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Effects of formative test and attitudinal types on students' achievement in mathematics in Nigeria

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ABSTRACT

The study investigates interaction effects of formative testing and attitudinal types as they affect students' achievement in mathematics. A total of 120 students are drawn from the three geopolitical zones of Delta State and participated in the experiment. Three-of-the-four formative test instruments were used namely: self-report rating scale; quadratic achievement test, graphical solution of Quadratic equation achievement test, and graphical solution of quadratic equation ability instrument to aid data collection for the study. Data were analyzed using mean, standard deviation and two-way analysis of variance. Results shows that formative test (with reference to close book formative testing) contributed significantly to students' achievement in mathematics. Close book, followed by open book formative testing type are found to significantly contribute to students' achievement. Implications of the findings will help to boost the quality of teaching and learning of science (with respect to mathematics) education in Nigeria such as yield a useful direction towards the development of mathematics education in relation to learners' achievement as well as give a picture of the importance of formative testing to performance achievement mathematics.

Keywords: Interactions, close book, formative test.

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INTRODUCTION

Science and technology has become an integral part of our culture. Thus, we must keep abreast with its dynamic and fast changing trends, in that unless our children have excellent understanding of scientific processes and technological concepts, actualizing our societal goals in the 21st century and those of future generations will be a mirage. It becomes imperative to create awareness about the importance of science, technology and mathematic in our educational system, stating potential prospects and problems as encountered and why the system has failed in the past. The goals and mission of today's education must ensure that students are scientifically and technologically literate, to adapt with the changes ahead. Thus, Ivowi (1990) in Ojugo et al. (2007) recalls these objectives as follows: (a) provides basic science and technology literacy for everyday living, (b) provide preparation for further training in science and mathematics, (c) provide skills and attitude in preparation for technological development and experienced, (d) it will stimulate as well as enhance creativity, and (e) knowledge application via a user-friendly interface for interaction of diverse profession.

Vygotsky (1978) notes that the poor performance in science related subjects has been attributed to reasons such as: (1) Nature of the subject itself, (2) the curriculum's design, (3) Learner's characteristics, (4) the Teachers' characteristics cum the manner of presentation, and (5) Hurried teaching to meet examination deadlines.

Various methods devised for teaching, to foster understanding of basic science concepts via theories of constructivism (Ojugo et al., 2012), alongside previous studies have not been able to address the problem with readability of science and technology related textbooks (Abonyi, 2003). Thus, he further proposed use of cultural constructivism as a means to aid readability of textbooks as adapted to Nigeria such that learners construct meanings from the Nigerian context.

Science education requires a considerable change in

attitude that will enable both teachers and students take advantage of unrestricted online access to resources, as they contribute and share knowledge with the rest of the society. Leaping into *knowledge* era is not all about technology integration but more of the attitude of the teacher/learner as well as about changes made in teaching/learning methods as enabled by Information and Communication Technology (ICT). It also requires teachers to face fundamental issues and ask questions such as: (a) the nature of teachers' literacy and awareness with this new form of education that integrates the use of ICT (called hypermedia) enabled, learning environment, (b) how do teachers negotiate and navigate this new technology and (c) what are their expectations (Ojugo et al., 2006).

Mathematics is a very important subject the world over. In Nigeria's school curriculum, its importance is easily felt and thus, it occupies the most enviable position in any nation's science education curriculum and yet serves the other sciences. Many studies points note that Nigerian Post Primary (Secondary) students perform very poorly especially in mathematics (related) courses in the nation's public examination, which has raised concerns for educators, who have conducted survey experiments with results, aimed at enabling educators in the Nigerian Educational System, to formulate policies that will provide a better way of teaching Mathematics (Aprebo, 2002; Ojugo et al., 2008).

Now, problems that seem to have been formerly averted appear to have taken a new dimension, witnessed mainly in the aspects of internal assessment by mathematics educational outcomes in schools. It is disappointing to know that Mathematics teachers are usually provided with common teaching and evaluation syllabi with the number of tests to be conducted per term stipulated.

Maduewesi (2005) defines testing as *short* examination as classifies testing into *formative* and *summative*, and further opines *end* of a course or programme tests as summative whereas periodic tests undertaken within an ongoing course is formative. It is thus, clear that formative tests are conducted to achieve two purposes namely: (a) *effects* of the programmes in question, and (b) *diagnostic* information on programme deficiencies.

The National Teachers' Institute classifies formative testing into: (a) out of class, (b) open book and (c) closed book assessment techniques respectively. But, formative testing and the relative contributions of its components to qualitative mathematics educations are yet to be clear.

Thus, Adeniji (2000) defines attitude as a stable, long lasting learned predisposition to respond to things in a certain way. It may also be in its restricted sense to denote students' feeling about a subject/course. They further comments that attitude, which encompasses a wide range of affective behaviour, has cognitive, affective and a psychomotor dimension that is better measured with a self-report instrument. Thus, most prominent *quality* of attitude is to evaluate directionality (favourable and unfavourable feelings) towards an event. Ali (1995) opines "attitude acts as powerful motive in realization of expected goal," and to ensure goals of mathematics education must be assessed, with relative contributions of attitude to students' achievement obtained as a result of directionality, being of paramount interest to mathematics education as well.

Obvious but yet unclear is the effect of interaction of formative testing with attitudinal type. "Quality" is synonymous with "high standard" and to strive for such in mathematics, will enable Nigeria evolve a spectacle in Mathematics Education that will be reliable, excellent, worthy, eminent, valuable and usable in the 21st century. With this achieved, its basic concepts, ideas, ideals and facts is then easily transplanted within and across subject matter contents areas (Ojugo et al., 2008).

Formative versus summative testing

This refers to a process used by teachers as part of instruction to provide feedback to adjust ongoing teaching and learning to improve the student's achievement of core content. Thus, it refers also to a range of formal/informal assessment procedures employed by teachers during the learning process in order to modify the whole process of teaching and learning activities so as to improve student attainment. Thus, it involves qualitative feedback (rather than scores) for both students and teachers that focuses on the details of the content and performance. Employed as assessment method, its practices provide students with clear learning targets, examples and models of strong and weak projects, regular descriptive feedbacks, and the ability to self-assess, track learning as well as set goals (Iowa, 2013).

In contrast, summative tests provide a snapshot of the student's performance at that point in time via periodic quizzes, end of unit tests, end-of-course tests and/or standard tests. They are used for formative evaluation of programs contents and grading (Abonyi, 2003).

Nicol and McFarlane-Dick (2012) note the seven principles of formative test as thus: (a) it clarifies what good performance is with set goals, criteria and expected standards, (b) it facilitates the development of self-assessment in learning, (c) provides high quality information to students about their learning, (d) encourages teachers and peer dialogue around learning, (e) encourages positive motivational beliefs and self-esteem, (f) provides opportunities to close the gap between current and desired performance, and (i) provides information to teachers that can be used to shape teaching and learning.

Attitudinal types

Attitude refers to an expression of favour or disfavour

towards a person, place, thing or event. It may also refer to a person's perspective towards a specified target and way of saying and doing things. It also implies the manner, disposition, feeling, position etc with regards to a person or thing. It is the tendency or orientation (especially) of the mind towards (Dictionary.com, 2013). In this regard, it refers to the students' and teachers' attitude towards mathematics (science and technology) education especially with respect to quadratic equation.

Issues in science education

Oranu (2004) note that science education is not taken seriously as it is often misunderstood by educators in Nigeria. To address this, proper values must be placed on the need for science education to help us attain the much desired technological growth. This is because there is the misconception that science education (as related to technical subjects) is for those who cannot pursue pure academic programmes. This notion must be erased from the mind of parents, students and educators, because we should be aware that most industrialized nations today employed both the help of highly intelligent and less intelligent (technical students) in the growth towards technological development.

Technological advancement cannot be spoken of without science education, which is the bedrock for every impact made so far by science and technology. In Nigeria today, the level of technological advancement is a sad reflection of the quality of science education, which has and is still receiving stigmatization in our educational system as this has greatly hindered the expected technological progress of this nation. Urevbu (1983) asserted that nations that want to ensure growing prosperity as well as hold up their head high amongst other civilized nations must lay emphasis and pay close attention to science. Okunzuwa (2005) therefore lamented over the fallen educational standard and technological backwardness, which is attributed to the different educational system practiced via recalling the scanty, historical development of science education in Nigeria.

The problem of the study is that teaching is done and assessment conducted based on the recommendations in these syllabi, whereas evidence of such assessment at the final stage still appears very poor, all evidence that our internal assessment may be faulty. If the internal assessment of mathematics educational outcomes is a bit qualitative, the results of internal and external assessments will wear some semblance of a working whose annual final result is better. This is the crux and major reason for the study (Ojugo et al., 2008). The goal is therefore aimed at investigating interaction effects of formative testing and attitudinal types on the students' achievement in mathematics education in Nigeria, which has become imperative and aimed at reducing fear amongst other problems experienced by students to improve their performance at all levels.

Research questions/hypothesis

The study seeks to provide answers to the following questions:

1. What are effects of no formative testing on the students' achievement?
2. What are effects of out-of-class formative test on students' achievement in mathematics?
3. What are effects of open-book formative test on the students' achievement in mathematics?
4. What are effects of closed- book formative test on students' achievement in mathematics?
5. What are effects of positive disposition of students on their performance in mathematics?
6. What are effects of negative disposition of students on their achievement in mathematics?
7. What are effects of interaction between formative test and positive disposition on the students' achievement in mathematics?
8. What are effects of interaction between formative test and negative disposition on the students' achievement in mathematics?

These hypotheses were formulated and tested at a 0.05 level of significance as thus:

HO_1: No statistically significant difference in mean achievement of students in mathematics attributable to formative testing types.
HO_2: There is no statistically significant difference in mean achievement of students attributable to attitudinal types.
HO_3: There is no statistically significant difference in mean achievement of students attributable to the interaction of formative test and attitudinal types.

METHODOLOGY

Study adopts a quasi-experimental design with intact classes and a total of one hundred and twenty senior secondary school I students: (a) St. Patrick's Model Asaba (Oshimili South), (b) St. Gregory's Model Orerokpoe (Ethiope East), and (c) Omasan Technical, Ogbe-Ijaw (Warri South). Classes are assigned to four groups: (a) No-formative tested, (b) closed book formative tested, (c) Out-of-class formative tested and (d) Open book formative tested, with the four levels independent variable-formative testing. These schools were chosen from the three Geopolitical zones in Delta State

Each group had fifteen students, with *positive* and *negative* attitude towards mathematics. Grouping of students' performance was graded on 4-point attitudinal liker-scale, with quadratic equation achievement test administered before commencing the experiment. The instrument adopted is modified from Abonyi (2003) as thus:

1. No formative group were taught but were not exposed to any form of formative testing.
2. Out-of-class formative group was taught but their understandings of concepts taught were always assessed through out-of-class assignment such as take home assignments and exercises.
3. Open-book formative group was taught the unit and also exposed to open formative testing type. In other words, they were not allowed

Table 1. Student result on equation GSQEAI.

Formative tests	Positive attitude			Negative attitude			Overall		
	N	X	SD	N	X	SD	N	X	SD
No formative tested	15	40.64	10.06	15	35.67	8.39	30	38.17	9.6
Out-of-class	15	44.9	7.87	15	41	9.84	30	42.97	91.12
Open-book	75	55	13.43	15	45	13.87	30	50	14.54
Closed book Formative test	15	69.6	14.19	15	58	13.44	30	63.8	14.99
Overall	60	52.54	16.37	60	44.92	14.25			

Table 2. Students' two-way ANOVA on GSQEA1.

Source of variation	Sum of squares	DF	Mean square	F-test distribution
Rows	11205.54	3	3735.18	25.65
Columns	1748.04	1	1748.04	11.99
Interaction	284.69	3	145.58	0.65
Total	29543.2	112		

to exchange ideas but could consult their textbooks.
4. Close book formative group was taught the unit and was exposed to only the close book formative testing type. Thus, this group was not allowed to exchange ideas or consult textbooks when need.

The unit/content taught was the "graphical solution of quadratic equation" to all experimental groups within the five weeks period. All the groups were equally tested twice before the final test examination; the *first* was administered immediately after the treatment ends, the *second* was at the end of the 5th week after revision, and *third* was administered as part of students' first term examination for all classes by the teachers trained specifically for the experiment by the researchers.
Instruments of data collection are: (a) Graphical solution of quadratic equation achievement test (GSQEAT), (b) Graphical solution of quadratic equation revised test (GSQERT) and (c) Graphical solution of quadratic equation ability instrument (GSQEAI). Each instruments consists of 20 multiple-choice type item (Section A) and two essay items type (Section B), developed by researchers using the same test blue print. Efforts were however made to ensure non-repetition of specific items to ensure that *recall* effect plays no major role in students' performance. All instruments were subjected to both face and content validation; while a further reliability coefficient (test/retest) of 0.75 and 0.71, 0.78 and 0.72, and 0.74 and 0.73 were obtained via the test/retest method. Thus, the instruments have sufficient item variance that warrants their use as measuring instruments.

Each item in Section A that is correctly responded to out-of the 20 attracts 3 marks, while each in Section B earns 10 marks (total of twenty if correctly responded to). Thus, administration of GSQEAT and GSQERT forms the treatment; whereas, scores emanating from administration of GSQEAI were used for the final analysis.

Statistical analysis

Arithmetic mean and standard deviation were used to present answers to the research questions. Two-way ANOVA was used to test hypotheses for samples where n is too large to be computed via (binomial, normal, Poisson and hyper-geometric or any) other tests. The honestly significance difference (HSD) is used to established significance level.

RESULT AND FINDINGS

The result is as presented in Tables 1 and 2. Table 1 shows the overall tendencies of the experimental groups with means 38.17, 42.97, 50 and 63.8 as well as deviations 9.6, 9.12, 14.54 and 14.99 respectively, to indicate the result that all experimental groups exposed to formative testing relatively performed better than no-formative tested experimental group in the GSQEAI. In particular, the close book experimental group recorded the highest and best mean achievement of mean of 63.8 and standard deviation of 14.99. This result shows that close book formative tested experimental group recorded the best performance on the GSQEAI. A corresponding hypothesis tested at $\alpha = 0.05$ indicates an F-critical value of 8.53 at 3 and 112 DOF, found to be highly significant. Thus, null hypothesis is rejected implying that close book formative test significantly facilitates mathematics achievement.

This further compelled the honestly significance difference test (HSD), with a valve of 8.11, when applied to the data. Differences in mean achievement of each experimental groups were calculated and compared, and its results shows that the difference in mean achievement amongst the experimental groups: closed book and No-formative testing tested ($X_{CB} - X_{NO}$), close book and out of class ($X_{CB} - X_{OC}$), close book and open book groups ($X_{CB} - X_{OB}$) and open book and no formative testing ($X_{OB} - X_{NO}$) tested groups are all significant.

DISCUSSION

The results from Tables 1 and 2, implies that the differences between computed mean achievements is significantly: (a) better with students exposed to close-

book *instead* of out-of-class, (b) better with close-book *instead* of open-book, and (c) better with open book *instead* of no formative assessment. In contrast, no experimental groups who were exposed to the open and out-of-class formative testing types.

Table 1 indicates an overall mean achievement of the experimental groups as a result of the independent variable attitude, having the mean scores of 52.54 and 44.92 with standard deviations of 16.37 and 14.25 respectively, for the positively and negatively disposed groups. This indicates that positive attitude fairly facilitates student's achievement than negative attitude.

The hypothesis indicates that an F-ratio of 11.99 with 1- and 112-DF (degree of freedom) at α = 0.05 is far less than an F-ratio critical value of 253.3 (as computed from the F-Table). Thus, the null hypothesis is accepted with the conclusion that there exist ***no*** statistically significant difference in the mean achievement than the interaction between formative testing types and negative attitude.

A corresponding hypothesis tested at α = 0.5 as in Table 2 indicates an F-value of 0.65 as against 8.55 at α = 0.05 for 3- and 112 DF. Thus, the null hypothesis is accepted with the conclusion that there is *no* statistically significant difference in mean achievement as a result of the interaction of formative testing and attitude.

Conclusion

Generally, formative test is an important evaluation technique that adds quality to any nation's mathematics education if it meets its requirements of being functional, usable and ensuring instructional effectiveness, because teaching and testing are complimentary processes to each other. Mathematics teachers are hereby urged to adopt an organized assessment programmes within schools in order to inject quality in the Nation's mathematics education in the century.

RECOMMENDATION

The result of this experiment provides useful direction towards the development of mathematics education in the 21st century that are purely instructive to mathematics teachers in our nation's post primary (secondary) schools and others in various educational institutions on the relative statuses of the different formative testing techniques on the learner's achievement. It also gives a picture of the importance of formative testing to performance achievement mathematics. In particular, close book or *supervised* formative test can be used instead of *other* forms of formative testing. However, the result emphasis that instead of no-formative at all, open book can be used to assess the learner to help inject quality into mathematics education in Nigeria in the 21st century.

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