A Comparative study of Computed Aided Learning and Traditional Teaching Method on the understanding of Linear and Quadratic Functions in Mathematics

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Abstract
This study examined the effect of Computer Aided Learning and Traditional Teaching Method on the understanding of quadratic functions in Mathematics. To carry out the study, the researcher formulated two hypotheses to give direction to the study. The sample of the study comprised sixty (60) randomly selected students from two Unity Secondary Schools in Main Land local Government Area. Lagos State Nigeria. The instrument employed in the study for data collection was a self - developed questionnaire. Data collected was analyzed using the independent t- test Statistical tool. The two formulated hypotheses were tested at 0.05.level of significance. The results obtained were: There was significant difference in the post test due to the effects of computer aided learning on linear quadratic functions and also there was significant difference between the type of school used and mathematics achievement. Based on the research findings the following recommendations were made: Mathematics teaching should laid credence to the use of computer based as this will provides useful means of communication between the teachers and the students; students should frown at the traditional mathematics classroom that have no computer based in it where the students opinion are no heard and others.

Introduction

Technology provides students an opportunity to use "hands-on" techniques in problem solving. Technology also helps students to develop an understanding of the processes and reasoning that are the heart of mathematical problem solving (Hudnutt, 2007).Mathematics association of Nigeria (MAN) also supports the use of technology to enhance student learning. As stated in one of the seven principles in the *Principles and Standards*, “Calculators and computers are reshaping the mathematical landscape, and school mathematics should reflect those changes. Students can learn more mathematics more deeply with the appropriate and responsible use of technology. They can make and test conjectures. They can work at higher levels of generalization or abstraction. This research was conducted to find out whether or not using the software (Graph) during the instruction of Quadratic can improve students’ understanding of functions and their ability to create and interpret graphical representation of functions. The software that will be used in this study is ‘Graph’, free graphing software from www.padowan.dk/graph/. The software can be used to draw mathematical graphs in various (i.e. Cartesian, Polar) coordinate systems. Users can easily draw graphs of functions and the program makes it very easy to visualize the functions. Students can readily enter a list of expressions using the graph editor, watch the graph, and explore a function through a numeric display of coordinates, intersection points, slopes, tangents and maxima. All these features are designed to be accessed through buttons and ‘Menu’ commands, and are extremely powerful for users of mathematics who are seeking data on a specific function or equation. I have chosen this software rather than other advanced graphing software, because it is easy to understand and manipulate by algebra beginners.

Statement of the Problem

Complexity of the subject with respect to linear and quadratic functions; incompetent teachers to teach the concepts properly; lack of interest by the students due to repeated algorithms during the process of plotting the graph using traditional method; bad mathematics foundation; abstract nature of the subject; misconception of quadratic functions and the methods used without regard to instructional materials;

It has been observed that concepts of functions are among the difficult topics in the teaching and learning of Mathematics. During the teaching of Mathematics, it became evident that there are numbers of conceptual obstacles to progress in concept formulation regarding linear and quadratic functions. One of the obstacles is the difficulty to construct graphs of functions.

In order to construct graphs of functions using paper and pencil, students spend a lot of time in performing repeated algorithmic computations and sketching the graphs (to find and plot points) which is a tedious work. In this case, they do not get sufficient time to explore the nature and properties of functions and their graphs. The construction of graphs of functions using paper and pencil has not only hindered students' progress in understanding functions but has also fostered in students a negative attitude towards mathematics in general and towards functions in particular. A quadratic function is one of the compulsory topics that students can't escape in W.A.E.C and NECO examinations. The major difficulty in Mathematics and other science subjects is the method by which the subjects were customarily taught without regard to instructional materials. The pedagogical approach in imparting knowledge to learners has become inadequate to their needs. Therefore, this research is to investigate the influence of graphing software as an instructional material on conceptual understanding of linear and quadratic functions in teaching of mathematics.

Objectives of the Study

The purpose of the study is to compare the effect of Computer-Aided Learning (Graphic Software) and the Traditional Method of teaching (Chalk-and- Talk method) in conceptual understanding of linear and quadratic functions in Mathematics among Senior Secondary Schools in Main Local Government Area of Lagos State Nigeria.

Specifically, the study is designed to:

1. Find out if significant difference exist between the experimental and control group due to the effect of doing less graphing of functions by hand from calculated values on students' understanding of linear and quadratic functions and
2. Examine the difference between the school type and students' Mathematics achievement due to the influence of graphing software.

Hypotheses

1. There is no significant difference between the experimental and control group due to the effect of doing less graphing of functions by hand from calculated values on students' understanding of linear and quadratic functions.
2. There is no difference between the school type and students' Mathematics achievement due to the influence of graphing software.

Literature Review

The Role of Technology in Teaching and Learning Mathematics

The great potential of computer technologies in mathematics instruction is increasingly believed to bring a transformation in mathematics education and has brought new possibilities to the teaching and learning of mathematics. Goldenberg (2000) points out that one of the strongest forces in the contemporary growth and evolution of mathematics and mathematics teaching is the power of new technologies. Goldenberg (2000), thereupon, claims that "In math, computers have fostered entirely new fields. In education, they have raised the importance of certain ideas, made some problems and topics more accessible, and provide new ways to represent and handle mathematical information, affording choices about content and pedagogy that we have never had before."

Technological tools such as computers and calculators can play a significant role in providing an environment where students may gain appropriate experiences to construct mathematical concepts. In an environment where technologies are available there is a shift in the emphasis of mathematics instruction since the algorithmic computations involved in traditional mathematics instruction are often lengthy and time-consuming. Most of the class time is devoted to rote practice of these procedures. But in a technologically rich classroom environment the instruction can change to concept development and problem-solving by concentrating on the underlying concepts since these tools remove the burden of lengthy and time-consuming routine work (Branca, Breedlove & King, 2002; Fey, 2009; Hennessy *et al.,* 2001; Wheatley & Shumway, 2002).

Technology brings a new richness of information into the classroom and provides students with access to multiple sources of information that could be used to solve complex problems. Sound, pictures, video, graphs, charts, maps, three-dimension and animation all make for interesting, exciting content. Advances in the processing power of computers permit students to visualize phenomena formerly invisible and to instantly grasp relationships once obscure or difficult to understand. Pictures and graphics add new dimensions to ways of presenting information that was responsive to alternative learning styles. Using computer technology, pupils can transform a graph and watch the algebraic symbolism change or alternatively manipulate the symbolism and watch the graphical representation changes (Sutherland, 2000). Kaput (in Sutherland, 2000) claims that: ... the dynamic nature of the medium supports dynamic changes in variable values that renders the underlying ideas of variable and function more learnable, which should make them accessible to a younger population, and which in return makes possible a much more gradual and extended algebra curriculum, beginning in the early grades.

The Impact of Technology on Mathematics Education

Technology impacts on what is taught and how it is taught, what students learn and how students learn and how the learning is assessed (Beckmann, 2009). Fey (2009) asserts that technology influences mathematics education in such a way that it has an impact on the selection of the content and process goals, organization of teaching and learning environments and assessment of achievement. In connection with this, Pollak (2006) writes: The first and most readily apparent effect of technology on the teaching of mathematics is the use of technology in teaching existing mathematics – in helping to overcome the innumerable pedagogic difficulties with which we are so familiar, in helping to motivate students at a place where the background is weak (after the

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computer has found where that is!), in helping the teacher to do a better job. We can use the microcomputer to provide practice for the student with a new technique, to tutor the student, to show some new applications of the current subject matter, to diagnose a persistent pattern of error, to try out special cases in a situation in which the mathematical pattern is not clear, or to manage a series of individualized tests.

Mathematical Sciences Education Board (in Confrey, 2002) suggests that computing devices will decrease on manual skills, increase the importance of topics previously deemed too difficult to teach, emphasize both problem formulation and problem-solving of realistic problems and lead to the creation of tools undreamed of by mathematics educators. In the subsequent sections we will discuss the impact of technology on the curriculum (content, educational goals and assessment) and the classroom environment.

Content: One influence of technology on mathematics education, particularly the mathematics curriculum, is that it makes certain topics possible to teach - which we have always wanted to include in the curriculum, but which we were simply unable to handle pedagogically (Pollak, 2006). A good example of this kind of topics is data analysis. Technology also makes certain topics necessary. For example, discrete mathematics, topics like combinatorics and graphs and logic. These are part of “mathematics for computer science”, the tools that have to be available for the student to understand how you do things on a computer and why. Technology influences the school mathematics curriculum in such a way that the subject is transformed from a procedurally dominated subject to a study of patterns and relationships (Wheatley & Shumway, 2002:1; Yerushalmy& Gilead, 2007). Technology allows for a reorganisation of mathematical concepts within a topic in which more concepts are covered and less emphasis is placed on memorization and manipulative skills (Heid, 2008). Furthermore, it allows students to move quickly and easily beyond the usual computational burden and to experience some of the true richness of the subject (La Torre, 2003:162). Technology also provides students and teachers greater opportunity to engage in more realistic problems so that they can solve problems of real life situations (Fey, 1989; Heid, 2008).

Educational Goals: Another impact of technology on mathematics education is that it makes us revise or examine the goals and objectives of our traditional mathematics instruction which has been dominated by mastery of skills and procedures. According to Fey (1989:249), the use of computers has forced to facilitate the reconsideration of curricular objectives in traditional mathematics topics that the potential of computers can be explored. As Fey (1989:266) points out, revision of curricula goals to acknowledge that computers and other electronic information technologies are now standard tools for problem-solving and decision-making will lead to significant changes in what we ask and empower students to learn.

Assessment: Technology also impacts on how learning is assessed (Beckmann, 2009). *Assessment Standards for School Mathematics* (NCTM, 2005) recommends that technology should be an important feature of assessment so that assessment and instruction are aligned. "Not only has technology changed what we teach and how we teach, it has also changed how we test our students" (Laughbaum, 2008). By using technological tools in assessment, teachers can more easily measure student growth in conceptual understanding and problem-solving ability through the use of problems that are more open-ended and non-routine (Branca*et* , 2002). Teachers can now emphasise the process and not only the product of learning and understanding, not just knowledge (Kinzer, 2006). Beckmann *et al.* (2009) note that the assessment items that have been used to assess students' understanding of mathematics (functions) are no longer appropriate in a technologically rich classroom environment. Appropriate assessment will naturally follow as school reform incorporates technology into the mathematics curriculum (Matusevich, 2005). Harvey and Osborne (2001) state that due to the contribution of the use of technologies to a better conceptual learning, a more extensive knowledge of applications, development of higher order skills and improved problem-solving performance becomes more accessible for assessment by de-emphasising testing of lower level skills.

Technology and Mathematics Education: Case of Graphs and Graphing

Graphs and graphing are particularly considered by many teachers and researchers to be the most important and fundamental concepts in all of mathematics (Doerr & Zangor, 2000; Leinhardt, Zaslavsky, & Stein, 2000; Mevarech & Kramarsky, 2007), since graphs are essential for school algebra and can be used as a bridge between concrete thinking and abstract thinking (Piaget, Grize, Szeminska, & Bang, 2007). As technological environments support visualization and experimentation (Arcavi & Hadas, 2000), technology has allowed much more emphasis to be placed on graphs and their interpretation. They offer many advantages over manual graph plotting, such as multiple representations, and they also allow students to examine many more graphs more quickly with a high degree of accuracy and with minimal input effort (Forster, 2006; Fung, Hennessy, & Scanlon, 2001; Pierce, Stacey, & Barkatsas, 2007). With technology, students can plot the graphs and then observe their patterns and make connections among algebraic, tabular, and graphical representations with high accuracy in shorter periods of time compared to manual plotting of graphs (Heid, 2005; Interactive Educational Systems Design, 2003). This is particularly important as students find it very hard to understand relationships and translate among representations, because each representation and translation among them requires a different psychological process (Leinhardt, Zaslavsky, & Stein, 2000). For instant, in most problems involving graphing, translations from equation to graphs and from graphs to equation are required. Concerning these two translations, movement from graphs to their equation would be a more difficult task because it involves pattern detection. If the latter is in the form of a matching-type item, students check for the equations and do not attempt to move graphs to equations. On the other hand, the graphs in textbooks usually have equal scales, and critical points (e.g., *x-y* intercepts, axis of symmetry) are usually integers. However, in realistic or real-life problems, students are faced with unequal scales and rational or decimal critical points, and they find it difficult to interpret results on the graphs. Partial views, axes without labels,

Graphing technology creates a constructive environment that helps students to explore mathematical concepts in an organized way. According to Yerushalmy (2009), graphing software helps to organize mathematical concepts by a limited collection of important terms, objects and actions. Graphing technology makes these organizations visible to user and thus becomes a strong mathematical thinking tool, tool for planning, and tool for problem posing. The inquiry of using the graphing technology in mathematics instructions is also influenced by the socio-cultural view, described by Forster & Taylor 2000). Forster and Taylor, socio-cultural perspectives focus on the provision of opportunities for students to co-construct valid mathematical meaning through participation in rich mathematical conversations with the teachers, graphing calculators and fellow students. In their research with graphing calculators, They found most of the students who used calculator during the instructions were able to successfully transfer their knowledge from a specific situation (without calculator) to another situation when they were permitted to use calculator.

Graphing technology can make designing, creating and using multiple representations easier. When using this technology during instruction, rather than using time for laborious and tedious calculations, students can have more time and mental energy to explore various underlying concepts. As an example, during instruction on quadratic equations, students can easily investigate the effects of changing the value of a, b and c on the graph of $ax^2 + bx + c$, which can be very tedious when using paper-pencil graphing techniques. Specific research has shown that students can often reason best when they experience mathematics through related representation, such as equations, tables and graphs (Goldenberg, 2005; Kaput, 2002). Furthermore, technology can create connection between the representations, enabling students to make conceptual connections, such as, understating how a change in an equation links to a change in a graph (Roschelle, 2006).

Function in Algebra

Algebra is a branch of mathematics of Arabian origin which may be characterized as generalization and extensions of Arithmetic in which symbols are employed to denote operations and letters to represent numbers and quantity (Wikipedia, 2007). Algebra as a generalization and extension of Arithmetic was classified as; Elementary algebra, where properties of operations on the real number system are recorded, symbols are used as “place holders” to denote constants and variables, and the rules governing mathematical expressions and equations involving these symbols are studied; abstract algebra, where algebraic structures such as groups, rings and fields are axiomatically defined and investigated; specific properties of vector spaces are studied in linear algebra; universal algebra, where those properties common to all algebraic structures are studied; computer algebra, where algorithms for the symbolic manipulation of mathematical objects are collected (Wikipedia, 2007).

Graph Method: This method of solving quadratic equation involves forming a table of value for values of x and y. Then, drawing the graph

For example: Solve the equation $x^2 - x - 2 = 0$ with range of x from -4 to + 4

Table of value

x	-4	-3	-2	-1	0	1	2	3	4
x^2	16	9	4	1	0	1	4	9	16
-x	4	3	2	1	0	-1	-2	-3	-4
-2	-2	-2	-2	-2	-2	-2	-2	-2	-2
y	18	10	4	0	-2	-2	0	4	10

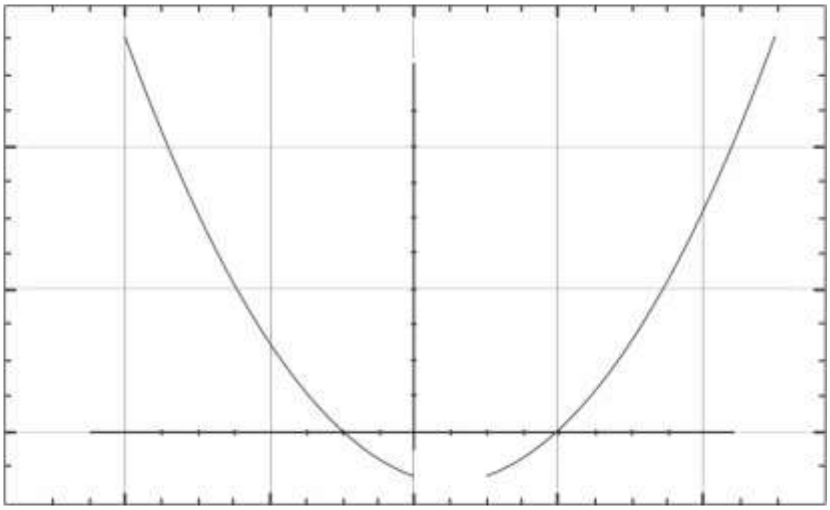

Table 1: This method gives the solution of the quadratic equation. The computer is capable of doing this job. Instead of using hand to do the computation and graphing, Computer Algebra Application (CAAS) software through free software can manipulate symbolic expressions or equations, find exact values for equations and also graph functions and plot relations. The advantage that computer has over manually solving the questions is that, the computer does it faster and more accurately. Reading the values and getting the solutions to the quadratic problems can easily be done by students.

Hypothesis 1: There is no significant difference of the post-test due to the effect of doing less hand graphing soft-ware on linear quadratic functions.

Table 2: Significant Difference of the due to the effect of doing less hand graphing soft-ware on linear quadratic functions

Group	NO.	Mean	ST.D	df	tcal	tcritical
Experimental	30	42.30	3.95	58	4.12	1.67
Control	30	32.77	4.56			

Table2: Showing the significant difference post-test due to the effect of doing less hand graphing soft-ware on linear quadratic functions. The calculated t_cal value of 4.12 is greater than the t critical value of 1.67 given 58 degree of freedom at 0.05 level of significance. It is therefore means that the null hypothesis posited which states that there is no significant difference of the post-test due to the effect of doing less hand graphing soft-ware on linear quadratic functions is rejected while the alternative hypothesis is obtained. This implies that there is significant difference of the posttest due to the effect of doing less hand graphing soft-ware on linear quadratic functions.

Hypothesis3:-There is no significant difference between the type of school used and Mathematics Achievement in the post test.

Table 3. Show the difference between type of schools and mathematics achievement.

School Name	No	Mean	Std	Df	tcal	tcritical
Queens College	30	42.07	4.47	58	2.29	1.67
Y.T.C.S.S	30	39.40	4.54			

Table 3 above showed the significant difference between the type of schools and mathematics achievement. Evidenced from the table revealed that the calculated mean and standard deviation of Queen's college and Yaba College of Technology Secondary School of (42.07, 4.47) and (39.40, 4.54) respectively. Calculated t cal of 2.29 is greater than the critical value of 1.67 with 58 of degree of freedom given at 0.05 level of significance. It is therefore means that there is significant difference between type of school used and the mathematics achievement. This implies that the formulated null hypothesis is rejected as we upheld the alternative hypothesis.

Discussion

Hypothesis One:

Goldenberg (2001) who that explained that in mathematics, computers have fostered entirely by new fields. This difference can be felt from those students who are not exposed to it to perform low . He further explained that in Education, use of computer have raised the importance of certain ideals made some problems and topics more accessible. It was corroborated by Heid (2008) who confirmed that students who make connection between mathematics with deeper understanding. However, In the study of Smith and Shotsberger (2007 affirmed that computer technology also helps students to make connections between mathematical ideas between a real world phenomenon and its mathematical representations and between a student's everyday world and his/her mathematical world. But in the finding of Heid and Hennessy (2001) suggested that the use of multiple representations, interpretation from one representation to another, and the analysis requiring interplay between graphic, numeric and symbolic information are keys to understanding functions. They concluded that a student who makes connections between mathematical ideas creates a deeper understanding of those ideas and different representations of a problem allow a student to represent the problem in a way that best makes sense to the students

Hypothesis Two:

Ijeh (2005). Who explained that mathematics classroom where teaching and learning take place provides a powerful means of communication between the teacher and students? Students in unity schools and Federal government secondary schools enjoy facility like computer and full electricity and students in those schools perform better than public schools. However, he concluded that teachers can now emphasise on the process and not only the product of learning and understanding, not just the knowledge. To substantiate this view Kinzer and Beckmann 2008) noted that the assessment items that have been used to assess students' understanding of mathematics (functions) in some schools which are not computer oriented are no longer appropriate in a technologically rich classroom environment. They suggested appropriate assessment will naturally follow as school reform incorporates technology into the mathematics curriculum. In the study of Farrell (in Dunham and Dick, 2004) affirmed that students who use computer as learning devices became more active in classrooms in which graphing technology was being used, with more group work, investigation and exploration and real problem-solving.

Conclusion

The essence of this research study is to find out whether or not using the software (Graph) during the instruction of Quadratic can improve students' understanding of functions and their ability to create and interpret graphical representation of functions. The software that will be used in this study is 'Graph', free graphing software from www.padowan.dk/graph/. The software can be used to draw mathematical graphs in various (i.e. Cartesian, Polar) coordinate systems. Users can easily draw graphs of functions and the program makes it very easy to visualize the functions. Students can readily enter a list of expressions using the graph editor, watch the graph, and explore a function through a numeric display of coordinates, intersection points, slopes, tangents and maxima. All these features are designed to be accessed through buttons and 'Menu' commands, and are extremely powerful for users of mathematics who are seeking data on a specific function or equation. I have chosen this software rather than other advanced graphing software, because it is easy to understand and manipulate by algebra beginners. In this study, two hypotheses were formulated and the findings of the tested results include: There is no significant difference of the post-test due to the effect of doing less hand graphing soft-ware on linear quadratic functions and there is no significant difference between the type of school used and Mathematics Achievement in the post test.

Recommendations

1. Mathematics teaching should laid credence to the use of computer based as this will provides useful means of communication between the teachers and the students.
2. Students should frown at the traditional mathematics classroom that have no computer based in it where the students opinion are no heard.
3. Students should be exposed to these areas in mathematics:
   - Construction of tables of values using excel spread sheet
   - Interpretation of graphical information using (pictorial entailments).
   - Show the relationship between quadratic function and quadratic equationnfor clarity.
   - Seeming change in form of quadratic function whose parameter is zero.
   - Clarify the different types of roots of quadratic function.
   - Over emphasis on only one coordinate of special point (vertex)
4. Workshops / Seminars should be organized by the Government for mathematics teachers to enable teachers learn how to use computer in teaching mathematics especially quadratic equation.
5. Computers should be made available in schools, by the Government so that every student will have access to computers and make use of them in learning and others.

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