IMPACT OF OPTION LENGTH ON STUDENTS' MATHEMATICS ACHIEVEMENT IN COMMAND SECONDARY SCHOOLS IN NIGERIA

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Abstract. The study adopted Causal Comparative research design. A sample of 270 students was selected from five schools using stratified sampling technique. Three instruments: Three Options Mathematics Achievement Test (TOMAT) (r = 0.76), Four Options Mathematics Achievement Test (FOMAT) (r = 0.84) and Five Options Mathematics Achievement Test (FIOMAT) (r = 0.70), were used for data collection. 3-way ANOVA was used to test the hypotheses at 0.05 level of significance. Results of the analyses showed a significant effect of option length on students' Mathematic achievement ($F_{2, 267}$ = 19.652; P (0.00) < .05); no significant effect of gender on students' Mathematics achievement ($F_{1, 267}$ = .732; P (.482) > .05); a significant effect of field of study on students' Mathematics achievement ($F_{2, 267}$ = 12.623; P (.000) < .05), and a significant effect of option length and gender on students' Mathematics achievement ($F_{2, 267}$ = 3.504; P (.032) < .05). It is therefore recommended that teachers

of Mathematics should endeavor to devote more time and expertise to test construction, especially in the area of option length as this goes a long way in influencing students' achievement in the subject.

Keywords: option length, achievement test, command school, gender

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Introduction

Every individual need the knowledge of mathematics to function intelligently and efficiently in his or her world. Mathematics is an integral part of everyone's life and affects virtually every field of human endeavor. An average man needs Mathematics to survive no matter how rudimentary. There is no doubt that an individual can get on sometimes without knowing how to read and write, but can never push on smoothly without knowing how to count, measure, add and subtract. The many uses and applications of Mathematics in the home, office, in business, in industries, in agriculture, in decision making and even in governance abound and are innumerable. Usman (2002) noted that in everywhere we go, everything we do or propose to do, either the structure of Mathematics or its applications play a vital role and this is why most countries, races and peoples put emphasis in all aspects of studying, developing, and applying Mathematics.

Mathematics is the science of numbers, space and the language of science and technology. It is an essential requirement to cope with the challenges of life by every field of intellectual endeavor and human development (Miachi, 2006). Mathematics can also be said to be the queen and servant of the entire school subjects since it cut across the school curricula. It is equally seen as the language used to describe the problems arising in technology. It relates other school subjects in area like number and numeration, variations, graphs, fruitions, solutions of equation, and area and volumes (Ale & Adetula, 2010).

Valero (2017) reported that, the study of Mathematics is the motor of progress that improve the teaching and learning as a priority for national and international educational discourse which has repetitively pop-up in many political discussions, expert reports and even the discussions of parents with teachers on why their children should get good grades in Mathematics. The urge for internalizing the study of Mathematics in every nation educational system has become a naturalized truth. In view of this, the learning of mathematics in schools, as observed by Odili (2006) represents first, a basic preparation for adult life and secondly a gateway to a vast array of career choices. In this respect, Iji (2007) maintained that any country that aspires for national growth in science, industries, and technology must not neglect Mathematics. This is in view of the multi-dimensional values of mathematics in virtually all facets of human development and experience.

Despite the relevance and usefulness of Mathematics as a key in realizing any national development and aspiration, over the years, there has been a repeat of low level of achievement and failure of students in Mathematics at senior secondary school. This poor Mathematics achievement has assumed an alarming proportion and caused a lot of concern for students, parents, teachers, government and other stakeholders in education sector. The concern for this poor achievement is not only limited to Mathematics educators but also parents and other stakeholders. Studies ascribed the inadequacies to one or all of these areas namely, the nature of the subject, the learners' factors, the teachers' factors and the preparation process of the questions.

Korau (2006) also reported that several variables ranging from the learners themselves, teachers, textbooks, curriculum, school environment and system of preparation and administration of the achievement test to have been responsible for students' poor achievement in Mathematics.

In general evidence has also shown that all over the world, majority of Secondary School students' performance in Mathematics have been variously

reported by individuals and groups to be poor. For instance, reports on students' poor achievement on Mathematics were noted (Igbo, 2004; Aguele, 2004).

Table 1. Analysis of WAEC Mathematics achievement (2007-2016)

Year	Total No. Who Sat	No. of Students that Obtained credit & Above (A1 - C6)	% of Students with Credit & Above (A1-C6)	No. of Students with (D7- F9)	% of Students with (D7- F9)
2007	1,275,330	198,441	15.56	1,076,889	84.44
2008	1,369,142	314,903	23.00	1,054,239	77.00
2009	1,373,009	425,633	31.00	947,376	69.00
2010	1,351,557	453,447	33.55	898,110	66.45
2011	1,540,250	587,630	38.93	952,620	61.07
2012	1,675,224	819,390	49.00	852,834	51.00
2013	1,543,683	555,726	36.00	987,957	64.00
2014	1,692,435	529,732	31.30	1,162,703	68.70
2015	1,593,442	544,638	34.18	1,048,804	65.82
2016	1,544,234	597,310	38.68	946,924	61.32

Source: Test Development Division, West African Examination Council (WAEC) Lagos, Nigeria.

Table 1 shows the percentage of students with credit and above in 2007 was 15.56%. There seem to be a consistent increase on students' performance till 2012 where 49% of students examined for Mathematics that year had credit and above. However, in 2013 the percentage dropped to 36% and kept fluctuating below 40%. It is worthy of note that, within the period of 2007 to 2016 the yearly percentage of students who made credit and above could not reach 50%. This is more worrisome, and one wonders what then could be responsible for this poor performance despite its importance and recognition given by the society and various efforts made by the Federal Government and the Mathematical Association of Nigeria (MAN).

The inability of students to change to a thinking mode suitable for the particular problem in other to alter between a numeric, graphic, or symbolic form of representing Mathematical ideas deterred them also from solving a wide

range of Mathematical problems. The length of options in the multiple-choice question could also contribute to this poor Mathematics achievement.

Academic achievement is the extent to which a student, teacher or institution has achieved their short or long-term educational goals. Academic achievement is commonly measured through examinations or continuous assessments but there is no general agreement on how it is best evaluated or which aspects is most important procedural knowledge such as skills or declarative knowledge such as facts.

Assessment can take any form, with the students (trainees) playing active roles in the assessment of their achievement, such as observations, text and curriculum embedded questions, interviews, over-all tests, performance assessments, writing samples, exhibitions, simulations, portfolio assessment, project and product assessments, and modes of peer and co-assessment, standardized testing, using multiple choice and open ended questions to oral questioning and teacher-made examinations (Dusic, 1998; Hudson, 2012).

Broadly, standard assessment can be essay type and/or multiple-choice type format as used by most examination bodies such as West African Examination Council, National Examination Council Board, Unified Tertiary Joint Admission Matriculation Board and National Board for Technical Education. Today, the multiple-choice type examination is increasingly becoming the most popular item formats used for educational testing (Oosterhof, 2001; Tozoglu et al., 2004), which required that the examinee should have broad and specific skills in order to get high scores (Nassar, 2006).

Bontis et al. (2009) noted that multiple choice question format is most frequently used for the purposes of acquiring data in educational testing, survey research, elections and market products. The multiple-choice items consist of a stem and a set of options (Beckert et al.,2003). However, anything may be included as long as it is necessary to ensure the utmost validity and authenticity to the item. Haladyna & Downing (1993), in their taxonomy of multiple-choice item-writing guidelines, suggest 43 guidelines of which 10 are concerned with

general item writing, six are related to stem development, and 20 refer to option development. The fact that a good number of guidelines have dealt with the issue of option development is an indicator of the importance of this last concern. One of the most frequently mentioned guidelines with regard to option development deals with the number of options to be written for each item.

Haladyna et al. (2002) recommend writing as many plausible distracters as possible. Traditionally, it is recommended to use four or five options per item in order to reduce the effect of guessing. Most classroom achievement tests and international standardized tests usually follow the rule of four options per item. In spite of the widespread use of four or five options per item advocated by many authors and test developers, most of the studies carried out to investigate the optimal number of options have ended with recommending the use of three-choice items

Shizuka et al. (2006) compared the psychometric characteristics of three- and four-choice English reading comprehension items using the Rasch model. Thirty-eight multiple-choice items intended to tap reading comprehension as a part of a university entrance exam in Japan formed the four-choice form. Later, the three-choice form was constructed by eliminating the least frequently chosen distracter, and it was linked to the four-choice test form using common-item equating. The two test forms were given to two separate groups. The effects of the number of options per item on the psychometric characteristics of the two test forms were investigated. The results revealed no significant change in the mean item facility. No notable change was observed in test reliability and the number of discriminating distracters. Thus, considering issues like reducing the chances of providing unintended cues by offering more options per item, costs of test development and administration time, three options per item were concluded to be optimal.

Gender factor is very strong in learning and thus determines the interest and achievement and consequent career choice. It is interesting to note that while Jahun & Momoh (2001) established that gender is significant in school

Mathematics achievement. Other studies such as that of Aiyedun (2000) found no significant difference between males and females in school Mathematics achievement. Badmus (2009) is of the argument that males are better at Mathematics than female because of genetic, some because of societal influence and some said it is due to Mathematical anxiety level. Also, in agreement, are Onabanjo (2007) and Ojo (2004) who independently found out that boys perform significantly better than girls in senior secondary school Mathematics. This difference is often over-slated and its cause is often highly debated. Low performance trends of females in Mathematics have been observed to influence the lower participation of females in science and Mathematics related profession. Still on gender differences in achievement in Mathematics some other researchers put male and female discrepancy in Mathematics achievement in favor of males performing better than their female counterparts to be as a result of the female belief towards Mathematics.

Statement of the problem

Examinations are a very common assessment and evaluation tool in schools (primary, secondary, colleges of education, polytechnics and universities) using various types of formats, of which multiple choice format is one. Studies in the area of impact of option length on students' performance in examinations are grossly inadequate. This makes it practically difficult to decide on the appropriate number of options for the examinees to choose from. It is observed in local and standard examinations that there is no unified number of options that multiple-choice test should provide. Therefore, different examining bodies and sometimes depending on subject provides options ranging from 3 to 5. This has been seen to create confusion in the students especially those in SS3. Could the number of options in multiple-choice examination format has an impact on performance of students in their academic achievement? Therefore, this study basically examines the impact of option length on students' performance in mathematics achievement test.

Purpose of the study

The general purpose of this study was to investigate the effect of option length on students' mathematics achievement in Command secondary schools based on gender and field of study. The following hypotheses are raised: (1) there is no significant effect of option length on students' mathematics achievement in Command secondary schools in Nigeria; (2) there is no significant effect of option length on students' mathematics achievement in Command secondary schools in Nigeria based on gender; (3) there is no significant effect of option length on students' mathematics achievement in Command secondary schools in Nigeria based on the field of study; (4) there is no significant influence of option length on students' mathematics achievement in Command secondary schools in Nigeria based on gender and field of study

Methodology

The research adopted 3x3x2 factorial matrix. This include the 3 types of option length by 3 levels of field of study for the students and 2 level of gender with the total of 18 cells as shown in the Factorial Matrix table (Table 2).

Table 2. Factorial Matrix Table of 3x3x2

Option Type	Male			Female		
	Science	Commercial	Art	Science	Commercial	Art
3 options Type A						
4 options Type B						
5 options Type C						

Population of study

The target population of this study comprised of all SS2 students in twenty-one (21) Command Secondary Schools in Nigeria.

Sample and sampling technique

Simple random sampling technique was used to select one geo-political zone among the six geo-political zones in Nigeria. In the selected geo-political zone, 5 schools were randomly selected for the research. The instruments were administered to the respondents in the five (5) selected schools. In each of the school, the students were divided into three groups. Each group consists of all field of study (Science, Commercial and Art). The Three Option Instrument (Type A) was administered to first group, Four Option Instrument (Type B) to the second group and the Five Option Instrument (Type C) was administered to the third group in the same school. This was repeated in all the schools visited. In all, 270 students participated in the study.

Research instruments

Three research instruments were used in this study. The first, second and third instruments are well-structured with 25 Mathematical Achievement test items each of three (TOMAT), four (FOMAT)and five (FIOMAT) Options respectively with reliability coefficients of 0.76 for TOMAT, 0.84 for FOMAT and 0.85 for FIOMAT using Cronbach alpha. The instruments were developed by the researcher to measure the Mathematics achievement based on SS II syllabus. The section A of the instruments consists of demographic information of the students, while section B consisted Mathematics test items for SS2.

Data analysis

A 3-way ANOVA statistical tool was used to test the hypotheses at. 0.05 level of significance.

Results

*Hypothesis One ($H0_1$)***:** There is no significant effect of option length on students' mathematics achievement in Command secondary schools in Nigeria.

Table 3. Tests of between-subjects' effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial R squared
Corrected Model	983.340a	18	54.630	5.099	.000	.269
Intercept	3593.978	1	3593.978	335.348.951	.000	.574
Option Length	421.105	2	210.553	19.652	.000	.136
Gender	15.685	2	7.843	.732	.482	.006
Field of Study	270.491	2	135.245	12.623	.000	.092
Option Length * Gender	73.093	2	37.547	3.504	.032	.027
Option Length * Field of Study	78.654	4	19.664	1.835	.123	.029
Gender * Field of Study	12.737	2	6.368	.594	.553	.005
Option Length * Gender * Field of Study	75.245	4	18.811	1.756	.138	.027
Error	267.854	249	10.714			
Total	27422.000	268				
Corrected Total	3651.194	267				

Table 4. Multiple comparisons involving option length

(I) Option length	(J) Option length	Mean Diff.(I-J)	STD. Error	Sig.
Type A	Type B	2.36*	.488	.000
	Type C	2.90*	.489	.000
Type B	Type A	-2.36*	.488	.000
	Type C	.55	4.92	.539

Looking at the tests of between-subjects' effects ($F_{2, 267}$ = 19.652; P (0.00) < .05) on Table 3, there is a significant effect of option length on students' Mathematic achievement in senior secondary schools. Thus, the null hypothesis is rejected. Further, information from Table 3 (R^2 = .136) indicates that option length makes a contribution of 13.6% to variance in students' Mathematics achievement.

Multiple comparisons involving option length on Table 4 (Mean Difference – 2.36) indicates that the difference in students' Mathematics achievement was in favour of type A when compared with type B and also same when compared with type C (Mean Difference = 2.90). Difference in students' Mathematics achievement was also in favour of type B (Mean Difference = .55) when compared with type C.

Hypothesis Two (HO_2): There is no significant effect of Option length and gender on students' mathematics achievement of Command secondary schools in Nigeria

Based on the result of the test of between-subjects' effects ($F_{2, 267}$ = 3.504; P (.032) < .05), there is a significant interaction effect of option length and gender on students' mathematics achievement in senior secondary schools. Thus, the null hypothesis is rejected. The coefficient contribution (R = .027) shows that the interaction effect involving option length and gender to variance in students Mathematics achievement is 2.7%.

Hypothesis Three (HO_3): There is no significant effect of Option length and and field of study on students' mathematics achievement of Command secondary schools in Nigeria.

Given the results of tests of between-subjects effects ($F_{4, 267}$ = 1.835; P (.123) > .05) on Table 3, there is no significant interaction effect of option length and field of study on students' mathematics achievement in senior secondary schools. Thus, the null hypothesis is not rejected. Interaction effect of the two variables makes 2.9% (R = .029) contribution of variance in students' Mathematics achievement.

Hypothesis Four (HO_4): There is no significant difference in students' mathematics achievement of Command secondary schools in Nigeria based on option length, gender and field of study.

According to the results of tests of between-subjects' effects ($F_{4, 267}$ = 1.756; P (.138) > .05) on Table 3, there is no significant interaction effect of option length, gender and field of study on students' mathematics achievement in senior secondary school. Therefore, the null hypothesis is not rejected. Meanwhile, the contribution of the interaction effect involving the three variables to variance in students' Mathematics achievement was 2.7% (R = .027).

Discussion

The findings from the results of the above analysis shows that there is a significant influence of option length on students' Mathematic achievement in Command secondary schools which necessitated the rejection of the null hypothesis. This finding corroborates Gray (2004) who reported that test items arrangement plays a vital role in determining the performance of students in examinations. It could be that while some students may find it difficult in guessing answers in multi-choice item for instance, others on the other hand may find it easier while some may totally prefer essay questions. Test item format differs depending on the examiner and the purpose for which the test is conducted. In all these, the various item arrangement formats in which they are presented could as well play a vital role in determining students' responses. The finding also supports Ackerman & Kanfer (2009) who reported that as test length increases, two concerns arise. First, is the task causing cognitive fatigue; in other words, is it tasking students' mental functions enough that it may cause a decrease in their performance? Second, is the task causing perceptions of fatigue, or subjective fatigue? More importantly, is this subjective fatigue leading to a self-regulated withdrawal from the process and consequently lower performance? In both cases, fatiguing conditions can lead to lower students' performance not attributable to a lack of knowledge, and consequently less than accurate assessment outcomes. Crehan et al. (1993) carried out item analysis and test analysis comparing multiple-choice tests composed of four-choice items with

those containing three choice items. The results revealed that the three-choice items were less difficult than four-choice items.

Also, the finding of the study reveals that there is no significant effect of gender on students' Mathematics achievement in senior secondary schools, which informed upholding the null hypothesis stated. However, the interactive effect of gender and length of option is significant. This supports the report of Meremikwu & Enukoha (2011) who, after using item multiple-choice Mathematics Achievement Test (MAT) designed by the researchers in their experimental study, reported that students' Mathematics achievement was significantly dependent on gender. However, the finding refutes the position of Obioma (2005) who developed, validated and formed a Diagnostic Mathematics Achievement Test (DAMAT) for Nigerian Secondary School students and finally reported that gender, among other factors, is a significant predictors of students' achievement in Mathematics. Also, the finding is against the position of Grootenboer & Hemmings (2007) who examined how mathematically affective factors and such background characteristics as gender may contribute to the mathematics performance of students and reported that mathematics performance was significant in the direction of gender.

In addition, the study also found that there is no significant influence of field of study on student mathematics achievement in senior secondary schools, hence, the null hypothesis was rejected. Though there is a dearth of empirical findings on this variable, yet, the finding refutes Konstantopoulos(2006), who examined trends of school effects (students' choice of class – science, commercial or arts) in secondary school on students' achievement, reported that the substantial proportion of the variation in students' achievement lies within schools, not between schools and therefore concluded that that certain school-specific variables have significant impact on students' achievement.

Furthermore, the study found that there is a significant interaction effect of option length and gender on students' mathematics achievement in senior secondary schools. In view of this, the null hypothesis was rejected. This shows

that the interaction between option length and gender do have significant effect on mathematics achievement. While Gray (2004) and Tsui (2008) reported that singly, test item arrangement may positively influence students' achievement in Mathematics and that gender has no significant effect on Mathematics achievement, respectively, yet when the two variables interact, they do have significant effect on Mathematics achievement of secondary school students. The studies of Bronholt et al. (1994) and Tsui (2008) revealed no significant effect of gender on Mathematics achievement of students

The study further reports that there is no significant interaction influence of option length and field of study on students' mathematics achievement in senior secondary schools. Based on this finding, the null hypothesis was not rejected. While studies such as Gray (2004) and Shizuka et al. (2006) reported that it may be best to avoid lengthy options and that school-specific variables (students' choice of class – science, commercial or arts) have significant impact on students' achievement, yet, not study has specifically reported any significant interaction effect of option length and field of study on students' mathematics achievement in senior secondary schools.

Also, the study found that there is no significant interaction effect of gender and field of study on students' mathematics achievement in senior secondary school. In view of this finding, the null hypothesis was sustained. When viewed singly, studies including Wonu & Anackwe (2014), Meremikwu & Enukoha (2011), Josiah & Etuk-Iren (2014), and Grootenboer & Hemmings (2007) reported both positive and negative relationships between gender and Mathematics achievement; positive relationship between field of study and mathematics achievement (Shizuka et al., 2006), however, no study has specifically reported no significant interaction effect of gender and field of study on students' mathematics achievement in senior secondary school. Finally, the study found no significant interaction effect of option length, gender and field of study on students' mathematics achievement in senior secondary school. Therefore, the null hypothesis is not rejected.

Conclusion

Results revealed significant effect of option length on mathematics achievement of students in Command secondary schools in Nigeria. The difference in the performance of students in mathematics based on the option length improves with increase in option length particularly when option three is compared with option five, however, the difference reduces when option four is compared with option five (Table 4). It could then be deduced that items with five option will yield better results.

Recommendations

It is recommended that teachers of mathematics should endeavour to devote more time and expertise to test construction, especially in the area of option length as this goes a long way in influencing students' achievement in the subject. Again, the impression that Mathematics is not relevant in the Arts or in the Commercial class should not be impressed on students by teachers, rather, they should be motivated with the fact that mathematics is important in all the classes.

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