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Gender Differentials in the Use of Flipped Instructional Strategy in Enhancing Performance and Retention among Low-Achieving Secondary School Physics Students in Zaria, Kaduna State, Nigeria

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ABSTRACT

This study examined the Effect of Flipped-Instructional-Strategy on Retention and Performance in Wave Concept among Low-Achieving Secondary School Physics Students in Zaria, Kaduna State, Nigeria. The study employed quasi-experimental involving pretest and posttest control group design. The population of the study comprises all public co-educational Senior Secondary School II (SS2) Physics Students in Zaria Education Zone of Kaduna State. In this study, available data revealed that there were 3357 SSII students (2184 males and 1173 females) offering Physics in the Zone. The sample of the study comprised 115 SS II Physics low achievers (76 males and 39 females) from two (2) randomly selected public co-educational senior secondary schools in Zaria Education Zone. The study was guided by two objectives with their corresponding research questions and null hypotheses. A validated instrument namely; Wave concept Performance Test (WCPT) was used to collect data. The reliability coefficient of WCPT was obtained to be 0.76 using Pearson Product Moment Correlation Coefficient (PPMCC). The data collected was subjected to analyses at two different levels via descriptive and inferential statistics. The descriptive statistics of mean and standard deviation were used to answer the research questions raised. While at the inferential level, independent sample t-test was used to test the null hypotheses formulated at the significance level of $\alpha \leq 0.05$. The inferential statistics level forms the basis to permit decision on whether to reject or retain the null hypotheses after being tested. Results of findings revealed that, there is no significant differences between the performance means scores of male and female low achieving secondary school students taught wave concept using Flipped Instructional Strategy ($p=0.62$). There is no significant difference between the retention ability male and female secondary school students taught wave concept using FIS ($p=0.76$). Based on the findings of the study, it was recommended among others, that Physics teachers should be encouraged through training and retraining programmes by state Ministry of Education and professional bodies such as STAN on the use of FIS in teaching Physics concept like wave, as it enhanced students' retention ability and academic performance as it was found to be gender friendly.

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INTRODUCTION

Science is the foundation upon which the bulk of present-day technological breakthrough is built. These days, developing nations all over the world including Nigeria are striving hard to develop scientifically and

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technologically since the world is becoming scientific and proper functioning of lives depend greatly on science. Its relevance as a requirement for technological development of a nation cannot be underrated. Bell (2015), viewed science as an integral part of human society. Its impact is felt in every way of human life so much that, it is intricately linked with a nation's development. Science as a field of study has done a lot for mankind. For instance, life has become easier for man as a result of the advancement in science. Through science, man has been able to understand his environment. For example, by drastically changing our means of communication, the way we work, our housing, clothes and food, our methods of transportation, and indeed even the length and quality of life itself, science has generated changes in the moral values and basic philosophies of mankind. It is for these reasons that science is taught in Nigeria's senior secondary schools as recognised by the West African Examinations Council (WAEC) and the National Examinations Council (NECO) in their Chief Examiner's Reports as Biology, Chemistry and Physics.

Physics is one of the science subjects taught in Nigeria's senior secondary schools. It deals with the study of the behaviour of matter in relation to energy. According to Egoyan (2017), Physics is the most fundamental and all-inclusive of sciences and as science is considered a veritable tool widely recognized as being of great importance for the development of the economic well-being of any nation, therefore, the knowledge of Physics cannot be overemphasized. Moreover, the role of the knowledge of Physics in technological advancement such as in electronic and computer technologies made it an enviable and attention-seeking subject within the science domain. As far back as 1984, Wenham, Dorlin, Snell and Taylor (1984) asserted that, Physics is and will remain the fundamental science subject that has contributed significantly to the technological development of the world at large. Almost four decades after, this assertion according to Ballah and Ugwumba, (2015) has not changed.

Despite the relevance of Physics in technological advancement and the steps taken by government of Nigeria to improve teaching and learning of the subject in schools, students' performance in the subject as reported by Amusa, Ayanwale, Oladejo and Ayedun (2022), had perpetually been poor. In addition, the poor academic performance in SSCE Physics has become a trend in the WAEC results of Nigerian candidates. The WAEC Chief Examiner's Report (2019) revealed low achievement of students in Physics specifically in Wave concept. In a study conducted by Onyewuchi, Adewusi, Okebukola, Odekeye, Gbeleyi and Awaah (2021), Wave concept has been considered by students as abstract and difficult to understand which contributed to their poor performance.

Moreover, a preliminary survey of students' terminal achievement records of coeducational schools in Zaria Education Zone for 2021/2022 SS II Physics students first and second terms results, revealed that out of 2941 SS II students who sat for the first term examination, only 1326 students representing 45.09% scored the pass mark of 50% and above, while 1615 students representing 54.91% failed with scores below 50%. Also, in the second term of the same session, 1175 students representing 39.95% scored 50% and above out of 2941 SS II Physics students who participated in the examinations, while 1766 students representing 60.05% failed to score up to the benchmark of 50%. In view of these statistical data reviewed, it is evident that students' achievement in Physics has not been encouraging.

Regrettably, the percentage of students who achieved below average in their academic pursuit is on the increase. This trendy movement towards the direction of low achievement in Physics learning could likely suggest that tomorrow's Physics education practitioners may be bereft of techno-scientific competencies required for future development and the applications of Physics in achieving the goals of Physics education (FME, 2014). The achievement momentum of students in the classroom teaching and learning of Physics varies according to certain factors such as; students' background,

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developmental level in terms of chronological and cognitive maturity. Such variations lead to "labeling" students as "talented" generalized as high-ability group and the under-achievers (limited learners), dropout, all being descriptions of weak and low ability group.

Low achievement according to Mulanayi (2024), is due to inability of classroom instructional experience to stimulate the innate potentials of learners. Packiam, Selvi, and Fathima (2020) described low achievers as those students who scored an average less than 50per cent marks consecutively over two years in their previous examinations. Magableh and Abdullah (2021) viewed low achievers as those students whose ability is not quite so limited but nevertheless who have more difficulty in learning than average students. The students' attainment is not in tune with their capability but below the expected level of achievement. Low achievers in this study are regarded as students who score below average in three consecutive Physics examinations. This low achievement in Physics students' performance according to Omebe and Akani (2015) could be attributed to many factors ranging from the attitude of students towards the subject, lack of motivation on the part of the students, lack of basic science background at the primary school and fundamentally, teachers' strategy which is considered as an important factor.

Nigeria secondary school students taught Physics by "chalk and talk" conventional method have repeatedly demonstrated poor motivation, low performance and retention in and from their Physics education programme. Conventional method has been described by Renau (2016), as oral presentation of information about a particular subject. It is often used to deliver a large amount of information to the students in a short period. It is designed to deliver new information to a large group of students. It is also known to be effective in dealing with a large class. Regrettably, Ali and Akubue, (2015) asserted that, most science teachers in a bid to cover their syllabus adopt conventional method. Conventional method is mainly teachers centered and subject driven. It does not encourage initiatives, curiosity, and creativity in students and does not offer them opportunity to interact effectively with their peers and learning materials. This has resulted in students' low motivation, reduced participation and poor learning performance. Student-centred strategy supported by educational media could enhance effective teaching and learning. Among student-centred strategy is flipped instructional strategy.

Flipped instructional strategy, is a new model for effective teaching. Leo and Puzio (2016) referred to it as the process by which students gain first hand exposure to learning content outside the class, usually via reading or lecture videos, and then use class time to do the harder work of assimilating that knowledge through problem solving, discussion, or debates. Flipped instructional strategy is a form of blended learning in which students learn content online by listening to audio lectures or watching video lectures, mostly at their various home, and assignment is done together in the class with teachers and students discussing and solving questions. Students can work together on a task, exchange their opinion, experiences, views, discuss and negotiate strategies, actions and results through flipped classroom (Ichinose & Clinkenbeard, 2016). These actions can provide students with opportunity to help, discuss, review teach, influence each other and thereby enhance a motivational situation for developing a learning community. Flipped classroom instructional practice is student-centered, making students active participants of the learning task as well as enable students to retain learned concepts.

Retention has been defined by Valderama and Oligo (2021), as the ability of a student to store information which can be recalled at a later time after exposure to a series of instruction or training. Bowles and Brindle (2017) observed that, students' experience is a significant factor in retaining learnt concept and that, the strategies of improving retention rate can be adopted by the teacher. In a statement by Mogbo (2023), anything which aids meaningful leaning improves students' retention while things that lead to interference among learned materials decrease the speed and efficiency of learning and accelerates forgetfulness. Materials to be learned

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depend on the strategy used in teaching and have an effect to the quality of retention in terms of their meaningfulness, familiarity and image evoking characteristics. Among the factors capable of aiding students' retention as outlined by Ibrahim (2015), is the instructional strategy adopted in teaching the concept. Researchers such as Onyenma and Olele (2020), and Mohammed (2021), had shown that, retention of scientific concepts is better enhanced by exposure to flipped instructional strategy than conventional method. The question is, could students' retention be influenced by gender?

Gender is a contemporary issue in science education and has attracted the attention of many researchers. According to Martin and Slepian (2021), it is the property that distinguishes individuals based on their reproductive roles. Gender refers to the characteristics of men, women, girls and boys that are socially constructed; this includes norms, behaviours and roles associated with being a woman, man, girl or boy as well as relationships with others (WHO, 2022). WHO (2022), gave different types of gender to include masculine, feminine, transgender, pangender, genderqueer, cisgender, gender neutral among other. Schmal, Haucap and Knoke (2023), also observed that, as social construct, gender varies from society to society and can change over time. However, for the purpose of this study, the term narrowed down to male and female gender as recognized in Nigeria. Furthermore, gender bias is a common issue in Nigeria educational system (Ogbobe, 2018).

Research conducted on the effects of gender on students' motivation, performance and retention has so far been inconclusive. Studies by Adegboyega (2018), and Bichi (2019), observed that, gender has no significant effect on students' motivation. On the contrary, Muhammad (2016), observed that significant differences exist among male and female students' motivation. Likewise, researches on gender and academic performance such as that of Jia (2020) reveal that boys achieved academically better than girls. On the other hand, studies by Mwihia (2020) pointed out that female students achieved academically better than their male counterparts in Biology. However, a number of other studies like Okafor and Egbon (2011) reveal no significant difference in the academic performance of male and female students. Moreover, researches on gender and retention such as Yusuf (2019) and Yusuf (2022) reveal no significant gender difference in students' retention ability. On the contrary, Dorji (2020) reported gender sensitivity in favour of female students. These contradictory findings have caused for inclusion of gender as one of the moderating variables for this study. Therefore, this study investigated the effect of Flipped Instructional Strategy on Retention and Performance in relation to gender in Wave Concept among Low-Achieving Senior Secondary School Physics Students in Zaria, Kaduna State, Nigeria.

Statement of the Problem

There is growing concern about which instructional strategy or method of teaching would reverse the deteriorating trends in secondary schools Physics students' performance. Students' failure in senior secondary school West African Examination Council (WAEC) is becoming the order of the day in which only few candidates obtained the requirements for further studies into Nigeria higher institutions. The WAEC Chief Examiner's Report (2019) and Augustine (2018), observed that, teachers' use of ineffective teaching method is among the factors that has contributed to the deteriorating trends in secondary school Physics students' performance. This may account for the current low students' performance, motivation and enrolment in the subject.

Besides, a good number of studies such as Williams (2018) and Okeke (2019), had investigated the causes of the appalling state of Physics students' performance. These causes were identified to include low students' motivation to learn Physics, poor teaching strategies used by Physics teachers, poor learning environment, perceived difficulty of the subject and inadequate instructional materials among others. Students shun sciences particularly Physics when given an option and this applies to girls.

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The teaching of Physics in Nigeria has predominantly been through conventional method, which has been implicated by researchers to bring about poor academic performance and low motivation among students. The use of conventional method discourages initiatives, curiosity and creativity in students and does not offer them opportunity to interact effectively with their peers and learning materials. Al-Zoubi and Younes (2015), observed that conventional method of teaching does not take cognizance of low achievers due to its short comings but form part of the students that seat for examination in which the outcome is generally poor. The low achievers are not encouraged to participate actively in the teaching and learning process. This has resulted in larger number of students' poor academic performance and poor retention ability of learnt concepts. In view of these, the study investigated the effect of Flipped Instructional Strategy on Retention and Performance in relation to gender in Wave Concept among Low-Achieving Senior Secondary School Physics Students in Zaria, Kaduna State, Nigeria

Objectives of the Study

The study has the following objectives. To:

1. find out the difference between the performance of male and female low achievers taught wave concept using Flipped Instructional Strategy among secondary school Physics students and
2. find out the difference between the retention ability of male and female low achievers when taught wave concept using Flipped Instructional Strategy among secondary school Physics students

Research Questions

The following research questions are formulated and answered:

1. What is the difference between the academic performance mean scores of male and female low achievers taught wave concept using Flipped Instructional Strategy?
2. What is the difference between the retention ability of male and female low achievers taught wave concepts using Flipped Instructional Strategy?

Null Hypotheses

Based on the objectives and research questions stated, the following null hypotheses were formulated and tested at $\alpha \leq 0.05$ level of significance:

Ho_1: There is no significant difference between the performance of male and female low achievers taught wave concept using Flipped Instructional Strategy

Ho_2: There is no significant difference between the mean retention ability scores of male and female low achievers taught wave concept using Flipped Instructional Strategy.

METHODOLOGY

A pretest and posttest quasi-experimental control group research design was used for the study. Two groups of students participated in the study; experimental group (EG) and control group (CG). The target population of this study comprises all public co-educational Senior Secondary School II (SS2) Physics Students in Zaria Education Zone of Kaduna State, Nigeria. In this study, available data revealed there are 3357 SSII students (2184 males and 1173 females) offering Physics in the zone.

The sample for this study comprised 115 SS II Physics low achievers (76 males and 39 females) from two (2) randomly selected public co-educational senior secondary schools in Zaria Education Zone, Kaduna State, Nigeria. Simple random sampling was used to select four (4) schools from the twenty (20) co-educational senior secondary schools in the study area. Low achievers from these schools were identified based on their teachers' record of three consecutive exams in Physics subject. From the preliminary survey, students who consistently scored below 50 were considered as low achievers.

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To further ensure homogeneity in the students' ability level, pre-test was administered to the low achievers in each of the four schools randomly selected to determine their equivalence in terms of academic performance in wave concept. This was achieved by subjecting the results obtained from the pre-test to Analysis of Variance (ANOVA) and Scheffe's post-hoc test at $p \leq 0.05$. ANOVA was used to determine the existence of any significant difference in the four schools while the Scheffe's post-hoc test was used to separate the schools and figure out which schools were significantly or not significantly different. Two schools were statistically homogeneous and were therefore used for the study.

A validated instrument namely; Wave concept Performance Test (WCPT) was used to collect data. Test-retest method was used to determine the reliability coefficient of Wave Concept Performance Test (WCPT) and computed to be 0.84 using Pearson Product Moment Correlation Coefficient (PPMCC).

For the purpose of data collection, the following sequential steps were used. The Wave concept Performance Test (WCPT) was administered to the students as pretest, posttest (at 6 weeks interval) and post-posttest (at 2 weeks interval) to determine their performance and retention ability. The data collected was subjected to analyses at two different levels, that is, descriptive and inferential levels. At the descriptive level, the descriptive statistics of mean, standard deviation, was used to answer the research questions raised. While at the inferential level, independent sample t-test was used to test the null hypotheses formulated at $\alpha \leq 0.05$ level of significance. The inferential statistics level forms the basis to make decision on whether to reject or retain the null hypotheses.

RESULTS

Results obtained from the data collected were analyzed as follows:

Research Question One:

What is the difference between the academic performance mean scores of male and female low achievers taught wave concept using Flipped Instructional Strategy?

To answer research question one, posttest scores of male and female SS II Physics low achievers in the experimental group generated from WCPT were subjected to descriptive statistics of mean and standard deviation. The summary of the analysis is presented in Table 1.

Table 1: Mean and Standard Deviation of Posttest Scores of Male and Female SSII Physics Low Achievers in Experimental Group

Groups	*N*	Mean	Std. Deviation	Mean Difference
Male	34	34.29	1.09	0.16
Female	22	34.45	1.30	
Total	56			

Table 1 shows that the posttest mean (WCPT) scores of male group is 34.29 with standard deviations of 1.09 and that of the female group recorded mean (WCPT) scores of 34.45 with standard deviations of 1.30. The mean difference is 0.16 in favour of the female low achievers in the experimental group. The table revealed that female SS II low achievers exposed to FIS performed better than their male counterparts taught same concept using FIS. To determine whether the mean difference is significant or not, null hypothesis four was tested at $\alpha \leq 0.05$ as presented in Table 2.

Null Hypothesis 1:

There is no significant difference between the performance of male and female low achievers taught wave concept using Flipped Instructional Strategy.

To test null hypothesis one, the posttest scores of male and female SS II low achievers obtained from WCPT of the experimental group were subjected to an independent samples t-test

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statistic at α ≤ 0.05. Summary of the analysis is presented in Table 2.

Table 2: Independent Samples t-test Analysis of Posttest Performance Scores of Male and Female SS II Physics Low Achievers in Experimental Group

Group	*N*	Mean	Std. Dev.	Df	t	p	Remark	Decision
Male	34	34.29	1.09					
				54	-0.50	0.62	Not Sig.	Ho_4 Retained
Female	22	34.45	1.30					
Total	56							

Not Significant at p > 0.05 level

Table 2 shows that the post-posttest means (WCPT) scores of male and female SSII Physics low achievers in the experimental group. The male students recorded a mean score of 34.29 with standard deviations of 1.09 and that of the control group recorded mean (WCPT) scores of 34.45 with standard deviations of 1.30. The mean performance difference between the two groups is -0.16. The p=0.62 calculated is greater than the alpha value 0.05 level of significance which indicates that there is no significant difference between the performance of male and female low achievers in the experimental group. Therefore, the null hypothesis which stated that there is no significant difference between the performance of male and female low achievers taught wave concept using Flipped Instructional Strategy is retained. This means that the performance of male and female SS II Physics low achievers was enhanced when taught wave concept using FIS. This implies that flipped instructional strategy is gender friendly.

Research Question Two:

What is the difference between the retention ability of male and female low achievers taught wave concept using Flipped Instructional Strategy?

To answer research question two, the post-posttest scores of male and female SS II low achievers in the experimental group obtained from WCPT was subjected to descriptive analysis of mean and standard deviation. Summary of the analysis is present in Table 3

Table 3: Mean and Standard Deviation of Post-Posttest Retention Ability Mean Scores between Male and Female SSII Physics Low Achievers in Experimental Group

Groups	*N*	Mean	Std. Deviation	Mean Difference
Male	34	36.35	1.12	0.10
Female	22	36.45	1.29	
Total	54			

Table 3 shows that the post-posttest mean (WCPT) scores of the male group is 36.35 with standard deviation of 1.12 and that of the female group recorded post-posttest mean (WCPT) scores of 36.45 with standard deviation of 1.29. The mean retention difference is 0.10 in favour of the female group. To determine whether the difference is significant or not, null hypothesis two was tested at α ≤ 0.05 as presented in Table 4.

Null Hypothesis Two:

There is no significant difference between the mean retention ability scores of male and female low achievers taught wave concept using Flipped Instructional Strategy.

To test null hypothesis three, the post-posttest scores of male and female SS II Physics low achievers in the experimental group obtained from WCPT was subjected to independent samples t-test analysis at α ≤ 0.05 level of significance. Summary of the statistics is presented in Table 4.

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Table 4: Independent Samples t-test of Post-Posttest Retention Ability Performance Scores between Male and Female SSII Physics Low Achievers in Experimental

Group	*N*	Mean	Std. Dev.	Df	t-cal	p	Remark	Decision
Male	34	36.35	1.12					
				54	-0.31	0.76	Not Significant	$H0_6$ Retained
Female	22	36.45	1.29					
Total	56							

Not Significant at p > 0.05 level

Table 4 shows that the post-posttest mean (WCPT) scores of male group is 36.35 with standard deviations of 1.12 and that of the control group recorded post-posttest mean (WCPT) scores of 36.45 with standard deviations of 1.29. The mean retention difference between the two groups is 0.10. The p=0.76 calculated is less than the alpha value of 0.05 which indicates that no significant difference exist between the groups in the experimental group. Therefore, the null hypothesis which stated that there is no significant difference between the mean retention ability scores of male and female low achievers taught wave concept using Flipped Instructional Strategy is retained. This implies that SS II male and female Physics low achievers taught wave concept using FIS retained learnt concept.

DISCUSSION OF FINDINGS

The findings and results of the study are discussed as follows: The findings in Table 1 reveal that female students in the experimental group had a higher mean academic performance score than their male counterparts. The difference was however not significant as shown by the independent samples t-test analysis in Table 2. This indicates that male and female students taught wave concepts using FIS do not significantly differ in their mean academic performance scores. This implies that FIS is gender-friendly as it equally improves the academic performance of male and female students exposed to it. This observation could be attributed to the fact that the FIS allows for the active participation of students irrespective of gender.

More so, FIS offers flexible learning paths, allowing male and female students to learn at their own pace who have different learning styles. The finding agrees with earlier research findings of Tambaya (2015), Gambari, Bello and Adeoye (2016), Odewumi and Yusuf (2018), Mrnaz, Tabassum and Ahmad (2018), Elian and Hamaidi (2018), Cheng, Ritzhaupt and Antonenko (2019), Abolarinwa (2020), Ipem, Onyemanche and Onwudiwe (2021), Osuafor and George (2023), Abbas and Idris (2024) that the performance of male and female students was improved when exposed to FIS. On the other hand, this finding is in disagreement with those of Ifeanyi and Ugwu (2022), Oyewumi (2021) who reported that boys performed better than girls when taught using FIS in the experimental group. More so, Chiquito, Castedo, Santos, López, and Alarcón (2020) reported that female performed better than male when students were taught strength of materials on engineering students using FIS.

The findings in Table 3 reveal that female students in the experimental group had a higher mean retention score than their male counterparts. The difference was however not significant as shown by the t-test analysis in Table 4. This indicates that male and female students taught wave concepts using FIS do not significantly differ in their mean retention scores. This implies that FIS is gender-friendly in respect to secondary school students' retention ability as it engenders no significant difference between the groups.

This finding is in agreement with the earlier findings of Kutigi, Gambari, Tukur, Yusuf, Daramola and Abanikannda (2022) that there was no significant difference in retention ability between male and female students taught using flipped instructional strategy. On the contrary, Isa and Bukar (2023) observed significant difference in the retention ability between male and female students taught Chemistry concepts among NCE

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II students in favour of the male students. The disagreement may be attributed to the fact that during the classroom instruction, flipped mastery model was used to determine those that attain mastery of unit taught and those that requires remediation inform of problem solving which creates avenues for better understanding and retention

CONCLUSION

Based on the findings of this study, the following conclusions were made: This study investigated the effect of Flipped Instructional Strategy on Retention and Performance in relation to gender in Wave Concept among Low-Achieving Senior Secondary School Physics Students in Zaria, Kaduna State, Nigeria. The strategy was found to be gender-friendly across the dependent variables and is therefore recommended for classroom instruction in co-educational schools.

RECOMMENDATIONS

On the basis of the findings obtained from this study, the following recommendations are made:

1. The Federal and State Governments through the Ministries of Education should provide standard computer laboratories in secondary schools to enable Physics teachers use the FIS to teach difficult and abstract concepts like wave concepts.
2. Professional bodies like STAN in collaboration with the Federal and State Ministries of Education should embark on nationwide training and retraining of Physics teachers on how to design and implement classroom instructions based on the FIS through regular national, state and local seminars, workshops and conferences.

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