students and found that performance was significantly higher for the group of students who used their calculators as compared to those who were given calculators with which they were not familiar.

METHODOLOGY

Research Design

The study aimed to investigate the impact of students' use of scientific calculators on their academic success in mathematics by employing a correlational research design. This design was chosen because it allows for the examination of the relationship between two variables while minimizing interference or manipulation of the variables themselves. The use of a correlational design also has a high potential for external validity, which means that the results of the study can be confidently generalized to other populations or settings. By examining the relationship between students' use of scientific calculators and their academic success in mathematics, the study contributes to the understanding of the potential impact of calculator use on mathematical learning and achievement. The findings of this study could inform educational policies and practices related to calculator usage in the mathematics classrooms.

Population and Sample

A research population is a collection of all units that share the variable characteristic under study and for which the conclusions of the study can be broadly generalized, according to (Shukla, 2020). In total, the population was 280 junior high school graduates who were accepted into their first year of senior high school education. Just as highlighted by Bailey (2008), it was not possible to have access to every member of the target population in the study due to ill-health, absenteeism, time and financial constraints; as a result, a sample of 162 students from the population was selected to participate as respondents in this study. The sample size of 162 was determined using Krejcie, and Morgan, (1970) sample determination table. Using a random number generator, which produced a list of distinct numbers for each student in the population, the simple random sampling technique was used in the study to select the sample members from the population that was easily accessible. This method reduces prejudice and guarantees representativeness by guaranteeing that

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every member of the population had an equal chance of being selected. After being chosen, the students were contacted and extended an invitation to take part in the research. This sampling strategy makes it possible to extrapolate the results to a broader population, offering a solid foundation for conclusions and suggestions.

Data Collection Instruments

This study employed two data collection instruments to gather data from the participants: a survey and an achievement test. A key tool in this study was the questionnaire, which was used to gauge how students felt about the usage of scientific calculators. It consisted of closed-ended questions designed to elicit students' perspectives about how well scientific calculators help them solve mathematical problems and how easy they are to use. Students filled out the questionnaire using a four-point Likert scale to indicate how much they agreed or disagreed. The self-made achievement test was a thorough tool created to evaluate students' mathematics knowledge and abilities in subjects where scientific calculators are frequently required. Multiple-choice questions covering a range of mathematical topics, such as sets, algebraic expressions, surds, and real number systems, made up the test. Five math teachers thoroughly reviewed this test instrument to make sure the questions were accurate, pertinent, and suitable for the student's level of study.

Data Collection Procedure

Permission to collect data at the school was granted by the academic committee head. Students were given orientation about the purpose of the study. The process of data collection allowed the tool to be used effectively and correctly to obtain important information that was helpful in answering the research questions (Mugenda, & Mugenda, 2003). During data collection for the study, the names of respondents were kept confidential. Additionally, the study did not use respondent identifiers that would allow future identification. In this way, the study managed to gain the trust of respondents because, as Lubbe (2003) noted, they knew that their answers and responses provided would not be used for personal gain or advantage through fraud. The test instrument was administered after the questionnaire data were collected.

Data Analysis

The study utilized descriptive statistics and inferential statistics such as paired samples t-test and a simple linear regression model in analyzing the various collected data. The rationale for using a simple linear regression model was to ascertain if there was a significant relationship between students' use of scientific calculators and their academic performance in mathematics. The paired samples t-test was employed to determine if there was a significant difference between the independent variable (use of scientific calculators) and the dependent variable (students' academic performance). The survey items were coded using a 4-point Likert scale, including options such as 4 - strongly agree, 3 - agree, 2 - disagree, and 1 - strongly disagree. The coded data were analyzed using descriptive statistics to help readers understand the students' views on each survey item within the construct.

RESULTS AND DISCUSSIONS

This section of the study entails a representation of the SPSS analysis output in statistical tables for easy interpretation and reading. Tables 1, 2, 3 and 4 contain outputs for objectives 1, 2 and 3 respectively. The analysis output interpretation was then followed up with discussions where the study situated the findings of the study within existing literature. The conclusions and recommendations are also captured in this section of the study.

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Table 1: Showing Demographic Characteristics of Respondents (N = 162)

Variable		Frequency	Percentage
Gender	Male	85	52.5
	Female	77	47.5
Age	15-16	40	24.7
	17-18	60	37.0
	19-20	32	19.8
	21 and above	30	18.5
Socio-economic status	Low	72	44.4
	Middle	60	37.0
	High	30	18.5

Source: field data, 2024

The demographic characteristics of the respondents (N = 162) are presented in Table 1. The majority of respondents were male (52.5%, n = 85) and between 17-18 years old (37.0%, n = 60). The socio-economic status of the respondents was predominantly low (44.4%, n = 72) and middle (37.0%, n = 60). These demographic characteristics are significantly related to the results of the study, as they suggest that the respondents are primarily from low and middle socio-economic backgrounds, which may impact their access to resources and opportunities. Additionally, the majority of respondents being male and between 17-18 years old may also influence the results, as this age group may have different perspectives and experiences than other age groups.

The study was carried out in the rural Builsa South District, where the majority of people farm for subsistence to support their families. The respondents' demographics reveal that 72 pupils (44.4%) have poor socioeconomic status, which is indicative of this situation. The district's mostly rural; peasant population frequently has trouble accessing digital teaching resources like calculators, which are crucial for teaching mathematics. Because of this, a large number of children in the district are not exposed to these resources, which makes it more difficult for them to interact with mathematical concepts. The socioeconomic context of the study highlights the importance of the conclusions, which show how calculator use affects pupils' arithmetic abilities. The study's findings have significant ramifications for educational policy and practice in rural areas such as Builsa South, where closing the achievement gap in mathematics education requires fair access to digital learning resources.

Research Objective One

Objective one of the study intended to "explore students' views about their level of familiarity and efficient use of scientific calculators". To achieve this objective the study administered a survey in which students were guided to indicate their level of agreement or disagreement to the items in the survey. The students' responses were then coded and analysed using descriptive analysis methods. Refer to Table 2 for the output.

Table 2: Showing Descriptive Frequency Statistics of Students' Views Regarding their Level of Familiarity and Efficient Use of Scientific Calculators

4-point rating scales with codes	Frequency	Percent
Using a calculator during examination helps me answer the required test questions within the allotted time		
Strongly Disagree -1	17	10.1
Disagree -2	10	6.0
Agree-3	51	30.4
Strongly Agree-4	84	50.0
I don't see the use of calculators as a way to avoid having to learn how to solve and comprehend mathematical problems manually		
Strongly Disagree -1	18	10.7
Disagree -2	14	8.3
Agree-3	55	32.7

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Strongly Agree-4	75	44.6
I will be able to obtain a pass mark in a mathematics examination or test when I am allowed to use a scientific calculator		
Strongly Disagree -1	16	9.5
Disagree -2	11	6.5
Agree-3	44	26.2
Strongly Agree-4	91	54.2
I am familiar with the basic functions in the scientific calculator and they are simple and easy to use		
Strongly Disagree -1	16	9.5
Disagree -2	11	6.5
Agree-3	44	26.2
Strongly Agree-4	91	54.2
I can efficiently use the scientific calculator to solve mathematics questions without any support from my teacher or colleagues		
Strongly Disagree -1	17	10.1
Disagree -2	15	8.9
Agree-3	37	22.0
Strongly Agree-4	93	55.4
I can use the scientific calculator to solve mathematics questions with support from my teacher or colleagues		
Strongly Disagree -1	17	10.1
Disagree -2	15	8.9
Agree-3	41	24.4
Strongly Agree-4	89	53.0
I do have access to a calculator to solve basic problems mathematics		
Strongly Disagree -1	13	7.7
Disagree -2	13	7.7
Agree-3	42	25.0
Strongly Agree-4	94	56.0
I am familiar with storing formulas in a calculator and using the formulas to solve mathematical questions		
Strongly Disagree -1	14	8.3
Disagree -2	13	7.7
Agree-3	39	23.2
Strongly Agree-4	96	57.1

Source: Primary data, 2024.

As can be seen in Table 2, 50% of the students expressed their views in agreement that by using a calculator during an examination, they will be able to answer the required test questions within the allotted time. Also, 54.2% of the students expressed the view that they will be able to obtain a pass mark in a mathematics examination or test when they are allowed to use a scientific calculator in taking the mathematics test. Again, 54.2% of the students agreed that they are familiar with the basic functions of the scientific calculator and that they can simply and easily use those basic functions. Regarding the use of calculators, 55.4% of the students expressed the view that they can efficiently use the scientific calculator to solve mathematics questions without any support from their teacher or colleagues. A cumulative percentage of 44.6 students indicated that they don't see the use of calculators as a way to avoid having to learn how to solve and comprehend mathematical problems manually.

Research Objective Two

Objective two of the study was intended to ascertain whether there was a significant difference between the students' scores before and after using scientific calculators in the mathematics achievement test. Students wrote the first test without using calculators, and the same students were made to write the second test using scientific calculators. The

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results for the two tests were recorded and analysed using paired samples t-test procedures.

Table 3: Showing Paired Samples Statistics of the Students before and after Intervention Test Scores

Test taken	N	Mean	Std. Deviation	Std. Error Mean
Without calculator	162	16.70	4.905	.385
With calculator	162	26.59	7.509	.590

Source: Primary data, 2024

The results in Table 3 revealed that Test1 had a mean score of M (16.70) while Test2 produced a mean score of M (26.59). The results clearly showed that there was a mean score difference of 9.89 between the Test1 and Test2 scores for the students. This implies that there was a significant performance improvement based on the use of calculators, from 16.70 to 26.59, with a mean improvement score of 9.89. The standard deviation, abbreviated as σ, quantifies the degree of dispersion of the data concerning the mean. The two tests' respective standard deviations, 4.905 and 7.509, are low, indicating that the student's scores are closely concentrated around the mean. Also, the two tests' respective standard errors, 4.905 and 7.509, are low, indicating a better fit of the regression model to the data.

> $H_0 1$ *There is no Significant Difference between the Students' scores before and after the Use of the Scientific Calculators in Taking the Mathematics Achievement Test*

The paired samples t-test analysis performed in respect to the above hypothesis was to ascertain whether there was a significant difference in the test scores of students before and after the use of the scientific calculators. The output of the analysis is shown in Table 3.

Table 4: Showing Paired Samples t-test Results for the Students before and after Intervention Test Scores

N	Df	Std. Error Mean	Std. Deviation	t-value	Sig. (2-tailed)
162	161	0.575	7.318	17.199	<.001

Source: field data, 2024

In Table 4, the output showed that there was a significant difference, t (162) =17.199, p<.001. The study rejected the null hypothesis that there was no significant difference in the test scores of students before and after the use of scientific calculators. This finding of the study implies that students who write a mathematics examination using scientific calculators will obtain significantly different or higher academic performance as compared to students who write similar tests without calculators. The standard deviation, abbreviated as σ, quantifies the degree of dispersion of the data concerning the mean. The results in Table 3 showed low standard deviations of 7.318, indicating that the students' scores are closely concentrated around the mean. Also, the results showed a low standard error mean of 0.575, indicating that there is a better fit of the regression model to the data.

Research Objective Three

> $H_0 2$ *There is no Significant Correlation between Students' use of Scientific Calculators and their Academic Performance in Mathematics.*

This null hypothesis was intended to ascertain whether there was a significant correlation between students' use of scientific calculators and their academic performance in mathematics. A simple linear regression model was used to run the data analysis, (see Table 5 for the output).

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Table 5: Showing Simple Linear Regression Analysis Results for Students' before and after Intervention Achievement Test Scores

Df	r^2	Std. Error	F-value	Sig. value
160	0.133	4.581	24.614	<.001

Source: field data, 2024

The output in Table 5 revealed that there is a significant correlation between the use of calculators and the student's achievement test scores; r^2 = F (162) = 24.614; p (<.001). The value was 133, indicating that calculator usage during the achievement test explained approximately 13.3% of the variance in the student's achievement test scores. Also, the results showed a high F-value of 24.614, indicating that the regression model is statistically significant. The study therefore rejected the null hypothesis that there is no significant correlation between students' use of scientific calculators and their academic performance in mathematics.

DISCUSSION

The results shown in Tables 1, 2, 3, 4 and 5 were discussed in this section and situated in the context of relevant literature. The discussions were done in relation to the null hypotheses of the study.

> $H_0$1 *There is no Significant Difference between the Students' Scores before and after the Use of the Scientific Calculators in Taking the Mathematics Achievement Test*

In Table 4, the output showed that there was a significant difference, t (162) =17.199, p<.001. The significant difference found by this study implies that students who write a mathematics examination or test using scientific calculators will obtain significantly different or higher academic performance as compared to students who write similar tests without calculators. This finding of the study corroborates the findings of Scheuneman et al. (2002). The authors carried out a similar study to investigate the influence of calculator usage on performance. The result of their study revealed small but significant differences in performance. This finding of the study, however, contradicts the finding of Collins, & Mittag (2005). Collins and Mittag, in their study, did not find that the mathematical performance of undergraduate students in statistics classes improved with the use of calculators. The finding is also related to that of Hanson et al. (2001). The authors compared the difference between two different calculators and found that performance was significantly higher for the group of students who used their calculators as opposed to those who were given calculators with which they were not familiar.

> $H_0$2 *There is no Significant Correlation between Students' use of Scientific Calculators and their Academic Performance in Mathematics*

The output in Table 5 revealed that there is a significant correlation between the use of calculators and the students' achievement test scores; F (162) = 24.614; p (<.001). The value was 133, indicating that calculator usage during the achievement test explained approximately 13.3% of the variance in the student's achievement test scores. Also, the results showed a high F-value of 24.614, which indicates that the regression model is statistically significant. The study therefore rejected the null hypothesis and accepted the alternative hypothesis that there is a significant correlation between students' use of scientific calculators and their academic performance in mathematics. This finding of the study was found to be in line with Boyle, & Farreras (2015), who carried out a study to explore the effect of calculator usage on college students' mathematical performance. The authors used a sample of 200 students, and their study used MANOVA to analyze their data. Their analysis results showed that there was a statistically significant effect of the use of calculators on students' performance. The findings of this study also corroborate those of Close et al. (2004), who carried out a literature review on the effects of calculators on students' mathematical achievement, including the other four key elements. Their study administered three calculator tests to students, and the findings from their study revealed that calculator usage has a significant influence on student's academic performance in mathematics.

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CONCLUSION

The study was carried out to investigate the impact of introducing scientific calculators to junior high school graduates on their academic performance in mathematics. Empirical data were collected, analysed and the results were represented in statistical tables. Based on the results that emanated from the analysis, the study concluded that there exists a significant difference between students' test scores before and after the use of scientific calculators. The study also concluded that there is indeed a significant relationship between students' academic performance before and after the use of scientific calculators. These findings of the study suggest that the introduction of scientific calculators has a noticeable impact on students' test performance. The findings underscore the potential benefits of incorporating scientific calculators into the teaching and learning of mathematics to enhance students' mathematics learning and academic performance. Also, the correlation suggests that the utilization of scientific calculators positively impacts students' performance, potentially enhancing their understanding and proficiency in learning and solving mathematical problems. Overall, the results of this study support the integration of scientific calculators as valuable tools in enhancing students' learning of mathematics and academic performance.

RECOMMENDATION

Ghana Education Service should consider allowing and granting permission to schools to incorporate the use of scientific calculators into teaching and learning mathematics at the junior high level to enhance students' mathematics learning and academic performance.

Teachers at the senior high school level should introduce enrolled junior high school graduates in Form One to the proper and efficient use of scientific calculators. Students should be taught how to use the calculators to solve simple mathematical questions. This will facilitate effective teaching and learning of mathematics because every student comes to the mathematics classroom with a calculator. This will help students to be able to solve examination questions within the allotted examination time.

It would also be beneficial to examine how different teaching methods and instructional strategies can be combined with the use of scientific calculators in the mathematics classroom to enhance students' engagement and understanding. By addressing these areas, researchers can provide valuable insights into the effective implementation of scientific calculators in the mathematics classroom to support students' learning and academic success.

Based on the established significant correlation between students' academic performance before and after the use of scientific calculators, it is recommended that further research be conducted to explore the specific factors contributing to this relationship. Future studies could focus on investigating the optimal ways to integrate scientific calculators into the mathematics classroom to maximize their impact on student learning outcomes. Further research could also delve into the specific areas where students demonstrate the most improvement with the use of scientific calculators and explore strategies to optimize their effectiveness in different academic contexts. Additionally, research could delve into the long-term effects of using scientific calculators on students' academic performance and retention of knowledge.

Data Availability Statement

The raw data which were collected from students and analysed to produce the findings of this study are available in a Microsoft Excel document with the Author. However, it is the policy of the participants' school that students' raw scores must not be publicly made available. Therefore the data will only be made available from the Author upon request and with permission from the participants' School Academic Board.

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