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Effectiveness of Scientific Calculators' Usage in the Teaching and Learning of Grade 11 Parabola Functions to Improve Learner Performance

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ABSTRACT

The use of scientific calculators in teaching parabola functions has been shown to have significant effect in learner performance. This study examined the effectiveness of scientific calculators' usage in the teaching and learning of Grade 11 parabola functions to improve learner performance. Bandura's observational learning theory underpinned this study. A non-equivalent quazi-experimental design was espoused to collect data from the experimental and control groups. A pre-test and a post-test were administered to both experimental group and control group in the same day and at the same time, to avoid contamination of results. Wilcoxon-Rank sum test was used to determine the significant difference between the two study groups. The results showed that the experimental group performed significantly better than the control group in the post-test after the implementation of scientific calculators in teaching parabola functions. The study suggests that scientific calculators can be used to teach parabola functions to improve learner performance and advance teacher content knowledge, pedagogical content knowledge and professional development.

KEYWORDS

Parabola functions; scientific calculators; learner performance; mathematics education; teaching and learning.

INTRODUCTION

Before the advent of the 4th industrial revolution (4IR), the previous three industrial revolutions brought the creation of the steam engine, the construction of railways, urbanisation, and enhanced communication, spanning the period from 1760 to 1840 (Schwab, 2016). From the 1960s onward, the computer and digital revolution was catalysed by individual computing between 1970 and the 1980s. Since the 1990s, the adoption of the internet has grown human communication (Schwab, 2016). Humans have been exposed to four industrial revolutions, which include the era of the machine, the electrical energy stage, the era of electronic engineering and the era of the internet (Peters, 2017). Schwab (2016, maintains that technology could change the interaction of individuals with the emerging breakthroughs in technology, highlighting various fields, such as artificial intelligence (AI), robotics, 3D printing, materials for science and mathematics, the Internet of things, energy storage and quantum computing.

Furthermore, the National Development Plan (NDP) in South Africa (SA) (2011) states that to ensure that the learning environment is well structured, every South African ought to attain, as well as use, knowledge efficiently with the usage of information communication and technology (ICT) (Waghid et al., 2019). Teachers must be prepared to transition to 4IR teaching and learning (Awodiji & Katjiteo, 2023). Kupe (2019) urges South African schools and their counterparts worldwide to play a part in advancing and improving their communities through teaching and learning approaches that will generate civilised and socially mindful citizens, prepared for competence in 4IR.

The usage of information and communication technology within the context of school mathematics is mainly by using non-programmable calculators and computers, including access to the internet and materials for use with these tools (Van De Walle et al., 2019). Learners who use technological tools such as scientific calculators when solving mathematical problems perform better than their counterparts who do not (Dagan et al., 2020; Liburd & Jen, 2021; Rahman et al., 2022). The integration of information communication and technology in mathematics classrooms contributes to reflection, identification of problems and decision-making in mathematics (Kissane, 2016; Leong & Parrot, 2018).

A scientific calculator is one of the technological tools that is mainly used in teaching and learning mathematics, due to its significant potential to support teachers and learners in teaching and learning mathematical principles, such as graphs, which are challenging to explain when using traditional approaches (Kissane 2020; Nandwa & Wasike, 2016). Leong and Parrot (2018) assert that under the guidance of mathematics teachers, learners at various proficiency levels can employ technological tools, such as scientific calculators to support and increase mathematical reasoning. These technological tools include calculators, scientific calculators, graphing calculators, computer software, internet-based applications, projectors and video clips. Also, using a scientific calculator as a device has shown the potential to stimulate cognitive, affective and psychomotor skills (Nandwa & Wasike, 2016).

In this study, scientific calculators were used to teach Grade 11 parabola functions in experimental schools. Another focus was on the teacher who participated in this study and used scientific calculators as an intervention to improve learner performance in parabola functions. The researchers, in implementing scientific calculators in the experimental school, investigated whether this intervention might yield positive results in Grade 11 learners' performance in parabola functions.

Studies have been conducted on the use of scientific calculators to improve teacher pedagogical practices. However, there is a dearth of studies focusing on rural schools using scientific calculators to teach parabola functions. The study used quazi-experimental design as scientific calculators gained popularity in teaching mathematics. The teacher in the experimental school has used a scientific calculator to teach parabola functions. The researchers were able to measure whether the implementation of a scientific calculator in teaching parabola functions in the experimental school in a rural school, could improve learner performance in parabola functions. Parabola functions in this study referred to the $x - intercepts, y - intercept, axis\ of\ symmetry, turning\ points$, drawing of graphs and interpretation of graphs. The purpose of this study was to ascertain the effectiveness of using a scientific calculator to improve Grade 11 learner performance in parabola functions. To achieve this objective, the researcher tested the null hypothesis that,

H_0: *The use of a scientific calculator has no significant effect on the improvement of performance in Grade 11 parabola functions.*

This null hypothesis was tested against the alternative hypothesis that,

H_1: *The use of a scientific calculator has a significant effect on the improvement of performance in Grade 11 parabola functions.*

In this study, the focus was on the alternative hypothesis that using a scientific calculator has significant effects on learner academic performance in parabola functions. The study revealed that using a scientific calculator improved teacher pedagogical practice and had a positive impact on learner performance.

Related literature pertaining to the use of a scientific calculator is also presented. Observational learning theory is used to provide a framework for this study. Research methodology is discussed in response to the hypotheses tested. Finally, this study provides suggestions and recommendations to mathematics teachers, curriculum advisors and developers.

Scope and limitations

The study focused on Grade 11 mathematics learners in a rural secondary school of Limpopo Province, South Africa, in the 2023 academic year. The inclusion of other research sites may yield different results regarding implementing a scientific calculator to teach mathematics. In addition, the data set used for analysis has no significant covariates. Future research may incorporate these additional features in the research design. This study has specifically examined the use of a scientific calculator to improve Grade 11 learner performance in parabola functions.

RELATED LITERATURE

Literature review focused on the usage of scientific calculators in the teaching and learning of parabola functions, difficulties encountered in using scientific calculators in the teaching and learning of parabola functions.

The usage of scientific calculators in the teaching and learning of parabola functions

The use of 4IR tools, such as scientific calculators, graphic calculators and computers, has helped learners learn mathematics and attain conception and relational understanding (Dagan et al., 2020; Liburd & Jen, 2021). These technological tools have proven to improve appreciation of functions and variables as learners improved in answering mathematical problems involving drawing and interpretation of graphs (Leong & Parrot, 2018). Learners at all levels can use these technological tools to support and improve mathematical thinking and obtain access to the content. Problem solving contexts can improve computation with ease if they are guided by mathematics teachers (Leong & Parrot, 2018).

Dibble (2013) claims that learners had a better approach toward problem solving when using 4IR devices such as scientific calculators because they derived enjoyment from these technological tools. Moreover, several studies have shown that learners become motivated and increase their learning achievement when teachers incorporate the use of technological devices appropriately (Dagan et al., 2020; Kissane, 2020). The use of technological tools, such as scientific calculators, enables both teachers and learners to solve various mathematical problems and significantly decrease the traditional difficulty in problem solving (Abramovich et al., 2016).

Mutambara et al. (2020) claim that learners are confused when the parabola function is presented in different ways. As a result, learners need to be familiar with the different forms of parabolas before they start using scientific calculators to solve the problems. Learners should be familiar with variables, which include the *x* and *y* intercepts and the vertex of the y-intercept, the axis of symmetry, turning points, the roots of the equation, and the shape of the graph before using scientific calculators. When learners are equipped with the basic skills involved in parabola functions, it will be easier for them to make use of scientific calculators to solve problems on parabola functions (Kissane, 2016; Leong & Parrot, 2018). The use of various illustrations in the process of teaching parabola functions with scientific calculators enables learners to reason and have a better understanding of the concepts that are suitable for solving problems on parabola functions instead of just memorising the procedures on how to draw graphs of parabola functions (Davis et al., 2021; Memnun et al., 2015). Also, teachers should teach their learners how to make use of scientific calculators to solve problems and draw the graph of parabola functions by showing them the keys to punch from their calculators because calculators cannot reason without the input information (Leong & Parrot, 2018).

Difficulties encountered in using scientific calculators

The use of scientific calculators in mathematics instruction is essential for developing the skills of the teachers and the ability of learners to solve mathematical problems because they are devices for exploring, validating and improving the theoretical understanding of learners in problem solving (Leong & Parrot, 2018; Rahman et al., 2022). Also, integrating the usage of scientific calculators in teaching and learning mathematics enables teachers to utilise them to improve their learners' understanding when learning parabola functions (Daganet al., 2020; Rahman et al., 2022). Scientific calculators require learners to solve problems, but that is not always the case because some learners use calculators but do not learn the basic skills in mathematics learning. Masimura (2016) discloses that learners are reliant on calculators with reference to simple mathematical calculations, especially in fractions, square roots, division exponents and trigonometry. The use of all sorts of calculators cannot replace understanding mathematical concepts, skills and human reasoning. Furthermore, the researcher observed that scientific calculators are one of the technological tools most used for computation in rural areas in South African schools.

Despite the benefits of utilising scientific calculators to solve problems with parabola functions, mathematics teachers encounter difficulties when using scientific calculators to teach parabola functions. Some of these difficulties include the attitude of the teachers towards the use of scientific calculators in solving problems on parabola functions, lack of exposure of the teachers on the usage of scientific calculators to solve problems on parabola functions, lack of basic mathematical skills, the inability of the teachers to identify the misconceptions of their learners in parabola functions, lack of interest of the learners towards the learning of mathematics, and lack of frequent use of scientific calculators by the learners when solving mathematical problems (Dagan et al., 2020; Liburd & Jen, 2021; Leong & Parrot, 2018; Rahman et al., 2022).

Rahman et al. (2022) surveyed the proficiency and competency of scientific calculators among mathematics education secondary school learners in Malaysia. The findings reveal that teachers are not using scientific calculators to solve problems on various topics in mathematics classes. In their classes, mathematics teachers still use traditional methods to teach various topics, including parabola functions. Rahman and his associates also found that using scientific calculators to solve mathematical problems can improve the performance of weak learners in teaching and learning mathematics.

Research also shows that learners who use scientific calculators regularly achieve more than learners who seldom use them because a lack of regular usage of scientific calculators can also increase the inappropriate use of scientific calculators, while the regular usage of scientific calculators can enable learners to improve their understanding of the concepts of mathematics (Kissane, 2020; Liburd & Jen, 2021; Rahman et al., 2022). In addition, the attitude of the mathematics teachers towards the usage of scientific calculators in solving problems on parabola functions contributed to the poor performance of the learners. This is because some of the mathematics teachers believe that the use of scientific calculators in solving mathematical problems may not allow learners to learn the basic skills in solving problems on parabola functions. The role of mathematics teachers in the usage of scientific calculators has an influence on the attitude of learners towards the use of scientific calculators in solving problems on parabola functions. Learners who are taught how to use scientific calculators to solve mathematical problems usually perform better than their peers who are not using calculators (Kissane 2016; Kissane 2020; Liburd & Jen, 2021; Rahman et al., 2022; Leong & Parrot, 2018).

Parabola function

A function is an expression describing the relationship between two or more variables of input or independent variable having precisely one element in the output or dependent variable (Nielson, 2015). Nielsen (2015) also describe parabola function as one of the forms $f(x) = ax^2 + bx + c$ where $a, b\ and\ c$ are numbers and $a \neq 0$. The highest power of the variable in a parabola function is 2. This variable can have one, two or non-real roots. The graph associated with the quadratic function is called a parabola (Chazan, 1992, cited in Mutambara et al., 2020). Parent (2015) highlighted three forms of parabola function. They are the standard form, vertex form and factorised form. A parabola function in the form $f(x) = ax^2 + bx + c$ or $y = ax^2 + bx + c$ where $a, b\ and$ are constants and $a \neq 0$ is the standard form of parabola. It shows the point of the *y*-intercept (0;c). A parabola function has a power of 2 on the independent variable which is the highest power of the function. A parabola function can also be written in the form $f(x) = a(x - p)^2 + q$ or $y = a(x - p)^2 + q$ where $a \neq 0$ is the vertex form of the parabola. It shows the turning point of the parabola and the vertex is represented by $V(p; q)$. The factored form of the parabola is the form $f(x) = a(x - x_1)(x - x_2)$ or $y = (x - x_1)(x - x_2)$ where $a \neq 0$. It shows the point of *x*-intercept $(x_1; 0)$ and $(x_2; 0)$ (Ubah & Bansilal, 2018:850; Mutambara et al., 2020:2).

Research has shown that learners have difficulties in establishing a relationship between drawing the graph of the parabola and using the graph to find the equation of the parabola (Davis et al., 2021; Diaz et al., 2020; Ubah & Bansilal, 2018). Moreover, it is essential to ensure that learners are familiar with various activities involving parabola functions, which will enable them to draw various graphs on tasks involving parabola functions in relation to the given points from the graphs (Diaz et al., 2020; Memnun et al., 2015). The use of various representations with the use of technological tools can assist Grade 11 learners to learn parabola functions and these representations can improve their conceptual understanding (Davis et al., 2021; Memnun et al., 2015). The use of scientific calculators in mathematics classrooms can be beneficial in reducing the errors committed by learners when solving problems on parabola functions (Kissane, 2020; Liburd & Jen, 2021).

THEORETICAL FRAMEWORK/CONCEPTUAL FRAMEWORK

This study is underpinned by Bandura's observational learning theory (Bandura, 1986). Observational learning is defined as learning through modelling, which occurs when observers exhibit new behaviours that were impossible prior to modelling, even by using incentives through encouragement with the resultant consequences (Bandura, 1969; Rosenthal & Zimmerman, 1978; Schunk et al., 2014). Observational learning is a complex behaviour that can be taught to many individuals using a single model. This type of learning assumes that modelling influences learning principally through their informative functions and that observers acquire mainly symbolic representations of modelled activities rather than specific stimulus-response associations (Bandura 1969a, 1971a). Through modelling, people learn how to perform a behaviour and what will happen to them in specific circumstances if they do not perform that behaviour (Woolfolk, 2020). Bandura also defined observational learning as a constant, interactive process of learning which intervenes between cognitive, behavioural and environmental factors (Bandura, 1986; Makgakga, 2016). Bandura (1986) claims that learning takes place by observing the behaviour of others and the consequences of their behaviours. This study enabled Grade 11 mathematics learners to observe the way their teachers make use of scientific calculators in solving parabola functions problems and then to practice the skills involved in using it on their own, which makes it easier for them to solve various problems in parabola functions with the use of scientific calculators.

Social learning theory presented by Bandura, highlights the significance of observing a model and mimicking the behaviours, attitudes, and emotional responses of the model as well as imitating the behaviour of others (Bandura 1986; McLeod, 2016). Moreover, Bandura (1986) stresses that learning takes place in a social setting or environment by observing the behaviours of others and the consequences of those behaviours. In addition, Bandura (1977) claims that individuals are active processors of information and reason on the association between their behaviour and the outcomes of those behaviours. Learning through observation might never happen except through the processes of reasoning because persons do not inevitably notice the actions of a model and copy it (Makgakga, 2016; McLeod 2016). There is a particular thought preceding imitation, and this thought is known as mediational process. Mediational process arises when observing the behaviour of the stimulus and then imitating it by response (McLeod, 2016). Bandura (1986) presents four stages of mediational processes otherwise called the four phases of observational learning process, which include attention phase, retention phase, reproduction phase and motivational phase.

Bandura (1986) defined the attentional phase as the phase where an observer pays attention by concentrating on the behaviour and its significance in order to practice the conceptual demonstration of the behaviour. In order to copy an action, it must grasp our consideration. We learn through observation by paying attention to the model so that the act of the model can be perceived expressively (Makgakga, 2016; McLeod, 2016). Furthermore, teachers need to ensure that learners pay attention to the important features of the lesson by making clear representations and highlighting important points, while learners pay attention to the exact features of the lesson, which makes learning through observation easier for the teacher and the learners (Gage & Berliner, 1998; Woolfolk, 2020). The retention phase is where the observer can convert the information obtained in the process of observation into representative forms and arrange that information by storing it in the memory (Bandura, 1986). This involves coding and converting information from the model in place of storage in the memory by rehearsing the information mentally (Schunk et al., 2014).

The reproduction phase is the capability to do the actions demonstrated by the model (Bandura, 1989; McLeod, 2016). This involves transforming the visual and representative notions of modelled actions into performance. The skills learnt from the model are learned through directed practice and corrective response to reproduce the model's behaviour. Constant practice and corrective responses from the teacher enable learners to make improvements in their performance (Schunk et al., 2014; Woolfolk, 2020). The motivational phase is the will to execute the actions of a model, while the rewards and punishment that follow a performance are measured by the observer (Bandura, 1986; McLeod, 2016; Schunk et al., 2014). It also includes carrying out appreciated actions and activities with estimated positive consequences, or not performing the skill or behaviour acquired from the model unless there is some inspiration or encouragement involved in doing so.

In this study, learners pay attention to the mathematics teacher by concentrating on how the teacher is making use of scientific calculator to solve parabola function problems, while the mathematics teacher displays how to use scientific calculator to solve parabola function problems to the learners. The learners retain the information on how to use scientific calculators to solve parabola function problems through imitation and constant practice before being able to reproduce the action of using scientific calculators to solve parabola function problems, which include drawing graphs of parabola functions and finding the roots of the equations of parabola functions. These learners were motivated by the mathematics teacher on how to solve various problems on parabola functions with the use of scientific calculators.

RESEARCH METHODS

The study aimed at ascertaining whether the use of scientific calculators would enhance Grade 11 learners' performance in parabola functions. A non-equivalent quazi-experimental design was espoused to measure the significant difference between the comparison and experimental groups, between pre-test and post-test. Williamson and Johanson (2018) posit that in quazi-experimental study, the selected experimental and comparison groups are assigned the pre-test and post-test and only the experimental group received the intervention.

The study was conducted between March and May 2023 in a rural secondary school that participated in the master's study of one of the researchers in the Sekhukhune district of Limpopo Province. The school consisted of one principal, one deputy principal, three heads of departments (HODs) and 24 teachers, including six mathematics teachers. The school has an enrolment of 987 learners grom Grade 8 – 12. The use of scientific calculators was implemented in the experimental group to enhance the learning of parabola functions. This study is notable as the use of scientific calculators in teaching Grade 11 parabola functions is somewhat under-evaluated.

The participants of this study are Grade 11 mathematics teachers and learners. One teacher who used a scientific calculator to teach parabola functions in the experimental group and 42 learners (26 females and 16 males aged between 16 and 22) and one female teacher who taught in the comparison group and 38 learners (22 females and 16 males aged between 16 and 21). The pre-test was administered prior to the implementation of scientific calculators and the post-test was administered after the treatment to measure the significant effect between the pre-test and post-test, and between the two study groups. The parabola functions question items are adapted from the Grade 11 mathematics examination previous question papers focusing on determining the zeros, axis of symmetry, turning points using quadratic equations, drawing graphs and interpretation of parabola functions.

The pre-test and post-test instrument was divided into three questions, thus question 1 with three question-items, question 2 with three question-items and question 3 with five question-items. Question-items 1.1 and 1.2 assessed learners on how to solve quadratic equations given two different equations and question-item 1.3 was given to learners draw the graph of the given quadratic equation. Question-item 2.1 of question 2 assessed learners on how to solve graphically the value of x and y in the two given equations, one quadratic and the one linear. Question-item 2.2 assessed learners on how to draw a parabola graph of a quadratic equations involving fractions and question-item 2.3 assessed learners on how to determine a new graph after a cretin translation. Question-item 3.1 – 3.5 assessed learners on how to interpret the given graphs, one parabola and two linear graphs.

The test instrument was moderated by one mathematics education academic and an experienced in one of the secondary schools. The two mathematics education specialists found three questions similar and removed from the test instrument. The test instrument was then piloted in one secondary school that did not participate in the main study after moderation. The pre-test and post-test were administered on the same day at the same time to avoid contamination of results.

The researchers sought permission to conduct the study from the College of Education Ethics Committee under the Department of Mathematics Education, ethical clearance certificate number 2022/05/11/42027608/23/AM. Permission to conduct the study was also sought from the Limpopo Department of Education and two mathematics teachers from both the experimental and comparison groups prior the inception of the study. The primary aim of this study was explained to the participants and participation was declared voluntary, and the participants were allowed to withdraw from the study at any time without being prejudiced. The teacher from the comparison group has only assisted in administering and invigilating the pre-test and post-test. Table 1 shows the participating teachers' biographical information:

Pseudonyms were used in place of their names and schools to protect their identities and ensure their anonymity.

Table 1.

Teacher biographical information

Pseudonym	Gender	School	Mathematics Education qualifications	Mathematics teaching experience	Training Institution
Phuti	Male	Experimental group	Bachelor of Education major in Mathematics Education	15 years	North-West University
Nolo	Female	Comparison group	Bachelor of Education with Honors major in Mathematics Education	11 years	University of Limpopo

Data collection procedures

Prior implementing the use of a scientific calculator in the experimental group, the researchers administered a pre-test in the two study groups on the same day, at the same time. The two teachers invigilated the learners during the pre-test which took place after school, avoiding the interruption of the smooth running of school programmes. The day after the administration of the pre-test, the researchers then marked the scripts of the two study groups. Prior implementing the use of a calculator in teaching parabola functions, the researchers conducted four baseline lesson observations to establish how teachers in the two study groups taught parabola functions.

The researcher observed the lesson presentation and the learners' participation to understand how learners responded to teaching approaches and strategies during the lesson. After the lesson observations, the researcher planned an intervention with the teacher in the experimental school for implementation. The intervention included giving Phuti instructions on how to use a scientific calculator to teach parabola functions and training him on how to implement the usage of scientific calculators in teaching and learning parabola functions. The workshop schedule included two meetings in one of the two selected schools.

The teacher who taught the experimental group used scientific calculators in the teaching and learning parabola functions during lessons. Therefore, both teachers presented their lessons in the following manner: Group A (Experimental group), learners were taught by teacher A, and the lesson was presented to them with the use of a scientific calculator. In Group B (Control group), learners were taught by teacher B, and the lesson was presented to them without the use of a scientific calculator.

The researcher (first author) had a two-day workshop with teacher A in the experimental group introducing the use of a scientific calculator to teach parabola functions. In their discussion during the workshop, the researcher showed teacher A how to use a scientific calculator to teach parabola functions, for example, they have used different examples of quadratic equations to determine the $x\ and\ y - intercepts$, axes of symmetry, turning points, determining the domain and range, and lastly drawing graphs. Three forms of quadratic equations were used during the workshop in implementing the use of scientific calculator, those forms are $y = ax^2 + bx + c$, $y = a(x - p)^2 + q$, and $y = x(x - x_1)(x - x_2)$. Teacher B in the control group did not participate in the intervention, he used his own teaching approaches and strategies to teach parabola functions.

During the lesson presentation by teacher A, the researcher observed six lesson presentations and the learners' participation during the lesson using scientific calculators. After the workshop with the teacher in the experimental group on the usage of scientific calculators in teaching and learning parabola functions, there were six lesson observations with teacher A and the experimental group.

After the intervention, the researchers administered a post-test to the 80 learners to measure improvement in performance of learners in the experimental group. The researchers measured the significant effect between the pre-test and post-test in the experimental group. Further, the researchers measured the significant effect between the experimental and comparison groups.

Data analysis procedures

Micrsosoft excel was used to capture, organise and manage the data collected from the pre-test and post-test scripts (Microsoft, 2015). The researcher analysed the results using the Wilcoxon Rank-Sum (Mann-Whitney) test. The results of this study were normally distributed as they were symmetric about the mean, in other words data near the mean are more frequent in occurrence than data far from the mean. The comparison of students' performances between the comparison and experimental groups was conducted using Stata's *t-test* command. A *t-test* was used to compare the mean scores and determine the significant difference using the p-value. In other words, t-test was used for group comparisons. The interpretation was carried out with a 95% confidence level, and the outcomes are presented in tabular format. Note that the results are declared significant if the p-value is less than 0.05 and where the results are not significant, then the p-value would be greater than 0.05.

RESULTS

The aim of this study was to ascertain whether the use of a scientific calculator has a significant effect in teaching Grade 11 parabola function. The results are interpreted as: if the $p - value < 0.05$, then it shows that the use of a scientific calculator has a significant effect in teaching Grade 11 parabola functions, and if $p - value > 0.05$, then it shows no significant effect.

The study has used mean scores to measure the significant difference between the experimental and comparison groups in the pre-test and post-test results. The analyses of results include the results of quantitative and qualitative method of research. The results of the semi-structured interviews were analysed and then the results of the quantitative research design were used to build the results of the qualitative research design by comparing the results of qualitative and quantitative research design for validity and reliability.

Analysis of the results for pre-test and post-test

The analyses of the pre-test and post-test results are deliberated for all the items of the questions in pre- and post-test, by comparing the scores for testing the statistical significance between the experimental and control group. Table 1 specifies the analyses of results of learners for the pre-test.

Table 2.

Analyses of the results for the pre-test

Group	Observations	Mean	Std. Dev.	Min	Max
Experimental	40	8.375	2.861661	4	14
Control	40	14.45	3.13745	9	2

This table specifies that learners in the control group performed better than the learners in the experimental group in the pre-test because the mean score and the standard deviation of the marks of learners in the control group are higher than the mean score and the standard deviation of the learners in the experimental group. The mean score and the standard deviation of the marks of the scores of learners in the experimental group in the pre-test are 8.375 and 2.861661 respectively, while the mean score and the standard deviation of the scores of learners in the control group were 14.45 and 3.13745 respectively. Moreover, the analysis of the results for pre-test indicates that the p-value between the experimental and control group is less than 0.001 ($p < 0.001$) at 95% confidence level. The result of the p-value specifies that there is a significant difference between the performance of learners in the experimental and control groups when solving problems on parabola functions. Also, the scores of learners in the control group were higher than the score of learners in the experimental group in the pre-test. These scores indicate that learners in the experimental group had difficulties in factorisation, quadratic expressions, finding the intercepts, axes of symmetry and the turning point of the parabola (Davis et al., 2021; Diaz et al., 2020; Mutambara et al., 2020).

Table 3.

Analyses of the results for post-test

Group	Observations	Mean	Std. Dev.	Min	Max
Experimental	40	38.125	2.901702	34	44
Control	40	27.6	3.921015	20	35

The above table indicates that there were 40 observations in the control group on the occasion of post-test. The average mark was 27.6 with the standard deviation of 3.921015. The minimum and maximum values were 20 and 35, respectively. Furthermore, the mean mark and the standard deviation of the learners in the experimental group is higher than the mean mark and standard deviation of the learners in the control group. Moreover, the p-value which is less than 0.001 ($p<0.001$) at 95% confidence level signifies that there was a significant difference in the marks between the learners in the control and the experimental group. Additionally, the marks of the learners in the experimental group were higher than the marks of the learners in the control group. These results show that the learners in the experimental group performed better than the learners in the control group when they used scientific calculators to solve problems on parabola functions. Learners who were taught with the use of technological tools, such as scientific calculators, usually performed better than their counterparts who did not use scientific calculators when solving problems on parabola functions (Kissane, 2020; Liburd & Jen, 2021; Leong & Parrot, 2018; Rahman et al., 2022).

DISCUSSION OF FINDINGS

The study has ascertained the effectiveness of using scientific calculators to inform the teaching of Grade 11 parabola functions and improving the performance of learners. Though Diaz et al. (2020) and Memnum et al. (2015) posited that learners should be familiar with parabola functions' activities, the experimental group was found to have performed poorly in this topic. The results showed that the control group ($\bar{x} = 14.45$) performed significantly better than the experimental group ($\bar{x} = 8.375$) with the $p - value\ of\ 0.001$ less than the $p - value$ of 0.05. These results are supported by Diaz et al. (2020) that most of the learners have difficulties in understanding and interpreting parabola functions, which results in poor learner performance. Mutambara et al.'s (2020) study adds that learners have confusion in solving parabola functions problems and this affects their performance.

Though the experimental group performed significantly poor in the pre-test, this group has performed significantly better in the post-test results. The results depicted that the experimental group ($\bar{x} = 38.125$) has performed significantly better in the post-test results than the control group $\overline{(x} = 27.6)$ with the $p - value\ of\ 0.001$ less than the $p - value$ of 0.05. Dagan et al. (2020) and Kissanes (2020) support the assertion that the use of technological devices, including scientific calculators, in teaching mathematics has a significant effect in improving learner performance as depicted in the results. It is also found that learners who use scientific calculators to solve mathematical problems perform better than their counterparts who do not (Liburd & Jen, 2021; Rahman et al., 2022).

The study by Davis et al. (2021) found that the use of scientific calculators correlates with learner performance in parabola functions. However, the relationship does not subscribe to the principles of causality. Though this study has shown to have substantial evidence that the use of scientific calculators in teaching parabola functions has a significant effect in improving learner performance, some learners appeared to have performed poorly even after the intervention. Some learners appeared to have struggled to find the intercepts, axis of symmetry, turning points and drawing the graphs which are basics of parabola functions. As such, it can be concluded that the reasons for these difficulties experienced by the learners when solving parabola functions may vary from learner to learner.

Although this study did not investigate the reasons why learners experienced challenges in solving parabola functions problems, Mutambara et al. (2020) revealed the challenges learners experienced as finding the $x - and\ y - intercepts$, axis of symmetry, turning points, the roots of the equations and shapes of the graphs using scientific calculators. Lack of exposure of teachers in the use of scientific calculators, lack of basic mathematical skills of learners, lack of interest of the learners towards learning mathematics, and lack of frequent use of scientific calculators by learners when solving mathematical problems are also found to be factors affecting learner performance (Dagan et al., 2020; Liburd & Jen, 2021; Rahman et al. 2022). Furthermore, these scholars revealed attitude towards using scientific calculators in teaching parabola functions as one of the contributing factors as the teachers believed that the use of scientific calculators may impede learners learning.

The results showed that some learners in the control group performed better than others in the post-test. The researchers do not know the reasons for this better performance of learners. The reason may be that learners were familiar with the parabola functions with a deeper understanding to solve problems (Mutambara et al., 2020). The results in this study may argue that the improved performance in the post-test may correlate with the implementation of scientific calculators in teaching parabola functions. The question that remains is 'what has contributed towards better performance of learners in the control group as they were not involved in the intervention?' In the same vein, one can investigate why some learners performed well and some not in solving parabola functions problems. Future studies can be conducted on learner perceptions and experiences of using scientific calculators in learning parabola functions. Moreover, another study can be conducted on the teachers' perceptions and experiences of using scientific calculators in teaching parabola functions.

CONCLUSION

In conclusion, the results of this study provided evidence to support that the use of scientific calculators had a significant effect in the post-test results in the experimental group. Therefore, this study may account for the significant effects of implementing scientific calculators in improving learner performance. The results reported a higher mean score in the post-test than in the pre-test results in the experimental group. Observational learning supports that through modelling, learners paid attention to the model through interactions in social learning. In the experimental group, the teacher modelled using scientific calculators to teach parabola functions and learners retained the behaviour during modelling to improve learning.

Though the use of scientific calculators in teaching parabola functions may be logical, it may not be sufficient to apply it solely in teaching parabola functions without coupling it with other strategies. This study advised teachers to couple this intervention with other teaching strategies, frameworks and models that complement this intervention to improve learner performance in parabola functions. Furthermore, teachers are encouraged not to use a uniform teaching strategy to teach parabola functions to accommodate learners who do not perform well in parabola functions. In conclusion, for teachers to teach parabola functions effectively, they need to employ different teaching strategies to improve learner performance and advance their content knowledge, pedagogical content knowledge and professional development.

Recommendations and Limitations

This study recommended that the use of scientific calculator has significant effect in teaching parabola functions to improve learner performance. In addition, mathematics teachers cannot only use scientific calculator to teach Grade 11 parabola functions, but to also teach other topics in mathematics in various grades. This study is only limited to one Grade 11 mathematics class to measure the significant effect of suing scientific calculator in teaching parabola functions to improve learner performance as not aimed to generalize the results.

Conflict of interests

The researchers declare that there is no conflict of interest and no financial assistance received from any organisation in this study.

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