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Item Sequencing and Academic Performance in Physics: A Quasi - Experimental Approach with Gender and Test Anxiety as Control Variables

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A B S T R A C T

Purpose: This study seeks to examine the effect of item sequencing on academic performance using the control variables of gender and test anxiety.

Methodology: A total of 245 participants were used for the study. Two instruments, the Test Anxiety Inventory (TAI) developed by Spielberger in 1980 and the Physics Achievement Test (PAT) developed by Ibout in 2022, were used for data collection. The collected data were analysed using means, standard deviations, and analysis of covariance (ANCOVA).

Findings: The result showed that gender significantly influences students' performance in physics. Emotional test anxiety has a significant effect on test performance in Physics and item sequencing has a significant effect on post-test performance in Physics. The result further showed that no interactive effect exists between item sequencing and the dimension of test anxiety assessed on the post-test score in Physics.

Conclusion: Based on the result that are obtained for this study, it is evident that gender has a significant effect on student performance in Physics. Test anxiety (emotional test anxiety has a n effect on students score in the post test vin Physics and items sequence influences students' performance a s well. More so, there is no interactive effect of gender, anxiety, and items sequencing on students' performance in Physics.

Keywords: *Test anxiety, emotional test anxiety, gender, item sequencing, performance in Physics, ANCOVA*

1. Introduction

The issue of academic performance among students in secondary school has received concern over the years among scholars, educators, and practising scientists. This is because even though the child is supposed to be completely moulded in terms of affective and psychomotor skills acquired in the educational system, cognitive measurement has been key in determining the achievement of the learner after being exposed to instructional content (Efklides, 2009; Kahveci, 2015). Key among the areas that the learner is expected to do well, especially those that are science inclined, is in physics. Academic performance is the standing of the students after a particular exposure to instructional content. These standings are expressed in terms of the grades obtained when provided with either pen and paper tests, practical work, or oral examination, among others. The students' performance is often measured through assignments, classwork, laboratory practicals, and terminal examinations, among others (Daniëls & Schouten, 1970; Mallory, 2004).

Physics is a branch of science that deals with the study of matter. Physics is one of the science subjects that is considered very important in that it provides the learner with the opportunity to apply what is learned in everyday life. This discipline is learned through hands-on experience, and students are expected to get the required experience that will make them valuable to themselves and to society at large. This knowledge will inversely help them to explore, discover, and provide practical solutions to existing problems in society. This is why developing countries like the United States of America, the United Kingdom, and even China emphasise the development of science-based skills among students so as to provide opportunity for discovery, provide innovation in areas of need, and make the world a better place (Brunsell & Horejsi, 2011; Sungur Gül & Marulcu, 2014).

Physics is one of the important subjects that are offered to science students from Senior Secondary Class 1 (SS1) to SS3 in Nigeria. It is considered an experimentally based science subject where observation of natural objects is carried out in the laboratory in an attempt to explain certain laws and principles. In Nigeria, physics, one of the core science subjects, is offered to students at the SSS level of education (Aina & Akintunde, 2013; Josiah, 2011; Nkechi, 2020). The study of physics has helped come up with laws, theories, and principles that scientists have used over the years to improve the lives of men and the socioeconomic development of society. More so, the subject of physics is wide in scope in that it is applied in health, i.e., the development of instruments used in modern health practises. For example, the chemist needs physics for studies of molecular structure. The engineer studies physics to understand the intricacies of flat-screen televisions. The climatologist studies physics to understand how the ozone layer is affected by human activities, among others (Josiah, 2011). Given this background knowledge of physics, its importance cannot be overemphasised. Coffie et al. (2020) opined that if the foundation of students' knowledge in physics is strong, it will provide them with a foundation that will facilitate accuracy, precision, and exactitude when dealing with new problems. The performance in physics will provide an opportunity for them to function well scientifically (Coffie et al., 2020).

There have been a series of reports in national dailies (Nigeria Punch, 2021), West African Examination Council bodies (2022), and the National Examination Council (2022) that students' performance in physics is discouraging. For instance, in Cross River State, Akwa Ibom State, and River State (South-South Nigeria), emerging reports about students' performance in physics show that something needs to be done to improve the current abysmal failure in physics (Dami et al., 2019). Similarly, the report from Kaduna, Kogi, and Nasarawa states (North Central, Nigeria) indicates that students' performance in physics is poor (Aina & Akintunde, 2013). More so, in Anambra, Imo, and Abia states (south-eastern Nigeria), reports showed that the performance there is still abysmal (Stephen, 2010). Therefore, studying the statistics of students' performance in Physics in Nigeria for the past ten years showed that student's performance in physics have been up and down. This showed that students' performance in Physics is not just a zonal problem but a national type that should be addressed immediately.

These abysmal failures have triggered worries among stakeholders. The worries stem from the fact that, outside of being a requisite for admission to any science-based subject like space science, medicine, data science, computer science, pharmacy, and engineering, among others (Abuh, 2021), it is useful for the scientific and technological development of any nation and helps us understand the physical world (Baran et al., 2016; Guo et al., 2015). The spate of failures in figures has even raised the attention of many, including the national examination bodies in Nigeria. Nigeria Examination Council (NECO) and West African Examination Council (WAEC). Tinedi, et al (2018) noted that, despite its usefulness, physics is a difficult and

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challenging subject to learn, and that many students, because of the quantitative and deductive nature of the subject, find it difficult to cope with the demands of assessment. Researchers and science educators have identified various factors that influence students' performance in secondary schools (Tinedi et al., 2018).

The failure in physics have been attributed to so many factors ranging from home factors, political, economic and social factors (Adeyemi & Adeyemi, 2014; Iroegbu, 2013; Owan, 2022). Other factors include eak mathematics background, poor teaching method(), emotional instability, poor teacher preparation, lack of personal confidence, family support deficiency, conceptual mindreading,poor teacher qualification, temperament, inadequate practical facilities, lack of standard laboratory, poor attitude to assessment procedures (Adeyemi & Adeyemi, 2014), problems of school management, quality assurance practices, students' personality, political, economic, home and psycho-social factors (Bassey et al., 2019; Owan et al., 2018), poor school community relations (Owan, 2019; Robert & Owan, 2019) among others. In fact, Mekonnen (2014) summarized that students failure in physics is caused by home factors, parental income, educational qualification, occupation, previous interest in science; personal factors: age, sex, attitude tri the subject, anxiety, motivation among others and institutional factors: school facilities, school climate, school discipline, teachers preparedness, teachers service quality among others (Longobardi et al., 2016; Prino et al., 2016)

Several efforts have been done to determine ways to improve pupils' performance. Science teachers, for example, have received preferential treatment in schools; improved work pay (Lawrenz et al., 2009); promotion and provision of welfare packages (Vahedi & Yari, 2014). Despite the fact that all of these issues have been discovered and substantial efforts have been made to improve student performance, the problem persists. The researchers also believe that test item arrangement, when controlled for gender and performance anxiety, may influence students' physics performance. This context has provided the push for this study to be conducted. Prior studies provided a platform for further research to be carried out. That is, given the multitude of literature that is available in respect to the effect of item positioning on academic performance, many results align with the position that test order or sequencing significantly impacts students' performance, while other studies noted that there is no significant effect of item sequencing on performance. This shows clearly that there is disagreement among researchers about findings that warrant further studies in order to present a contribution to knowledge in the Nigeria context. This is because, given the utilisation of these item patterns in most Nigerian examination practises, it will be pertinent to validate these students in order to provide recommendations not just to the examination bodies but also to the teachers in the classroom sector on how to improve their assessment practises in Nigeria.

Research questions

The following research questions were raised for the study.

i. How does students' post-performance in Physics differ when test items are sequenced or positioned? (Easy-to-hard, hard-to-easy and arranged at random)?.

ii. How do male students differ from female students in terms of their pre-test and post-performance in Physic test items arranged in three formats (easy-to-hard, hard-to-easy and arranged at random)?

iii. What is the influence of test anxiety assessed from emotions and worries on students' post-performance in Physic test items arranged in three formats (easy-to-hard, hard-to-easy and arranged at random)?

Hypotheses

The hypotheses were stated in the null form as shown below.

i. There is no significant effect of test item sequencing on academic post-performance in Physics with pre-test serving as a covariate.

ii. There is no significant effect of test anxiety on academic post-performance in Physics with pre-test serving as a covariate.

iii. There is no significant effect of item sequencing on academic post-performance in Physics with pre-test serving as a covariate.

iv. There is no interactive effect of item sequencing and test anxiety on academic post-performance in Physics with pre-test serving as a covariate.

2. Methods and Materials

2.1. Study Design and Participants

The study adopted a pre-post-test randomised parallel control design with three groups. Two groups were the experimental group (Group A and B control design with three groups. Two groups were the experimental group (Group A and B), while one group (Group C) was the control group. The total number of respondents that were used in this study is 1456 senior secondary school students offering physics and are distributed among 21 schools in Calabar

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Metropolis, Cross River State, Nigeria. The selection involved a rigorous process in that certain criteria were used for the selection of the schools and students that were used in the study. First, the school must have existed for 10 years. Secondly, the school must have qualified physics teachers with a minimum of 5 years' experience. Thirdly, the school must have written a national examination at least five times. Finally, the school must have a standard laboratory for experiments. These criteria reduced the study school population to eleven (11) with a total of 465 science students. A simple random method was used in determining the schools that would be selected for the study. This was done through the balloting method, and 5 schools, which represent 50% of the total number of schools, were selected from a total of 245 respondents (132 males for 54% and 113 females for 56%). The researcher sets the basis for grouping using the pre-test score, which contains items from a test that were randomly arranged. The researchers ensured that all the test papers were arranged to be useful in the assignment process. To obtain a random assignment of subjects in equivalent groups, aromatic progression with a common difference method was used. Here, those who have serial numbers of 1, 4, 7, 10, were in Group A (Experimental Group A), those with serial numbers 3, 6, 9, and 12 were in Group B (Experimental Group Bas the control group. The total number of respondents that were used in this study is 1456 senior secondary school students offering physics and are distributed among 21 schools in Calabar Metropolis, Cross River State, Nigeria. The selection involved a rigorous process in that certain criteria were used for the selection of the schools and students that were used in the study. First, the school must have existed for 10 years. Secondly, the school must have qualified physics teachers with a minimum of 5 years' experience. Thirdly, the school must have written a national examination at least five times. Finally, the school must have a standard laboratory for experiments. These criteria reduced the study school population to eleven (11) with a total of 465 science students. A simple random method was used in determining the schools that would be selected for the study. This was done through the balloting method, and 5 schools, which represent 50% of the total number of schools, were selected from a total of 245 respondents (132 males for 54% and 113 females for 56%). The researcher sets the basis for grouping using the pre-test score, which contains items from a test that were randomly arranged. The researchers ensured that all the test papers were arranged to be useful in the assignment process. To obtain a random assignment of subjects in equivalent groups, aromatic progression with a common difference method was used. Here, those who have serial numbers of 1, 4, 7, 10, were in Group A (Experimental Group A), those with serial numbers 3, 6, 9, and 12 were in Group B (Experimental Group B), and those with serial numbers 2, 5, 8, and 11 were in Experimental Group C (Control Group). Thus, applying the arithmetic progression formula for determining the nth term, (245 = a+(n-1)d), given the first terms as 1, 2, and 3, and the common difference as 3, a total of 81 respondents were assigned to EG1, 82 respondents were assigned to EG2, and 82 respondents were assigned to EG3.

2.2. Measures

Two instruments were used for data collection. These were the Test Anxiety Inventory (TAI) and the Physics Achievement Test (PAT). The TAI was developed by Spielberger in 1980 and has verifiable psychometric properties. The instrument has a total of twenty (20) items and is divided into three groups: Test Anxiety Inventory Total (TAI-T), Test Anxiety Worry (TAI-W), and Test Anxiety Emotional (TAI-E). The test was developed on a four-point modified Likert scale of Likert response options. These options range from nerve to almost away, with a strong pattern of never (1-) and almost never (4-). The degree of consistency of the scale as originally established was 0.96 for TAI-T, 0.91 for TAI-W, and 0.91 for TAI-E. These coefficients, as established by Spielberger (1980), were not established in Nigeria; thus, the researchers had to verify these psychometric attributes in the Nigerian context. A reliability estimate was carried out using 50 students who were not part of the study. The coefficients of the subscales (.87 for TAI-T, 0.83 for TAI-W, and 0.88 for TAI-E), even though not as high as originally established, showed that the instrument can function well in this area and can be used for the study.

The Physics Achievement Test (PAT) was developed and validated by Ibout (2022). The PAT was made up of 50 items with four options. Response of A-D Face, content, and construct validity were already ascertained by the researcher (see Ibout, 2022). The content validity was carried out using a Table of Specifications with five content areas such as properties of waves (15%), radioactivity (10%), energy and society (20%), electric fields (25%), basic electronics (20%), and electromagnetism (10%), with their respective percentages or weights in brackets. The items index was accessed, and the coefficients for p-values ranged from 0.25 to 0.70. Items whose p-values were below or above these

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values were seen as too easy or too difficult to be considered for the test. With the knowledge of the p-values, the researchers then arranged the items into three formats. Format A was easy-to-difficult (EAD) items; format B was items arranged from difficult-to-easy (DEA) items; and format C was items that were randomly arranged (RAN).

The reliability of each of the formats was ascertained using the equivalent form reliability method. The coefficient values for each format are: format A (easy-to-difficult = 0.77, difficult-to-easy = 0.89, and random format = 0.79). The instrument for this study was adopted because of its sound psychometric properties, and the respondents that were used in the study were recently used in another study.

2.3. Data Analysis

The data collection was carried out in phases. First, the researchers administered the pre-test test of the PAT to all the respondents together with the TAI instrument in the three groups. The RAN instrument was used as the control measure. The data coaction was done after the researcher have collected ethical clearance in line with best practices of research from the institute of research and quality assurance, University of Calabar, Calabar (See code No: UIE/QAD/02/0678). This researcher appropriately obtained the informed consent of the respondents and explained the rationale of the study to the students. The students were also informed that the data that they are to provide will be used to publish a paper whose recommendation may be valuable for their future academics As a form of compensation, each of the respondents was given N300 to reinforce their participation in the study. Those who did not consent to the study were dropped. Out of the 245 students that were selected for the study, 2 were dropped, and these were those in the random and difficult-to-teach format. More so, the students were promised that the data would be protected from public invasion, and this was done by the lead researcher by protecting the data with a password that only the analyst has access to. After the pre-test was administered, the researchers allowed the school teachers to teach under supervision according to the weekly schedules that were drawn for the exercise. The researchers waited for four weeks before administering the post-test. The use of four weeks was to partially eliminate test-wiseness that may constitute a treat if administered within a very short interval. Data collection was done with the initial serial numbers that were given to each script to facilitate easy coding. Each respondent's data was entered accordingly, and the data collected were analysed using descriptive statistics (means and standard deviation) and an analysis of covariance (ANCOVA) using SPSS version 20.

3. Findings and Results

Research question one: How does students' post-performance in Physics differ when test items are sequenced or positioned (Easy-to-hard, hard-to-easy and arranged at random)?

The result in Table 1 revealed that the mean score of students in post-performance is higher when higher when items are arranged from easy-to-difficult ($\bar{X}$ =27.95, SD=1.51) more than when items are arranged from difficult -to-easy ($\bar{X}$ =20.59, S.D=2.13) and when arranged on random format ($\bar{X}$ =15.81, SD=2.46). This shows that students' performance differs according to test items style, largely, when arranged from east to difficult.

Table 1

Means and standard deviation of post-performance in Physics based in items sequencing.

Items format	N	Mean	Std. Error	Std Dev
Post-ETD	81	27.9506	.16750	1.50749
Post-DE	81	20.5926	.23686	2.13177
Post-Rand	81	15.8148	.27279	2.45515
Total	243	21.4627	.34704	5.40974

ETD=Easy to Difficult Test, DE=Difficult to Easy test and Rand=Random format

Research question two: How do male students differ from female students in terms of their pre-test and post-performance in Physic test items arranged in three formats (easy-to-hard, hard-to-easy and arranged at random)?

To answer this question, descriptive statistics were used, and the result is presented in Table 2.

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Table 2

Means and standard deviation of post-performance in Physics based on gender.

Items format	Gender	N	Mean	Std. Dev	Std. Error
PreTest score	Males	132	9.6288	1.58911	.13831
	Females	111	9.4955	1.32029	.12532
Post Test score	Males	132	24.8409	4.28886	.37330
	Females	111	17.4234	3.50986	.33314

Research question three: What is the influence of test anxiety assessed from emotions and worries on students' post-performance in Physic test items arranged in three formats (easy-to-hard, hard-to-easy and arranged at random)?

To answer this research question, the result is presented in Table 3. The result in Table 3 revealed that for the worry dimensions, those with low worries scored very high, in Physic Test TA-W (X=27.44, SD=2.44). at Moderate level of worries, the students' performance increased, TA-W (X=18.34, SD=3.570) and at high levels of worries, the performance of students was low, TA-W(X=17.78, SD=3.086). In the Emotion dimension of Test anxiety, those with low emotional issues scored very high, TA-E (X=27.95, SD=1.507). At Moderate level of emotional issues, the students' performance increased, TA-E (X=18.21, SD=3.71) and at high levels of emotion, the performance of students was low, TA-E(X=18.18, SD=2.802). in the aggregate of the test anxiety measures, the result further showed that students with low test anxiety scored very high in Physic Test (X=27.67, SD=2.10), those with moderate level of anxiety increased (X=18.85, SD=3.71) and the those with high level of test anxiety perform low (X=17.71, SD=2.80). the result generally showed that students with high level of anxiety perform very low, those with moderate level has an average performance while those with low level of test anxiety performs very high.

Table 3

Mean and standard deviation of Post-test performance in Physic based on levels of test anxiety.

Worry	N	Mean	Std. Dev	Std. Error
Low	88	27.3636	2.44094	.26021
Moderate	86	18.3488	3.57036	.38500
High	69	17.7826	3.08635	.37155
Total	243	21.4527	5.40974	.34704
Emotion	N	Mean	Std. Dev	Std. Error
Low	81	27.9506	1.50749	.16750
Moderate	87	18.2184	3.71804	.39862
High	75	18.1867	2.80296	.32366
Total	243	21.4527	5.40974	.34704
Total	N	Mean	Std. Dev	Std. Error
Low	82	27.6707	2.12018	.23414
Moderate	80	18.8625	3.97697	.44464
High	81	17.7160	2.80729	.31192
Total	243	21.4527	5.40974	.34704

Hypothesis 1: There is no significant effect of test item sequencing on academic post-performance in Physics with pre-test serving as a covariate.

To test this hypothesis b, ordinarily, one will have used the independent t-test but there will no measures for controlling for any pre-existing differences existing among the groups. Thus, the Analysis of Covariance (ANCOVA)

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was used, and the result showed that (F=221.240, p<.05). Since p(.000) is less than p(.05), the null hypothesis that stated that there is no significant effect of test item sequencing on academic post-performance in Physics with pre-test serving as a covariate was rejected. Thus, the alternate hypothesis was upheld. Similarly, the result further showed that the variation in the student's post-performance in Physics could be accounted by 48.0% contribution of the differences among the male and female students (see Table 2).

Table 4

Analysis of covariance (ANCOVA) on the effect of gender on post-performance in Physics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	3430.525[a]	2	1715.263	112.732	.000	.484
Intercept	3653.122	1	3653.122	240.095	.000	.500
Pre-Test Score	113.078	1	113.078	7.432	.007	.030
Gender	3366.241	1	3366.241	221.240*	.000	.480
Error	3651.680	240	15.215			
Total	118915.000	243				
Corrected Total	7082.206	242				
a. R Squared =.484 (Adjusted R Squared =.480)						

*= significant at 0.05 level

Hypothesis 2: There is no significant effect of test anxiety on academic post-performance in Physics with pre-test serving as a covariate.

To test this hypothesis, the traditional one-way analysis of variance will have been used. however, since the study seek to control for the pre-existing differences among the groups using the pre-test, the analysis of covariance (ANCOVA) is used, and the results as presented in Table 6. The result in Table 6 showed that between-subjects' effect as presented in Table 6, TA-W (Test Anxiety Worry) has no significant main effect on performance in Physics F(2, 229)=1.599, p=.201 >.05. For level of emotions dimension F(2, 229)=14.497, p=.000, <.05, this implies that that there is a significant effect of level of emotion as a test anxiety component(TA-E) on performance in Physics but for TA-T(Test anxiety Total), there is no main significant effect of TA-T on performance in Physics F(2,229)=1.620, p=.200, >.05. This implies that the null hypothesis was retained for TA- W and TA-T but rejected for TA-T. however, the result further showed that the test anxiety construct can contribute 73.2% variation in the performance of students in Physics. The Scheffe's post hoc test was carried to determine the mean differences of the students' performance based in emotional components of the test anxiety (See Table 6). The result revealed that the mean value (X=27.95) of students with low emotional test anxiety differ from the mean value (X=18.18) of students with high emotional anxiety and the mean value of students with moderate emotional anxiety (X=18.21). This implies that students with low emotional test anxiety perform better in Physics compared to other students with moderate and high emotional test anxiety.

Table 5

Summary of analysis of Covariance Result (ANCOVA) on the effect of test anxiety on post test score in Physics.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	5288.711[a]	13	406.824	51.945	.000	.747
Intercept	1972.896	1	1972.896	251.907	.000	.524
Pretest score	.054	1	.054	.007	.934	.000
Post test worry (Test Anxiety)	25.051	2	12.525	1.599	.204	.014
Post-Emotion Test Anxiety)	227.080	2	113.540	14.497*	.000	.112
Post-Total Test Anxiety)	25.377	2	12.688	1.620	.200	.014
Error	1793.494	229	7.832			
Total	118915.000	243				
Corrected Total	7082.206	242				
a. R Squared =.747 (Adjusted R Squared =.732)						

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Table 6

Scheffe's post hoc analysis of significant pair-wise multiple comparisons of test anxiety on performance in Physics.

Post-Emotional anxiety	(J) Post-Emotional anxiety	Mean Difference (I-J)	Std. Error	Sig.
Low	Moderate	9.7322*	.44034	.000
	High	9.7640*	.45701	.000
Moderate	Low	-9.7322*	.44034	.000
	High	.0317	.44937	.998
High	Low	-9.7640*	.45701	.000
	Moderate	-.0317	.44937	.998

The error term is Mean Square (Error) = 8.133.

*. The mean difference is significant at the.05 level.

Hypothesis 3: There is no significant effect of item sequencing on academic post-performance in Physics with pre-test serving as a covariate.

To test this hypothesis, analysis of covariance (ANCOVA) technique was used, and the result is presented in Table 8. The result in Table 8 showed that F ((2,239)= 697.235, p=.000, <.05. Since p(.000) is less than p(.05), this implies that there is a significant main effect of item sequencing on Post test performance in Physics among students. Hence, the null hypothesis is rejected and the alternate hypothesis retained. Similarly, the result showed that the variation in the students performance in Physics could be explained using 85.3% contribution of item sequencing. A post hoc test was carried out using Scheffes test and the result is presented in Table 8. The result in Table 9 showed that the mean value of students in group of Easy-to Difficult (EAD) (X=27.95) is different from those in group of Difficult -to-Easy (DEA) (X=20.59) and those in a group were random test items were administered (X=15.81). this implies that students exposed to easy to difficult groups performed better than those in other groups.

Table 7

Summary of analysis of covariance (ANCOVA)result on the effect of item sequencing on post-test performance in Physics

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6055.383[a]	3	2018.461	469.811	.000	.855
Intercept	2624.800	1	2624.800	610.940	.000	.719
Pretest score	.757	1	.757	.176	.675	.001
Item sequencing	5991.099	2	2995.550	697.235*	.000	.854
Error	1026.823	239	4.296			
Total	118915.000	243				
Corrected Total	7082.206	242				

a. R Squared =.855 (Adjusted R Squared =.853)

*= significant at.05 level

Table 8

Scheffe's post hoc analysis of significant pair-wise multiple comparisons of item sequencing on performance in Physics.

(I) Experimental groups	(J) Experimental groups	Mean Difference (I-J)	Std. Error	Sig.
Experimental (ETD)	Experimental (DTE)	-4.77778*	.32514	.000
	Random (Control group)	-12.13580*	.32514	.000
Experimental (DTE)	Experimental (ETD)	4.77778*	.32514	.000
	Random (Control group)	-7.35802*	.32514	.000
Random (Control group)	Experimental (ETD)	12.13580*	.32514	.000
	Experimental (DTE)	7.35802*	.32514	.000

*. The mean difference is significant at the 0.05 level.

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Hypothesis 4: There is no interactive effect of item sequencing and test anxiety on academic post-performance in Physics with pre-test serving as a covariate.

To test this hypothesis, analysis of covariance was used, and the result is presented in Table 10. The result in Table 10 showed that for the test of between subject of item sequencing on post-test performance in Physics, there is a significant main effect on performance in Physics, F(1,224)=119.699, p(.000), <.05. For Post test score on test anxiety for worries and performance in Physics, F(2, 224)= 2.249, p(.108), For Post test score on test anxiety for emotion and performance in Physics, F(1 224)=.025, p(.108) and for main effect of Post test score on test anxiety for total and performance in Physics, F(2, 224)=..753 p(.472), >.05. This implies that there is no main effect of post test score on worries, emotional and total test anxiety academic performance in Physics among students. Similarly, the results also showed that there is no interactive effect of item sequencing and TA-W (F=.051, p>.05). for interactive effect of item sequencing and TA-E, there is no significant effect (F=.902, p>.05) and for interactive effect of item sequencing and TA-T (F=1.316, p>.05). Since p(.822,.343 and.252) is greater than p(.05), this implies that the hypothesis for the interactive effect of item sequencing and test anxiety on post score performance in Physic is retained but rejected for the main effect of item sequencing on academic performance.

Table 9

Summary of the Analysis of Covariance (ANCOVA) result of the between-subject effects of main and interactive effects of test anxiety and item sequencing on post-test performance in physics.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	6223.445[a]	18	345.747	90.185	.000	.879
Intercept	19142.267	1	19142.267	4993.085	.000	.957
Item sequencing	458.895	1	458.895	119.699	.000	.348
Post test on TA-W	17.244	2	8.622	2.249	.108	.020
Post test on TA-E	.097	1	.097	.025	.874	.000
Post test on TA-T	5.770	2	2.885	.753	.472	.007
Item sequencing * TA-W	.194	1	.194	.051	.822	.000
Item sequencing * TA-E	3.457	1	3.457	.902	.343	.004
Item sequencing * TA-T	5.047	1	5.047	1.316	.252	.006
Error	858.761	224	3.834			
Total	118915.000	243				
Corrected Total	7082.206	242				

a.R Squared =.879 (Adjusted R Squared =.869). TA-W= Test Anxiety (Worry), TA-E= Test Anxiety (Emotion), TA-T=Test Anxiety (Total)

4. Discussion and Conclusion

The result showed that even though the male and female students' post-performance in Physics in the Pre-test score were not different, but they differ significantly on the post test score. This could be attributed to the very nature of the female folks that research have already established that they hardy do well on quantitative measures. The findings align with previous studies that have been carried out on the effect on gender on students' performance in physics (Guiso et al., 2008; Hazari et al., 2007) that have argued that male students perform better than the female students in physics. The differences in the scores of the students after various tests are presented may be due to the fact that the level of interest, the relevance of the subject to the future career of the learner, and the rationale behind the exercise may be perceived differently by the students. Other researchers have also explained that the differences in students' performance based on gender could be due to other factors other than the treatment or the attributes of the student. According to Salikutluk & Heyne (2017), most students are depressed at home, and such psychological disturbances may distract them from the real purpose of what they are supposed to do in the class (Salikutluk & Heyne, 2017). When such factors are not completely accounted for in the study, there is every tendency that the effect of the treatment may not completely explain the differences.

The result also showed that students emotional test anxiety influenced their post-test score in physics. The results affirm the studies by previous researchers who have shown that test anxiety influences the test outcome of students (Bandelow & Michaelis, 2015; DordiNejad et al., 2011). This is because most students are always very

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worried, and this makes them so emotional that they tend to lose concentration on details that would have helped them pass adequately. The emotional issues that they have about the test, characterised by panic, nervousness, and loss of self-confidence, often result in the students writing what they ought not to have written in the test. The questions that they may have answered easily when items were arranged in a particular format will be scored wrongly if the same format is presented to them. More so, the phobia attached to numbers makes them so afraid that they lose the self-concept, self-efficacy, and attitude required to do well in the test. The students end up with scores lower than they ought to be, as shown in the results presented in this study. Similarly, Eysenck et al. (2007) noted that students who are always anxious about their performance deflate their performing power as so many external factors come into play and sometimes may even avoid trying anything in the examination on the perception that the questions are difficult and they may not pass even if they attempt anything (Eysenck et al., 2007). More so, the findings of the study collaborate with those of Huberty (2012), who noted that test anxiety affects the quality of performance of students in any examination that is mathematically inclined (Huberty, 2009).

The findings of the study did not show any pre-existing difference among the three groups (EAD, DEA, and random group) on their performance in physics based on item sequence. This is natural since it is required for the researcher to first determine that the groups are equal before the treatment or manipulation of the variables will be carried out. However, when the post-test was administered, the result changed. That is, students who were presented with the items arranged from easy-to-difficult performed better than students who were presented with items arranged from difficult-to-easy and those who were presented with random items. This aligns with the earlier position of Guttman (1944) that test items should be arranged in that form (easy to difficult) or in ascending order. That where items are arranged in that form, it will help to identify where the learner's strengths are and what needs to be done to improve the students' performance.The findings of the study align with previous studies that have been carried out on the effect of item sequencing on performance score (Hauck et al., 2017; Soureshjani, 2011). The reasons for this result could simply be due to the fact that when items are arranged in this order (easy-to-difficult), it could trigger the development of confidence to approach the next item. That is, the students build confidence as they approach the items and gradually get them right. More so, Owan (2020) further noted that the rationale for the result could be due to the fact that the correct performance on one item reignites interest in the learner to perform more (Owan, 2020). What is shocking in the study is the result that items arranged in descending order (difficult-to-easy) format have a higher response rate from students than those arranged in random format. This contradicts earlier studies that have seen that arrangement as the most distracting method of item arrangement. Many scholars noted that students often resort to guessing as they perceive the items as difficult and may not even want to attempt the answering of the items again (Opara & Uwah, 2017).

The result further showed that an interactive effect between test anxiety and item sequencing does not significantly influence post-test performance in Physics. The research output contradicts previous studies that show a significant interactive effect of test anxiety and item sequencing on academic performance (Owan, 2020). The result could be due to the fact that, although it has been established that students emotional test anxiety when taken as a single variable influences their performance, However, when it is controlled for using the pre-test score, there is no significant effect on item arrangement. The findings align with previous studies (Yousefi et al., 2010) that found that test anxiety, when taken interactively with item order, has no effect on student performance. The student's level of worries may not necessarily be because of the way the test items are arranged but on other factors that are impeding on the stability of the students. This study is germane in this area, as previous efforts have not been made to carry out such studies using these statistical techniques. It will be necessary for this study to be carried out in the area to validate this finding.

The study like every other study has some limitation even though that does not invalidate the findings of this study. First, the study involved a limited number of students and this may affect the generalization of the findings to a larger population. Further studies can involve a larger sample so as to provide a basis for generalising the findings and informed policy and decision about strategies of enhancing performance in physics. More so, some of the students may have become test wised in the cause of administering same test multiple times even though the format was change. Researchers may carry out a longitudinal study that will take a longer time before administering another format of the test so as to cancel practice effect on the performance of the students.

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Based on the result that are obtained for this study, it is evident that gender has a significant effect on student performance in Physics. Test anxiety (emotional test anxiety has a n effect on students score in the post test vin Physics and items sequence influences students' performance a s well. More so, there is no interactive effect of gender, anxiety, and items sequencing on students' performance in Physics. The implication is that, given the roe of gender on students' performance, the teacher must ensure that the female students are placed appropriately in the class and attention that is unique be paced on them to help them improve their scores in Physics examination. Similarly, environment that will reduce the level of anxiety among the students is created so that students will be confident of themselves to respond appropriately to whatever stimuli that is presented to them. Test experts, teachers and school assessors must place premium on items arrangement in the assessment practices in school to help teacher not only to teach but identify area of weaknesses and strength of the students. From the findings and conclusion of the study, the following recommendations were made. Based on the conclusion reached in this study, the following recommendations were made:

i. The psychological state of students should be worked on by counsellors and psychologist to reduce personal- social, educational and vocational issues that triggers anxiety among students in schools so as to build confidence in themselves.

ii. The mentality that has been built in female folks, executed by teachers and other policy makers that female students do not do well in quantitative should be de programmed through various motivational packages to rebuild confidence in the female folks to compete favourably with the male students in class.

iii. Test experts, teachers and measurement experts should ensure that assessment practices in school follow the option of item arrangements that will progress from simple to complex. This is not by any means seen as measure of combating examination malpractice even though is part of it, but other measure should be put in pace

Authors' Contributions

In this article, the corresponding author was responsible for the intervention implementation, data analysis, and manuscript writing, while the other authors supervised the data analysis and manuscript writing.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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