Impact of Modern Technologies in Understanding Mathematical Concepts in Nigerian Secondary Schools: A Study of Imo State Secondary Schools

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Abstract

As the broad aim of secondary education in Nigeria is to prepare the individual for useful living within his society and for higher education and as the achievement requires sound background knowledge of mathematics, no nation can therefore achieve any measure of scientific and technological advancement without a sound foundation in mathematics. This is enhanced using technological tools to promote higher thinking between taught concepts and life applications. The study therefore aimed at examining the impact of modern technologies in understanding mathematical concepts in Nigerian secondary schools using Imo state. To guide the study, two research questions and hypotheses each, were addressed and formulated respectively. Both descriptive and inferential designs were adopted with a 21-item instrument of two sub-scales named SIMTUMaC administered to 150 secondary school teachers in Imo state. The reliability of the instrument was determined as 0.82. The data collected were analyzed using mean rating and z-test statistic. The results showed that adoption of modern technologies in teaching and learning impact significantly in students' understanding of mathematical concepts and change their orientation in solving mathematical problems. Following the results and their impacts in teaching and learning a number of recommendations were made.

Key words: Impact, Modern Technologies, Concept, Understanding

Introduction

The broad aim of secondary education in Nigeria has been to prepare the individual for useful living within the society and for higher education (FRN, 2004). To achieve this objective requires sound background knowledge of mathematics which deals with relationships among figures and shapes.

No nation can therefore achieve any measure of scientific and technological advancement without a sound foundation in Mathematics (Moore, 2005) as mathematics is regarded as "the queen of sciences and the language of nature". The rapid development of technology on its own has created some impact in education as in other fields. Modern technologies like computer-based software, the internet and sophisticated electronic modeling

programmes and devices have created new opportunities for teaching and learning in education (Boling, 2003).

The recent advances in technology changed every aspect of modern life including education. The number of mobile and telephony services is increasing geometrically, yet despite access to modern technologies which has helped every potential to change or turn around mathematics education, some teachers steer clear in the use of digital tools and resources.

In mathematics therefore, the focus is in understanding mathematical principles, models and concepts as well as applying the knowledge in problem solving. Consequent upon this, while students feel that much time is spent in learning steps needed to solve problems that have no relation to real life, scholars like Roschelle (2013) claimed that education has been devalued by spending much effort solving problems that computers can solve with no stress. Roschelle, by this assertion believed that the emergent of modern technologies eliminated the much time spent in calculations done by free hand. The foregoing assertions therefore formed the discussions of the following concepts.

Modern Technologies

Modern technology, according to Greenfield (2008) is changing the way our brains work. It is simply an advancement of old technology, the impact of which in modern life is immeasurable (Ramey, 2012). Though the devices are referred to as modern, they are technically not new in some cases. Taking the case of mobile phones which have technologically evolved over the years into kinds of phone devices, old ones are being replaced with modern technologies. They are used every day and have increased human capabilities.

They make life very easy and simple and yet to some people they remain complicated electronic devices. Put simply, they are sources of radical changes happening in all phases of life. They are capabilities given by the practical application of knowledge (Merrian-Webster, 2007). They constitute a state of humanity's knowledge of how to combine resources to produce desired products, and to solve problems. Again, Ramey (2012) saw them as a science applied to practical purposes.

Mathematical Concepts

Mathematical concepts are not just words or expressions as in geometry, shape, addition/subtraction, numbers/shape and so on. Mathematical concepts are general and can be applied to a range of problems. They contain a wide variety of lessons that are arranged in (or by) topics. Some concepts like in fractions, geometry, and algebra are meant to integrate technology devices like calculators into the learning process. By this, they help students increase their mathematical understanding as they apply it to daily setting.

Some examples of what conceptual understanding involves include the following:

1. **30 + 10:** An understanding of this expression shows that 30 is 3 tens and 10 is 1 ten. Going further 3 tens and 1 ten will give 4 tens implying that the sum is 4 tens which is 40

2. **25% of 4:** The reasoning here is that 25% is simply ¼ and then multiplying a number by 25% is simply dividing such number by 4, hence 25% of 4 is 4/4 = 1.

Understanding Mathematical Concepts:

The key component of being a mathematician is conceptual understanding in mathematics. Many mathematics teachers do not have the conceptual understanding. This is because many think that if students know all the definitions and rules in working out

problems then they possess the understanding. Understanding, therefore, means being able to justify procedures used or stated why a process works (Merriam-Webster, 2007). It is the ability in a way why a particular mathematical statement is true or where the rule comes from. For instance, there is a difference between a student who can recall a mnemonic formula or approach to expand the product of such expression as (a+b)(a-b) and another who can explain the derivation of the formula. Being helped to generalize from one's specific knowledge is a key to genuine understanding; hence the National Council for Teachers of Mathematics (2010) was of the view that understanding mathematical concepts is essential for the development of mathematical competence.

In understanding mathematical concepts, one has to distinguish between "procedure" and "factual knowledge". A procedure is a sequence of steps by which an encountered problem may be solved (Willingham, n.d.). Factual knowledge of concepts only is no guarantee of conceptual understanding. Factual knowledge is not understanding (Ragon, n.d.). For understanding to take place, one has to keep an open mind, develop an intuition by allowing oneself to be a learner again. In such situations strange relationships are to be looked for, use of diagrams and analogies especially anything that makes the concepts more vivid. Knowledge of procedures and how they work are desirable in mathematical conceptual understanding (Willingham, n.d.).

Understanding mathematical concepts involves establishing connections of such concepts between components of the students' experience in doing such as symbols, pictures, concrete situations and language. The application of learner-centred activity-based instructional strategy that involves the teacher engaging the learners in simple experimental activities as in displaying or exhibiting manipulative instructional models or materials with intent of the students to correct ways of using them leads to understanding such models (Uduok, 2016) and inappropriate usage of the materials by the teachers and students may result in students' misunderstanding the concepts.

The framework on which the principle of understanding of concepts by students is based involves building up connections in their minds. Teachers teaching strategy of such concepts promotes understanding. Below are few concepts and processes of understanding them.

    i.   **Multiplication of two numbers together with answer always bigger than both of the original numbers**: This rule is true except when one or both of the numbers is/are less than one. Further explanations need to be given to students that rather than the word "times" the word can be substituted with "of". For instance ½ x ¼ is the same as ½ of ¼. Understanding such concept removes the expectation that product of two numbers will always be bigger than both original numbers.

    ii.   **Concept of multiplication by 10 just by adding a zero:** Not that the assertion is not always true. In expressions like 36.6 x 10; or 0.24 x 10. When the explanations are not made the misconception will pose problems. Spot and unpick the "just add zero" rule and explain appropriately.

        Again, rote learning without procedural knowledge of mathematical concepts has been the emphasis with little or no attention to understanding of mathematical concepts. Students demonstrate conceptual understanding in mathematics when they recognize and generate examples of concepts, relate models, diagrams and representations of concepts (NRC, 2001).

Modern Technologies and Understanding Mathematical Concepts:
The field of mathematics has greatly benefited from technology. The technological tools are used in mathematics classrooms to promote and enhance higher thinking and

highlight the links between taught concepts and the real life applications (Ragon, n.d.). However, modern technological strategies do not always accommodate every learning style and do not teach students the applications of mathematical concepts especially when to apply learned formulae and algorithms to real world situations (Alsup and Sprigler, 2013).

In spite of the advantages of modern technologies in mathematics instruction, scholars (Roschelle; Hondley; Gordin; and Means, 2000) were of the opinion that the use of calculators and other technologies will eliminate in the students the opportunities to sharpen their computational abilities. They further opined that students and teachers should always use calculators as a tool rather than a crutch as means of bringing mathematics in another and new forms, working more efficiently and accurately without an underlying comprehension of the concepts.

Technology can reduce the efforts devoted to tedious computations and as well increase students' focus on more important and understanding mathematics (CTL, 2007).

Subsequently as technology reduces tedious efforts in computations, increases students' focus and represents mathematics in somewhat ways, it can enable teachers to improve on both how and what students learn yet without procedural understanding.

Still more, modern technology tools are being introduced to assist or help students learn by supporting computations and making abstract ideas being more tangible. ICT-based tools are the proper tangible form for secondary schools (Kaput, 2007). They can support learning if appropriately integrated in teaching techniques.

Integrating computer-based materials in education, according to scholars Kurz, Middleton and Yanik (2004) has been of great importance because using computers as tools for instruction has been helpful. They reduce memorization in students and encourage awareness about problem-solving process and allow students to engage in mathematics. The computer- based instruction method motivates students and provides them with individualization.

As the use of technology in mathematics is not new, Roschelle (2013) opined that the effectiveness of technology-enhanced teaching approaches has sometimes been controversial. Research has shown that technology can increase students' understanding of mathematical concepts but only as part of a more comprehensive learning approach devoid of procedural knowledge (Roschelle, 2013).

Problem

The achievement of the aim of secondary education in Nigeria in preparing the individual for useful living within the society and higher education requires a sound background knowledge of mathematics. In spite of the importance of mathematics in the education of the students and the nation, the performances of students in mathematics in both internal and external examinations have remained unsatisfactory for years.

The general perception among secondary school students in mathematics is that it is abstract in nature and difficult to understand. This has been attributed to the fact that most teachers leave the use of manipulative and procedural strategies in teaching mathematical concepts.

The emergent of modern technologies eliminated the time spent in mathematical calculations done by hand. The worries are that students may not fully understand a lot of mathematical concepts when and if digital resources from modern technologies are completely adopted in teaching and learning processes. This has therefore left one to ask if modern technology has any significant impact in the procedural and manipulative understanding of mathematical concepts. The answer to this question forms the solution to the problem.

Purpose

The purpose of the study was to examine the impact of modern technologies in understanding mathematical concepts in secondary schools in Nigeria. The study specifically therefore aimed at:

1. Ascertaining if the adoption of technological devices in place of manipulative and procedural strategies in teaching and learning has any impact in understanding mathematical concepts.
2. Determining if the orientation of students in showing details solving mathematical problems changed with the use of modern technologies.

Significance

The study is considered to be of very significant in the teaching and learning of mathematical concepts in secondary schools. It would help the curriculum planners and federal government to avoid replacing completely the usual procedural strategy of teaching with use of technologies in the policy of integrating ICT in teaching and learning.

The study would serve the need for mathematics teachers to encourage and enforce in students the procurement of necessary mathematics texts rather than compulsory adoption of technology devices to replace the texts. It would also encourage teachers to ensure that students show every step to their solution of every mathematical problem.

Research Questions

To guide the study two research questions were addressed:

1. To what extent does adoption of modern technology devices in teaching and learning make impact in understanding mathematical concepts?
2. To what extent has the use of modern techniques changed the orientation of students in showing details of solving mathematical problems?

Research Hypotheses

Two research hypotheses were formulated to guide the study and were tested at 5% significance level.

1. The adoption of modern technologies in understanding mathematical concepts is not significantly different from the population mean ($P<0.05$).
2. The teachers' rating score on students' orientation in showing details solving mathematical concepts using modern technologies is not significantly greater than the population mean ($P<0.05$).

Methodology

Descriptive and inferential statistics were adopted in the study aimed at examining the impact of modern technologies in understanding mathematical concepts in Nigeria secondary schools. A scale of Impact of Modern Technologies in Understanding Mathematical Concepts (SIMTUMaC) consisting of two subscales of adoption of modern technologies in teaching and learning and students' orientation in showing details of work was used for the study.

A total of six hundred and seventeen (617) mathematics teachers in the Imo State owned secondary schools and about two hundred (200) mathematics teachers in the private secondary schools of the state constituted the target population of the study.

A total of fifty (50) government and private secondary schools in Imo state and one hundred and fifty (150) mathematics teachers of SSI to SS3 students from the sample

schools made up the sample. The schools were first clustered into the three education zones of Owerri, Orlu and Okigwe zones from which 20 secondary schools from Owerri zone and 15 secondary schools each from Orlu and Okigwe were purposely chosen. Three (3) mathematics teachers from each of the sample schools were selected to respond to the instrument for data collection.

The instrument for the study was developed by the researchers validated by two university lecturers in mathematics and a researcher and evaluator. The instrument adopted a Likert Scale of 5-points of Very Great extent; Great extent, Moderate Extent, Low Extent and Very Low Extent response options and weighted 5, 4, 3, 2, and 1 respectively.

The scale was a - 21 item instrument of two sections. Section A consisted of 13 items measuring mean responses on adoption of modern technologies in teaching and learning mathematical concepts and section B consisted of 8 items measuring mean responses on students' orientation in showing details solving mathematics using modern technologies. The reliability of the instrument was determined using a test retest method and calculated to be 0.82 which was considered appropriate for the study.

The instrument for the study was administered and collected after responses by the researchers with the help of two research assistants who were trained on how best to collect the data.

The data collected were analysed for each of the subscales to answer the research questions and test the hypotheses. The two research questions were answered with mean rated scores and the hypotheses tested using z-test statistic. A mean of 3.00 and above was adopted as the criterion mean (population mean) for acceptance and rejection of the mean rated score. On the other hand the absolute value of Z_{cal} greater than Z_{tab} was used for rejection of no significant difference or no significantly greater than.

Results:

Research Question One: To what extent does adoption of modern technological devices in teaching and learning make impact in understanding mathematical concep

Table 1: Teachers' responses on modern technologies adoption in teaching and learning

S/N	Item	VGE	GE	ME	LE	VLE	n	fx	x
1	Does not allow for practical representations of concept	101	23	26	-	-	150	675	4.50
2	Details of methods are not discussed	97	36	17	-	-	150	680	4.53
3	Lessons & textbooks are incomprehensible	31	43	37	14	25	150	491	3.27
4	Does not help in identifying principles in any given	29	55	30	18	18	150	509	3.39
5	Does not draw analogies	71	43	27	9	-	150	626	4.17
6	Eliminates computational abilities	36	33	49	19	13	150	510	3.40
7	Reduces efforts in computations	63	38	38	8	3	150	600	4.00
8	Creates opportunities to explore & discover results	12	31	38	28	41	150	395	2.63
9	Promotes active learning in maths	32	49	30	22	17	150	507	3.38
10	Stimulates higher-order thinking in students	18	56	48	27	1	150	513	3.42
11	Relates topics to life applications	22	34	35	28	31	150	408	2.72
12	Only help to visualize concepts & not to explain	33	29	31	38	19	150	469	3.13
13	Encourages teaching trivialize calculations to save	27	35	42	33	13	150	480	3.2
						Σ	1950	6863	45.74
						x			3.52

Note: VGE   -   Very Great extent
              GE   -   Great Extent
              ME   -   Moderate extent
              LE   -   Low Extent
              VLE   -   Very Low Extent

Table 1 shows that the rated mean (3.52) is greater than the criterion or population mean (3.00), showing that the adoption of modern technologies by both teachers and students, to a great extent, impact in students' understanding of mathematical concepts. This is with the exception in items 8 and 11 showing that modern technologies, to a low extent or not creates opportunities to explore and discover results as well as relating topics to life applications.

Research Question Two: To what extent has the use of modern technologies changed the orientation of students in showing details solving mathematical problems?

S/N	Item	VGE	GE	ME	LE	VLE	n	fx	x
1	Examples are not shown	41	32	37	28	12	150	512	3.41
2	Maths problems are solved accurately	48	43	21	23	15	150	536	3.57
3	Has no ability to formulate problems	27	33	32	40	18	150	461	3.07
4	Makes concepts more direct	36	35	48	13	18	150	508	3.39
5	Increases students efforts in learning maths	29	39	34	19	29	150	470	3.13
6	Provides students with motivation	41	32	29	20	28	150	470	3.13
7	Produces quick solution to problems	37	32	29	28	24	150	480	3.2
8	Reduces students' psychomotor skills	28	43	36	25	18	150	488	3.25
	$\sum$						1200	3925	26.15
	x								3.52

In table 2, the rated mean score (3.27) is also greater than the criterion mean (3.00). This also shows that the use of modern technologies change students' orientation in showing details of their work in mathematics to a great extent.

Research hypothesis One: The teachers' mean score on adoption of modern technologies in understanding mathematical concepts is not significantly different from the population (P<0.05).

Table 3: Z-test analysis of responses on adoption of modern technologies in teaching and learning

N	x	μ	SD	Std-error	Z_{cal}	Z_{tab}	Decision
150	3.52	3.00	1.32	0.11	4.73	1.96	Ho Rejected

Since $\bar{Z}_{cal}$ (4.75) > Z_{tab} (1.96), H_o is rejected. This implies that the adoption of modern technologies in teaching and learning has a significant impact in understanding mathematical concepts.

Research Hypothesis Two: The teachers' mean rating score on students' orientation in showing details solving mathematical concepts using modern technologies is not significantly greater than the population mean (P<0.05).

Table 4: Z-Test Analysis of Responses on Students' Orientation in Showing Details Solving Mathematical Concepts Using Modern Technologies.

N	x	μ	SD	Std-error	Z_{cal}	Z_{tab}	Decision
150	3.27	3.00	1.38	0.11	2.45	1.645	Ho Rejected

As Z_{cal} (2.45) > Z_{tab} (1.645), H_o is rejected, hence the mean rating score on students' orientation in showing details solving mathematical concepts using modern technologies is significantly greater than the population mean. This implies that students' use of technological devices change their orientation in showing details solving mathematical problems.

Discussion of Findings
Results of tables 1 and 3 showed that the adoption of modern technology devices in both teaching and learning impact in students understanding of mathematical concepts significantly. This is with exception of items 8 and 11 of section A of the instrument. The results supported Boling (2003) who opined that modern technologies including sophisticated electronic modeling programmes and devices have created new opportunities for learning and teaching in education. This, according to him changed every aspect of modern life including education. On her part Roschelle (2013) claimed that education is devalued without technologies by spending much efforts solving problems computers can solve with ease. She claimed that modern technologies eliminated much time spent in calculation due by free hand. But contrary to her assertion, Hoadley, Gordin and Means (2000) were of the opinion that the technological devices will eliminate in the students the opportunities to sharpen their computational abilities.
Table 1 item number 11 which disagrees that modern technology relates topics to life applications does not agree with Ragon (n.d.) who asserted that modern technologies promote and enhance higher thinking and highlight the links between taught concepts and

the real life applications. On the other hand the result of item 11 of table 1 supported the opinion of Alsup and Sprigler (2003) that modern technology strategies do not teach students the applications of mathematical concepts especially applying them to real world situations.

Again tables 2 and 4 showed that students' use of technological devices change their orientation in showing details solving mathematical problems significantly. This result corroborated with the claim made by Greenfield (2008) that modern technology is changing the way brains work. Again Merrian-Webster (2007) opined that modern technologies constitute a state of humanity's knowledge of how to combine resources to solve problems. Result of table 2 supported the idea of Kurz, Middleton and Yanik (2004) that using computers as instructional tools reduce memorization in students and encourages awareness about problem-solving process.

Conclusion

From the foregoing discussions, integrating technology into the classroom teaching can improve mathematics learning. It can be used by teachers to introduce better mathematics. As the tools are introduced in teaching and learning to assist students learns to support computations and to make abstract ideas more tangible, they are to support learning in secondary schools if appropriately integrated in teaching techniques. By so doing students will focus less on memorizing of facts and perform routine calculations as they develop more ideas and understand connections between the ideas.

Recommendations

Following the findings and implications, these recommendations were made:
1. The curriculum planners should integrate in their planning when best students should begin in the course of their study to use certain technological tools for the study of mathematics.
2. The federal government should also institute a firm policy for the integration of ICT in education
3. Mathematics teachers should always insist in the students showing details (step by step) of their mathematics problems
4. Recommended textbooks for students should be such that explain and discuss details and procedures of arriving at every concept.

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