INFLUENCE OF THREE MODES OF ORDERING TEST ITEMS ON SENIOR SECONDARY SCHOOL STUDENTS' ACADEMIC ACHIEVEMENT IN MATHEMATICS IN AWKA EDUCATION ZONE

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Abstract
The study investigated the influence of three modes of ordering test items on senior secondary school students' academic achievement in mathematics in Awka Education Zone. Four research questions guided the study and five null hypotheses were tested at a 0.*05 alpha level of significance. The study adopted ex-*post *facto design to achieve the purpose of the study. Population for the study comprised 5,057 senior secondary school three (SSS3) students which comprised of 2259 males and 2798 females in all the public secondary schools in Awka Education zone of Anambra State, Nigeria. Multi-stage sampling procedure was used to select 380 SSS3 students. The instrument for data collection was General Mathematics Achievement Test (GMAT). The GMAT was validated by three experts, one in the Department of Science Education, one in the Department of Educational Foundations (Measurement and Evaluation Unit), Nnamdi Azikiwe University, Awka, and one in the Department of Mathematics, Nwafor Orizu College of Education Nsugbe. Kuder Richardson Formula 20 was used to obtain the reliability coefficient value of 0.79, 0.81 and 0.82 for least difficult to most difficult item, most difficult to least difficult items and items in randomized order respectively. The mean, standard deviation, Analysis of Variance and independent t-test were used to perform the data analysis. The findings of the study showed that ordering of test items from least difficult to most difficult items favours the students more than ordering of test items from most difficult and randomized order. It was recommended among others that the examination bodies should* endeavour to a*dopt the method of arranging the test items from simple to complex order of difficulty.*

Keywords: *Mathematics, Ordering Test Items, Students' Academic Achievement, Senior Secondary School Students, Three Modes.*

Introduction

The problem associated with mathematics evaluation and achievement is a major challenge for educators. General concern about mathematics achievement has been evident for many years. A central and persisting issue is how to provide instructional environments, conditions, methods, and solutions that would assist in achieving learning goals for students with different skills and ability levels. The current debate among scholars is how students could achieve better result in mathematics examinations. The discussion emphasizes mode of ordering items to produce individuals who can understand and apply fundamental mathematics concepts. Mathematics is a fundamental part of human thought and logic, and integral to attempt at understanding the world and ourselves. Kolawole and Oluwatayo (2005) defined Mathematics as human invention, born out of human search to solve human problems. This implies that Mathematics is a creation of the human mind which is concerned with ideas, processing and reasoning. It plays a vital role in the study of science, technology and all

other spheres of human endeavours. According to Akaeze and Okigbo (2021), the function and relevance of mathematics to education and the society makes it to be regarded as the bedrock of science and technological development. The importance of mathematics to nation building cannot be over emphasized. Mathematics play a significant role on the development of both an individual and a nation.

As a condition for admission into tertiary institution, a candidate seeking admission to study any course especially in the university is expected to have passed five (5) 'O' level subjects including Mathematics and English language at credit level in one sitting or six in two sittings in the West African Senior School Certificate Examination (WASSCE) and National Examination Council (NECO). A credit pass in Mathematics is compulsory for all science based courses generally and at least a pass in Mathematics for all courses in social science except Economics where a credit is required (Unified Tertiary Matriculation Examination, 2020/2021). Despite the importance and usefulness of Mathematics to human existence and the enviable position it occupies in the field of disciplines, students' achievement in both internal and external examinations have continued to deteriorate year-by-year (Igbe, 2018).

Secondary School Students seem to perform poorly in both internal and external examinations like WASSCE and NECO. In national results showing the summary of students' performance in Mathematics in WASSCE from 2009-2021, it is evident that students' performance is below expectations. A close look at the results revealed that candidates in Nigeria did not record up to 50% credit in Mathematics in any of the years suggesting low achievement in the subject. The WAEC Chief examiners 2020 reported that there was 1.06% improvement in the students' performance in 2020 compared to that of year 2019. This improvement is infinitesimal compared to what should be expected in a subject such as mathematics which is the bedrock of all sciences and technologies. The low achievement in mathematics at both qualifying examination (SSCE, UME) has resulted in many students not being able to proceed in educational careers of their choice. The achievement of some of the few students who eventually made it into tertiary institution is equally not encouraging.

It is worrisome to note too that the academic achievement of students in mathematics has continued to deteriorate year after year (Ebenebe, 2019). This implied that there is low academic achievement of students in mathematics over the years, and therefore called for an investigation to the factors responsible for the situation. Many variables have been identified by scholars such as Suleiman and Hammed (2019), Emerson *et al.*, (2020) as being responsible for students' low interest and poor achievement in Mathematics. These variables include curriculum, examination bodies, teachers, students, environment and textbooks. From the studies by those authors carried out to identify the various factors which cause the persistent poor achievement and possible way to combat it, the identified causes are usually classified as intrinsic factors (psychological and physical factors inherent in the students including sex), Instructional factors (the strategy adopted by the teachers in the course of teaching, the structure, content, reliability, validity and mode of presentation and administration of the test instrument and environmental factors(Physical factors, condition and quality of the learning and examination).

This consistent poor performance by students in mathematics calls for serious national action to remedy the situation and to put mathematics on a sound footing to facilitate the realization of a great and dynamic economy in Nigeria. Attempts to find solution to the incessant failure rates of students in mathematics have made researchers in mathematics education to consider a number of factors (Adebayo, 2018). As such, government, school administrators among other educational stakeholders have collectively improved school environment, enhanced teaching methods in mathematics, and provided qualified/competent mathematics teachers (Nwankwo, 2021).

Wisdom (2018) posited that a number of programmes have been embarked upon like introduction of new mathematics textbooks, different mathematics competitions, workshops and seminars. Despite the efforts of these educational stakeholders in improving academic achievement of students in mathematics, the issue of poor academic achievement in the subject still persists. It appears that less effort are directed at problems from examinations and testing order such as ordering of test items from most difficult to least difficult level, random order or ordering from least difficult to most difficult. The author of this study is motivated *b*ecause ordering of test items and gender could have impacts on the achievement of students in mathematics in Awka Education Zone of Anambra State, Nigeria, since much effort have been made in improving the teaching and learning methods in mathematics *in the c*lassroom and poor performance of students in the subject persists.

Ordering of *a t*est item seeks to address the order in which test items should be presented to students. Ogunsanwo (2006) stated that there are three modes or levels of ordering test items. The three modes according to the author are: from least difficult level (those which are below one's ability) to most difficult level (demanding higher ability), from most difficult level (demanding higher ability) to least difficult level (those below one's ability) and Randomization (in no particular order of difficulty) of test items. Ini, Bassey and Valentine (2019) shades more light on these three modes of ordering test items using a typical hypothetical Guttmann (1946)'s scale that shows a perfect sequencing of test items. The Guttmann scale test item scale as shown in Appendix B (page 56) indicates the item in which position are hierarchical. They are arranged in a systematic and logical order. When an examinee responds correctly to item 3 for example, it logically implies that the examinees respond correctly to items 1 and 2. Responses from examinees can be predicted from their cumulative score since Guttmann scale is deterministic. Guttmann response pattern is the most probable response pattern for a person when items are ordered from least difficult to most difficult. It is often observed however that examinees respond to item in a way that portray marked inconsistencies across the test items. The job of a Mathematics teacher is therefore not just to teach but also to be knowledgeable in test construction and administration.

The fear of Mathematics has been an academic disease with its attendant virus, which the society is yet to get its effective treatment. The symptoms of the disease are always observed on the faces of students when learning and writing mathematics examinations. This has always led to poor academic achievement. The poor academic achievement with its attendant problems has been a great thing of worry to all stakeholders, such as parents, teachers, educational psychologists, counsellors, government and the society at large. This is because mathematics is today, part of the basic requirements for entrance into tertiary institutions. This consistent poor performance by students in mathematics calls for serious national action to remedy the situation and to put mathematics on a sound footing to facilitate the realization of a great and dynamic economy in Nigeria.

To address this situation, a number of programmes have been embarked upon like introduction of new mathematics textbooks, different mathematics competitions, workshops and seminars. The problems seem to continue because these interventions are outside the learner. It appears that less effort is directed at the ordering of test items. Research on the effect of the three mode of ordering test items on Senior Secondary Students' achievement in Mathematics would be another empirical dimension for documentation of significant roles of ordering test items which could improve the performance of the secondary school students in mathematics. It is on this note that this study will use the three mode of ordering test items to ascertain which of them affect male and female students' academic achievement in Mathematics in Awka Education zone of Anambra state.

Research Questions

The following research questions guided the study.

Research Question 1: What are the mean achievement scores of senior secondary school students examined with the three different modes of ordering test items in Awka Education Zone?
Research Question 2: What are the mean achievement scores of male and female students examined with test items ordered from least difficult to most difficult in Awka Education Zone?
Research Question 3: What are the mean achievement scores of male and female students examined with test items ordered from most difficult to least difficult levels?
Research Question 4: What are the mean achievement scores of male and female students examined with test items in a randomized order?

Research Hypotheses

The following null hypotheses were tested at a 0.05 level of significance.

Research Hypothesis 1: There is no significant difference in the mean achievement scores of secondary school students examined with three modes of ordering test items.
Research Hypothesis 2: There is no significant difference between the mean achievement scores of male and female students examined with test items ordered from least difficult to most difficult
Research Hypothesis 3: There is no significant difference between the mean achievement scores of male and female students examined with test items from most difficult level to least difficult level.
Research Hypothesis 4: There is no significant difference between the mean achievement scores of male and female students examined with test items ordered in a randomized order.
Research Hypothesis 5: There is no interaction effect of testing modes and gender on senior secondary school students' academic achievement in mathematics.

Methods

Research Design

The study adopted ex post-facto design research design to achieve the specific aims and objectives of the study.

Population and Sampling Technique

The population of the study was made up of 5,057 senior secondary school three (SS3) students which comprised of 2259 males and 2798 females in all the public secondary schools in Awka Education zone of Anambra State, Nigeria (PPSSC, 2023). They were selected because they are not external examination class. The sample size of the study was 380 SS3 students. Multi-stage sampling procedure was used in drawing the sample size of 380 SS3 students. First, purposive sampling method was used to select all the schools in Awka Education Zone with at least three arms of SS3 class. Using simple random sampling technique (Balloting), three schools comprising one single sex boy, one single sex girl and one co-educational schools were selected. The bases for stratification is to obtain threes (3's) from 3 strata according to school type in the study area. In stage three, any school with more than three arms of SS3, simple random sampling technique (balloting) was used to obtain only three classes. On the whole, three arms of SS3 students from each of the three schools were selected to obtain 9 classes. From that 3 schools, all the students found in each of the arms were used for the study.

Research Instrument

The instrument for data collection for this study was General Mathematics Achievement Test (GMAT) comprising of 50 standardized multiple choice objective questions taken from the 2022West African Senior Secondary Certificate Examination (WASSCE) past questions. The test items were

rearranged by the researcher in three modes to help in the identification of the most effective mode of ordering test items in secondary school mathematics.

Validation and Reliability of Research Instrument

*T*he validation of the instrument was ascertained by giving the questionnaire alongside with the purpose of the study, and research questions, one expert in the Department of Science Education and another one in the Department of Educational Foundations (Measurement and Evaluation Unit), both from Nnamdi Azikiwe University, Awka and the other expert from the Department of Mathematics, Nwafor Orizu College of Education, Nsugbe. The reliability of the three versions of the instrument was determined using 30 SS3 students in three secondary schools in Aguata Local Government Area which is outside the study area. The scores were correlated using Kuder Richardson Formula 20 and the reliability coefficient values of 0.79, 0.81 and 0.82 for least difficult to most difficult, most difficult to least difficult and randomized order respectively was obtained. The author with the help of three research assistants from each school administered the test to the respondents. The research assistants were briefed on the purpose of the study before data collection. The answer script bearing the type of test answered was marked and scores was obtained and analyzed item by item and school by school.

Data Analysis

Data collected using General Mathematics Achievement Test (GMAT) was analyzed with respect to each of the research questions and research hypotheses. The mean and standard deviation were used to answer the research questions one to four. The computation was perform using version 23 of Statistical Packages for Social Sciences (SPSS). The hypotheses one and five were tested using analysis of variance (ANOVA) while hypotheses two to four were tested using independent t-test. All the hypotheses were tested at 0.05 alpha level. Decision rule for the hypothesis is; reject any null hypothesis if the probability value (P-Value) is less than or equal to the significant value of 0.05 ($p<.05$), otherwise ($p>.05$) do not reject the null hypothesis.

Result

Answering Research Questions

Research Question 1: *W*hat are the mean achievement scores of senior secondary school students examined with the three different modes of ordering test items in Awka Education Zone?

Table 1: Mean Achievement Scores of Senior Secondary School Students Examined with the Three Different Modes of Ordering Test Items

	Modes of Ordering Tests	*M*	*SD*
1	Least to difficult	24.43	11.02
2	Most difficult to least difficult	21.15	10.35
3	Randomized	22.30	10.63

Table 1 revealed the mean achievement scores of students when they were tested using three different modes of ordering test items. Students in the least to most difficult test ordering format had the highest mean score followed by those tested with the randomized ordering format whereas students tested with the most difficult to the least difficult ordering format had the least mean score.

Research Question 2: What are the mean achievement scores of male and female students examined with test items ordered from least difficult to most difficult in Awka Education Zone?

Table 2: Mean Achievement Scores of Male and Female Senior Secondary School Students Examined with the Least to Difficult Ordering Test Items Format

S/N	Gender		Least to Difficult Ordering Test Items Format	
			M	***SD***
1	Male	94	23.32	10.61
2	Female	86	25.65	11.38

Table 2 showed the mean achievement scores of male and female senior secondary school students examined with the least to difficult ordering test items format. Female students had higher mean score than male students.

Research Question 3: What are the mean achievement scores of male and female students examined with test items ordered from most difficult to least difficult levels?

Table 3: Mean Achievement Scores of Male and Female Senior Secondary School Students Examined with the Most Difficult to Least Difficult Ordering Test Items Format

S/N	Gender		Most Difficult to Least Difficult Ordering Test Items Format	
			M	***SD***
1	Male	94	20.66	10.42
2	Female	86	21.69	10.30

Table 3 showed the mean achievement scores of male and female senior secondary school students examined with the most difficult to least difficult ordering test items format. Female students had higher mean score than male students.

Research Question 4: What are the mean achievement scores of male and female students examined with test items in a randomized order?

Table 4: Mean Achievement Scores of Male and Female Senior Secondary School Students Examined with the Randomized Ordering Test Items Format

S/N	Gender		Randomized Ordering Test Items Format	
			M	***SD***
1	Male	94	21.44	10.56
2	Female	86	23.23	10.69

Table 4 showed the mean achievement scores of male and female senior secondary school students examined with the randomized ordering test items format. Female students had higher mean score than male students.

Testing Research Hypotheses

Research Hypothesis 1: There is no significant difference in the mean achievement scores of secondary school students examined with three modes of ordering test items.

Table 5: ANOVA on Students' Achievement Scores Examined with Three Modes of Ordering Test Items

	SS	*df*	*MS*	*F*	*Sig.*
Between Groups	999.893	2	499.946	4.395	.013
Within Groups	61088.544	537	113.759		
Total	62088.437	539			

Research Hypothesis 2: There is no significant difference between the mean achievement scores of male and female students examined with test items ordered from least difficult to most difficult.

Table 6: t-test Analysis Mean Achievement Scores of Male and Female Students Examined with Test Items Ordered from Least Difficult to Most Difficult

Variables	*No*	*M*	*SD*	*t*	*df*	*β*	*p*	*Decision*
Male	94	23.32	10.61	-1.423	178	.157	0.05	*ns*
Female	86	25.65	11.38					

Table 6 shows that male students (M = 23.32, SD = 10.61) had a non-significant lower mean score on mathematics achievement in than female students (M = 25.65, SD = 11.38), $t(178) = -1.423$, $p > .05$. Hence, the hypothesis that there is no significant difference between the mean achievement scores of male and female students examined with test items ordered from least difficult to most difficult is not rejected.

Research Hypothesis 3: There is no significant difference between the mean achievement scores of male and female students examined with test items from most difficult level to least difficult level.

Table 7: t-test Analysis Mean Achievement Scores of Male and Female Students Examined with Test Items Ordered from Most Difficult to Least Difficulty

Variables	*No*	*M*	*SD*	*t*	*β*	*p*	*Decision*
Male	94	20.66	10.42	-.664	178	.508	*ns*
Female	86	21.69	10.30				

Table 7 shows that male students (M = 20.66, SD = 10.42) had a non-significant lower mean score on mathematics achievement in than female students (M = 21.69, SD = 10.30), $t(178) = -664$, $p > .05$. Hence, the hypothesis that there is no significant difference between the mean achievement scores of male and female students examined with test items ordered from most difficult level to least difficult level.

Research Hypothesis 4: There is no significant difference between the mean achievement scores of male and female students examined with test items ordered in a randomized order.

Table 8: t-test Analysis Mean Achievement Scores of Male and Female Students Examined with Test Items Ordered in a Randomized Order

Variables	*No*	*M*	*SD*	*t*	*β*	*p*	*Decision*
Male	94	21.44	10.56	-1.134	178	.258	*ns*
Female	86	23.23	10.69				

Table 7 shows that male students (M = 21.44, SD = 10.56) had a non-significant lower mean score on mathematics achievement in than female students (M = 23.23, SD = 10.69), $t(178) = -1.134$, $p > .05$. Hence, the hypothesis that there is no significant difference between the mean achievement scores of male and female students examined with test items ordered in a randomized order.

Research Hypothesis 5: There is no interaction effect of testing modes and gender on senior secondary school students' academic achievement in mathematics.

Table 9: Tests of Between-Subjects Effects

Dependent Variable: score

Source	Type III *SS*	*df*	*MS*	*F*	*Sig.*	Partial Eta Squared
Corrected Model	1436.381[a]	5	287.276	2.529	.028	.023
Intercept	276829.515	1	276829.515	2437.295	.000	.820
Gender	397.804	1	397.804	3.502	.062	.007
Categories	1014.796	2	507.398	4.467	.012	.016
gender * categories	38.685	2	19.343	.170	.843	.001
Error	60652.056	534	113.581			
Total	338532.000	540				
Corrected Total	62088.437	539				

a. R Squared = .023 (Adjusted R Squared = .014)

Discussion

The findings of the study showed that the mean achievement scores of students when they were tested using three different modes of ordering test items, performance in mathematics is best when test items are arranged in ascending order of difficulty (Least difficult to most difficult order). The findings of this study aligns with the findings of the studies by Ollennu and Etsey (2015) and Opara and Uwah (2017), who respectively indicated, that test items sequencing, order or arrangement have a significant effect on the performance of students in mathematics as well as other subject areas. The reason is that arrangement of test item from least difficult to most difficult order enables test-taker to reinforce after getting a previous item correctly, increasing their level of interest and motivation to score more. The similarity observed in the result of the present study and those related to it could be due to similarities in the areas of content scope or perhaps the varied approaches employed in these studies. The hypotheses tested revealed that item ordering has a significant effect on male and female students' academic performance in mathematics with those who answered the easy-to difficult arrangement performing significantly higher than those who answered difficult-to easy arrangement and randomized order. While those who answered difficult-to-easy arrangement performed the least in the mathematics achievement test.

The findings of the study showed the mean achievement scores of male and female senior secondary school students examined with the least to difficult ordering test items format. Female students had higher mean score than male students. Similarly, the findings by Wilson (2019) revealed that those female students' who received the forward-sequential version scored significantly higher than their male counterparts. Balch (2017), also agreed that female students performed better than their male counterparts on least to difficult ordering test items format.

The findings of the study showed that in the mean achievement scores of male and female senior secondary school students examined with the most difficult to least difficult order of difficulty, Female students had higher mean score than male students. To support these findings, Stout and Wygal (2011), supported that, there was a significant difference in students' achievement based on test item order of most difficult to least difficult levels with female students scoring higher. The findings by Wilson (2019) also agreed that there are good results regarding female students' achievement and test item order from most difficult to least difficult levels for multiple choice exams in Mathematics.

The findings of the study showed that in the mean achievement scores of male and female senior secondary school students examined with the randomized ordering test items format, Female students had higher mean score than male students. The finding of this study is in consonance with the findings from the studies by Ollennu and Etsey (2015), who posited that female students performed better than their male counterparts in test items ordered in a randomized manner. Opara and Uwah (2017) also supported that students' academic achievement was below expectation in a randomized order of multiple choice questions.

The findings showed there is no interaction effect of testing modes and gender on senior secondary school students' academic achievement in mathematics. Ini, Etuk, and Valentine (2019) supported that test item arrangement has no significant interaction effect on students' academic performance of male and female students in mathematics with female students performing significantly higher than their male counterparts. Also the female students who answered difficult-to-easy arrangement performed the least in the mathematics achievement test. The result is not surprising since it is expected that going from the known to unknown will make the students be more interested in attempting other questions. This gives the students motivation and confidence after answering the first item correctly to continue, while those who took the difficult to easy format lose interest after exerting efforts and attempts having failed to answer the first few questions correctly.

Conclusion

Based on the findings of this study, it was concluded that ordering of test item plays a significant role in determining the academic performance of students in mathematics. When test items are arranged from simple to complex, students will score higher than in situations where the items are arranged from difficult to easy or when the random arrangement is in place. Students answering test items arranged from simple to complex can be motivated to put in more efforts having scored the first few items correctly. The same cannot be said of students who would have been bored after failing the first items under the difficult to easy or randomized test item arrangement.

Recommendations

Based on the findings of the study, the following recommendations were made:

1. For a better academic achievement in mathematics, the examination bodies WAEC, NECO and JAMB should adopt the method of arranging the test items from simple to complex order of difficulty.
2. Test items in mathematics examinations should be developed to cover the wide scope of course content or syllabus with focus on providing every learner an opportunity to perform well in the subject.
3. The randomization of mathematics test items during the examination should be totally abolished school authorities and examination bodies should rather focus their attention toward arranging items in ascending order of difficulty (easy to complex order).

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