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Flipping the Classroom and Students' Performance in Physics

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Abstract

The study examined flipping the classroom and students' performance in physics. The study adopted the quasi-experimental design. The population for this study was all senior school two (SS II) students offering Physics. Three research instruments were used for data gathering and were analyzed with the t-test, ANOVA, and ANCOVA to test all the formulated hypotheses at the 0.05 alpha level. The results showed that there was no significant difference in the performance of students taught Simple Harmonic Motion using flipped classroom instructional strategy and those taught with the conventional teaching method, no significant difference in the performance of male and female students when taught using Flipped Classroom Instructional Strategy, no significant difference between low and medium scorers and there is a statistically significant two–way interaction effect between gender and score level when students are taught using flipped classroom instructional strategy. It was recommended, among others, that flipped classrooms be implemented in teaching other topics in physics.

Keywords: Flipping Classroom, Students Performance, Teaching Method, Simple Harmonic Motion

Introduction

The teaching method denotes the strategy by which a teacher delivers his/her subject matter to the learners based on some predetermined instructional objectives to promote learning in the students (Sewagegn, 2020). These strategies are determined partly by the subject matter to be taught and partly by the nature of the learners. The method of teaching is the process the teacher adopts to carry out the task of teaching effectively. Munna and Kalam (2021) stated that teaching method is the term used to describe the pedagogy, main principles of study, and educational strategies that are used by teachers in the classroom to instruct students. Miles (2015) emphasized that teachers should employ a variety of instructional strategies to ensure academic success for all science students. For any method to be able to bring good results in this present age, it should promote maximum social interaction (Dogani, 2023). Social interaction between students and between teacher and student plays a crucial role in learning (Ballen, 2020). These authors further stressed the need for the students to be provided with a supportive, open, and interactive environment, as this could help them discover knowledge.

The teaching methods commonly used in science education classes are lecture and demonstration methods (Aina & Keith, 2015). The traditional lecture method lacks an effective interactive approach, leading to poor academic performance in science education this observation was made by Fazio (2020). Therefore, these teachers lacked appropriate instructional strategies for teaching and often used the lecture method. In recent times, several innovative teaching methods that advocate more learners' involvement and participation have been introduced in teaching science in general and physics in particular. According to Lacambra, (2016) and Wilfredo (2016), innovation is a watchword in almost all areas of endeavour, and in the field of higher education, school administrators and teachers are concerned with improving student achievement and performance, teachers should focus on physical facilities**,** curricula, and overall learning environments. Innovations in these areas need to be designed and applied to meet the demands of these schools, making education more responsive to the needs of a fast-growing society. Students learn more and retain more when they learn by themselves. Through this innovative learning, students' skills are developed; they have access to information, solve their problems, and develop their decision-making skills (Wilfredo, 2016). As learning styles are constantly changing and upgrading, so are instructional strategies. One of the innovative teaching strategies in science education is the flipped classroom instructional strategy. A flipped classroom is a type of blended learning

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where students are introduced to content at home and practice working through it at school. This is the reverse of the more common practice (face-to-face) of introducing new content at school and then assigning homework and projects to be completed by the students independently at home. The flipped classroom was invented in 2007 by Jonathan Bergman and Aaron Sams when they began recording their classroom lectures so that students could access them at home. According to Clark (2013), flipped classroom (FC) is defined as using technology to provide lectures outside of the classroom while assignments with concepts are provided inside the classroom through learning activities. The flipped classroom is a classroom where homework is done at school and school work is done at home. The school work is the recorded lessons' videos adopted or adapted by the teachers on all the topics in any subject or course (Makinde & Yusuf, 2017). According to Makinde and Yusuf (2017), the students will need to watch the video at home online or offline in the absence of the teacher, then do the homework (assignments) in the class in the presence of the teacher, who will render assistance in the area of difficulties and monitor the learning progress in the class.

Donald (2014) opines that the flipped classroom model is one of the ways teachers begin to bring more technology into the student's learning environment and support a self-directed learner. The idea of using the flipped classroom model is that it changes the environment for the initial introduction of new material. The flipped classroom helps learners learn independently and collaboratively. By giving the students the freedom to learn at their own pace and allowing lectures to be viewed by a single student and not the entire class, the flipped classroom uses direct lecture instruction to encompass both the teacher-centred and student-centred electronic approaches to education at the same time. Halili and Zainuddin (2016) explained flipped classrooms as an instructional strategy in which the centre of attention is based on the students watching a prepared video of educational content outside the walls of the classroom via e-learning. It involves the active involvement of students. In line with this, Ihekoronye et al. (2015) viewed the flipped classroom as an inverted classroom where students get their first-hand information about the subject matter outside the classroom, thereby encouraging a student-centred approach to learning. Furthermore, these researchers stressed that the flipped classroom is a tacit admission that students no longer have the attention span to learn in the old way (the rigorous lecture method), which requires that they listen carefully to someone spinning a factual narrative, pay close attention, take detailed notes, and commit much of this information to memory. The use of the flipped instructional model (such as video-recorded lectures) to complement the traditional (face-to-face) teacher-centred method of learning has given the learner (student) responsibility for his/her learning. Flipping the classroom is not limited to the usage of video content alone; it can be text material, recorded teaching given to the students on the topic to be taught ahead of time, or blogs.

However, scholars such as (McCabe et al., 2017; Scott et al., 2016; Sheeren & Diala, 2018) reported that students performed better in the flipped classroom than in conventional methods in physics and sciences, respectively. On the contrary, Memler (2017) and Dixon (2017), in their different studies, found that students preferred traditional teaching methods over flipped classes. Other studies indicated no significant difference in student achievement when comparing flipped classrooms to traditional classrooms (Burnham & Mascenik, 2018; Cabi, 2018; Smallhorn, 2017; Tse et al., 2017). Besides the teaching method a teacher employs during classroom instruction, other factors influence the usage of the flipped classroom, such as students' gender, which has been identified as having a characteristic influence on the achievements of students after a given classroom instruction. Research reports have shown that no significant difference exists between the performance of male and female students when taught using the flipped classroom teaching strategy (Agbaje & Awodun, 2014; Okonkwo, 2015). Makinde and Yusuf (2017) reported that flipped classrooms improve students' performance irrespective of their gender. Similarly, a report by Ihekoronye, et al., (2015) indicated no main effect of gender on students' academic achievement in physics when a flipped classroom teaching strategy was used. Odewumi and Yusuf (2018) found that students’ gender did not significantly influence their performance when taught using flipped classrooms**.** Aside from the gender of the students, the score level should also be considered in a given classroom instruction.

Abdulwahab (2014) stated that a score level is a form of grouping in which the students are categorized as high, medium, or low scorers based on certain criteria that stem from their performance on prescribed items. Thus, score level is a considerable variable that groups students' performance into different scoring levels after testing. Anyanwu et al., (2014) reported that there was no significant difference in the performance of high, medium, and low-achieving students. Similarly, Olaniyan et al. (2015) reported that there is a significant difference in the performance of high, medium, and low-scoring students when taught using the Polya Problem-Solving Model**.** It is obvious from the reports from previous studies that the moderating variables, such as students' gender and score levels, were inconsistent, thus needing further investigation.

Research Questions

The following research questions were raised and answered in line with the purpose of this study:

1. What is the performance of senior school students in Simple Harmonic Motions taught using the flipped classroom instructional strategy compared to students taught using the conventional method?
2. Is there any influence of gender on students' performance when teaching simple harmonic motions using a flipped classroom instructional strategy?
3. Is there any effect of score levels on students' performance in Simple Harmonic Motion when taught using a flipped classroom instructional strategy?

Research Hypotheses

The following research hypotheses were formulated and tested at a 0.05 level of alpha:

H_{O1}: There is no significant difference in the performance of students taught simple harmonic motion using a flipped classroom instructional strategy and those taught with the conventional teaching method.

H_{O2}: There is no significant difference in the performance of male and female students when taught simple harmonic motion using the flipped classroom instructional strategy.

H_{O3}: There is no significant difference in the performance of high, medium, and low-scoring students when taught simple harmonic motion using the flipped classroom instructional strategy.

H_{O4}: There is no significant interaction effect of treatment, score levels, and gender on students' performance when taught simple harmonic motion using the flipped classroom instructional strategy.

Materials and Methods

This study is a quasi-experimental research study of the pretest-posttest, non-randomized, non-equivalent control group design. This study involved carrying out a pretest on the experimental and control groups. After that, treatment (the flipped classroom instructional strategy) was administered to the experimental group only, and a post-test was conducted on both groups. The independent variable was the flipped classroom instructional strategy; the dependent variable was the outcomes of students' performance in the post-test; and gender and score level served as moderating variables. Practically, the experimental group received a pretest, a treatment, and a post-test, and the control group received a pretest followed by a post-test. The population for this study was all senior school students offering physics in Ado-Ekiti, Ekiti State, Nigeria. The target population was all senior school two (SS II) students offering physics in the study area since the topic of interest is in the SS2 curriculum. Two intact classes were purposefully selected from two equivalent senior secondary schools in Ado-Ekiti, Ekiti State. The schools were grouped into an experimental group and a control group. The choice of the participating schools was based on the criteria that the schools must be co-educational, government-owned, have a well-equipped computer laboratory, and/or allow the participating students in the experimental group to come with an ICT device that would be used for collecting the video clips of the physics lessons. Three research instruments used for this study are the lesson plan on simple harmonic motion, the researcher-developed Flipped Classroom Instructional Manual alongside video clips (FCIM), and the Physics Performance Test on Simple Harmonic Motion (PPTSHM). The FCIM served as a teacher's guide for the implementation of the flipped classroom instructional strategy, and a video clip containing lessons on simple harmonic motion was given to students in the experimental group to watch at their own pace outside classroom time. These served as the treatment for teaching students in the experimental group for two weeks. The PPTSHM contains 25 multiple-choice questions with options a–d, and 4 marks for each question answered correctly were used to determine students' performance in the pre-test and a reshuffled version for the post-test.

The content validation of the Physics Performance Test in Simple Harmonic Motion (PPTSHM) together with the drafted lesson plan on Simple Harmonic Motion was given to two physics educators experts in the Department of Science Education, one expert from the Department of Educational Technology, all from the University of Ilorin, Ilorin, Nigeria, and two practising senior physics teachers in secondary schools to rate each scale item in terms of its relevance to the construct. The experts rated each item as relevant or not relevant, and the item-level content validity index (I-CVI) was computed. According to lawshe's averaging experts' ratings of item relevance and using a pre-

established criterion of acceptability. Only 20 out of 25 items received relevance ratings from all the experts, and the content validity index for scales (S-CVI) is .80, which was judged to be relevant.
A reliability test was conducted on the PPTSHM through a test-retest method as the pilot study. This was done by administering the PPTSHM at the initial date of the commencement of the reliability test and thereafter re-administering a reshuffled version of the instruments to the same set of students after three weeks of initial administration to ten SS II students who were not part of the sample that was selected for this study. Pearson's product-moment correlation was used to determine the correlation coefficient of the two test scores using SPSS version 20.0. The reliability coefficients obtained from the results were 0.78 and 0.81, respectively.

The researchers seek approval to carry out the study on their SS II students. The researchers met with the students to seek their consent and explain the aim and benefits of the study, as well as their level of involvement in the study. Permission from the parents was sought through a parental consent form that was given to each of the students for their parents to fill out and return to the researchers. Before the commencement of the fieldwork, the researchers employed the services of the physics teachers from the selected schools as research assistants. The research assistant was trained on the implementation of flipped classroom instructional strategies for one week so that they would be able to implement the required strategies for the experimental group. This would control for bias on the part of the researchers. A pretest on simple harmonic motion was given to the experimental and control groups to determine the student's level of understanding of the topic before teaching. Afterwards, the experimental group was taught by a trained research assistant using the flipped classroom instructional strategy for two lessons in the second week, while the control group was taught using the traditional method with the help of the research assistant. Both the experimental and control groups were taught only two lessons each to ascertain the effect of the treatment on the experimental group. The lessons lasted between 40 and 45 minutes. However, for the experimental group, video clips of all the classroom lessons were given to the participants to watch at their own pace before the actual classroom time. Students who were unable to watch the video clips at home were allowed to do so using the school's ICT gadgets at their own pace before actual classroom instruction.

For the experimental group, a class was organized to conduct the pre-test. The pre-test comprised 25 multiple-choice questions on simple harmonic motion that were administered to the students for 35 minutes. Two lessons were conducted to teach simple harmonic motion and its applications. For each lesson, classroom interactions were allowed among students and between students and the teacher in the video clips they watched before the class. This enabled the researchers to get feedback on their level of understanding of simple harmonic motion. After the classroom interactions, the teacher clarified any misunderstood concepts of the lesson and engaged the students in further classroom activities on the topic of the day. At the end of the whole exercise, assignments that were marked by the research assistant were given to the students based on the lesson, and the video clips to be watched in the next class were announced to the class. The research assistant marked the assignments and went through the solutions with the students. At the end of the treatment period, a post-test, which was a re-shuffled version of the pretest, was administered to the group.

In the control group, after the administration of the pre-test, students were taught two lessons using the conventional method. This conventional teaching would involve the research assistant delivering a lesson to the students using conventional means and ensuring their participation in the lesson without any special treatment. Assignments were given to the students, after which the research assistant marked the assignments and went through the solutions with the students. At the end of the two lessons, the post-test was administered to the students. The pre-test and post-test were marked for the two groups, and the scores were used for data analysis. The data collected from the pre-test and post-test of both groups were analyzed by calculating the mean gain scores and standard deviations for both groups to determine and compare the effective gains in the performance of both groups. The teaching of the experimental group was performed by a trained research assistant using a flipped classroom instructional strategy, while the teaching of the control group was performed by the research assistant using any conventional instructional method; this is intended to maintain the objectives of the study. The researchers assured the participating students that all submitted personal information and scores obtained during the research were for the singular purpose of the study and therefore will be treated with the utmost confidentiality. The researchers engaged the services of regular physics teachers as research assistants. Both the experimental and control groups were taught simple harmonic motion within the class schedule for the physics subject. This helped to prevent disorderliness in normal class routines.

The voluntary participation of selected students from the sampled schools was upheld by the ethical practices of research. A correspondence tagged "informed consent form" was presented to the school authorities, teachers, students, and parents/guardians for their willingness to partake in the study. The researchers and research assistants then take the lesson period for physics classes on "Simple Harmonic Motion" in line with the regular class schedule set by the school management. For the duration of the study, should any participant choose to back out of the research exercise at any time, such a request was granted without any hindrance. The identities of such respondents were not revealed at any point in the study. All related data were treated with the utmost confidentiality and were used exclusively for the research. The data collected from the pre-test and post-test were subjected to descriptive and inferential statistics. Hypotheses 1, 2, and 3 were tested using a t-test; hypothesis 4 was tested using ANOVA; and ANCOVA was used to test Hypotheses 5 at a 0.05 alpha level.

Results

Figure 1 shows the demographic data of the respondents in the experimental and control groups.

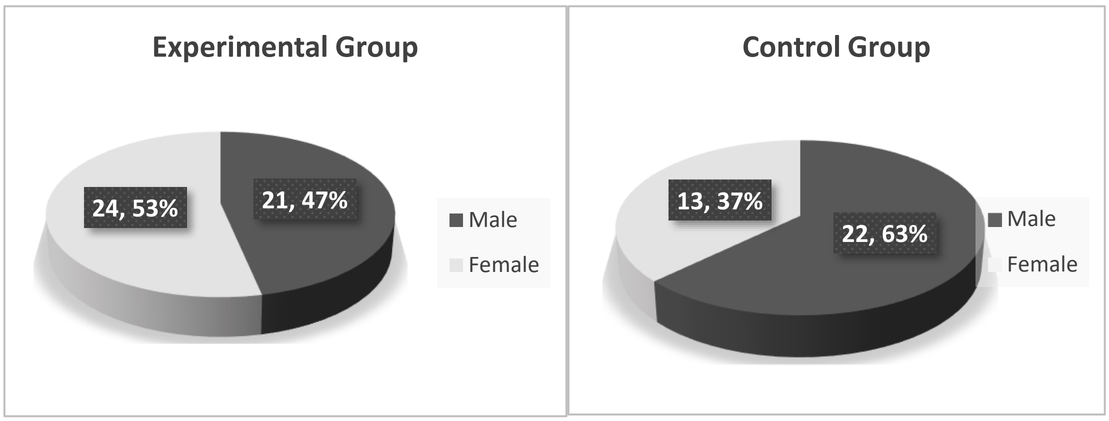

Figure 1: Demographic Distribution of the Respondents

Research Question One: What is the performance of senior school students in the pretest and post-test in Simple Harmonic Motions taught using flipped classroom instructional strategies and conventional methods?

Table 1 indicates the mean score and standard deviation of the pretest and posttest of students in the experimental group and control group taught using flipped classroom instructional strategies and conventional methods. The result indicated that the experimental group had a mean score of 10.76 with a standard deviation of 2.41 at the pretest, and the post-test mean score was 13.36 with a standard deviation of 1.99. The experimental group had a mean gain score of 2.60. Similarly, the pretest mean score of students in the control group was 10.97 with a standard deviation of 3.04, and the post-test mean score was 13.17 with a standard deviation of 4.09. The control group had a mean gain score of 2.20. This implies that the mean gain score of the students in the experimental group was 0.40 greater than the mean gain score of the students in the control group. Further analysis was conducted to test whether the mean score was statistically significant or not.

Table 1. Mean Gain Score Using Mean and Standard Deviation in Both Experimental and Control Groups

Treatments	N	Pre-test		Post-test		Mean Gain
		Mean	SD	Mean	SD	
Experimental	40	10.76	2.41	13.36	1.99	2.60
Control	35	10.97	3.04	13.17	4.09	2.20

H_{O1}: There is no significant difference in the performance of students taught simple harmonic motion using a flipped classroom instructional strategy and those taught with the conventional teaching method.

The results of the independent t-test analysis in Table 2 show a t-value of 0.27 with a degree of freedom of 78 and a p-value of 0.79. Since the p-value was greater than 0.05 alpha level, the null hypothesis one (H_{O1}) is therefore not

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rejected. Thus, there was no significant difference in the performance of students taught simple harmonic motion using the flipped classroom instructional strategy and those taught with the conventional teaching method (t(78) = 0.27; p = 0.79).

Table 2. Independent sample t-test on Students' Performance Using Flipped Classroom and Conventional Teaching Methods

Treatments	N	Mean	SD	df	t	Sig.	Remark
Experimental	40	13.36	1.99	78	0.27	0.79	Not significant
Control	35	13.17	4.09				

p>0.05

Research Question Two: Is there any influence of gender on students' performance when taught simple harmonic motion using a flipped classroom instructional strategy?

Table 3 shows the mean score of male students in the post-test was 13.57 with a standard deviation of 2.09, and the mean score of female students was 13.25 with a standard deviation of 1.96. The mean score presented little or no difference between male and female students when taught simple harmonic motions using a flipped classroom instructional strategy. Further analysis was conducted to test whether the mean score was statistically significant or not.

Table 3. Description of Students' Mean Scores Based on Gender When Taught Physics Using a Flipped Classroom Instructional Strategy

Gender	N	Mean	SD
Male	21	13.57	2.09
Female	24	13.25	1.96

H_{O2}: There is no significant difference in the performance of male and female students when taught simple harmonic motion using the flipped classroom instructional strategy.

The result in Table 4 shows a t-value of 0.53 with a degree of freedom (df) of 43 and a p-value of 0.60. Since the p-value is greater than 0.05, hypothesis two was therefore not rejected. Thus, there was no significant difference in the performance of male and female students when taught simple harmonic motions using the flipped classroom instructional strategy. (t(43) = 0.53; p = 0.60).

Table 4. Independent sample t-test Analysis on Male and Female Students' Performance When Taught Using a Flipped Classroom Instructional Strategy

Gender	N	Mean	SD	df	t	Sig.	Remark
Male	21	13.57	2.09	43	0.53	0.60	Not Significant
Female	24	13.25	1.96				

p>0.05

Research Question Three: Are there any effects of score levels on students' performance in Simple Harmonic Motion when taught using a flipped classroom instructional strategy?

Table 5 shows the mean and standard deviation of the posttest scores of students in the experimental group based on score level. From the table, the posttest mean score of students who were categorized as low scorers was 12.14, with a standard deviation of 2.73. The medium scorers had a posttest mean score of 13.39 with a standard deviation of 1.72, while those grouped as high scorers had a posttest mean score of 13.75 with a standard deviation of 1.86. Although the mean scores of the low, medium, and high achievers were not too far from each other, further analysis was conducted to ascertain the level of alpha.

Table 5. Description of Students' Mean Scores Based on Score Level When Taught Physics Using a Flipped Classroom Instructional Strategy

Score Level	N	Mean	SD
Low	7	12.14	2.73
Medium	18	13.39	1.72
High	20	13.75	1.86

H_{O3}: There is no significant difference in the performance of high, medium, and low-scoring students when taught simple harmonic motion using the flipped classroom instructional strategy.

From Table 6, an *f*-value of 1.75 and a p-value of 0.19 were obtained. There was no statistically significant difference between groups as determined by one-way ANOVA ($F(2,42) = 1.752$, $p = 0.186$). Since the p-value obtained was greater than 0.05 alpha level, hypothesis three, which states that there is no significant difference in the performance among high, medium, and low scorers when taught simple harmonic motion using a flipped classroom instructional strategy, was not rejected. Hence, when students are taught simple harmonic motion using a flipped classroom instructional strategy, there is no significant difference among the performances of low, medium, and high-achieving students. This implies that the instructional method did not favour any set of students based on their score levels. Notwithstanding, Turkey's post-hoc test was conducted to check if there was any significant difference between any two of the groups. Turkey posthoc multiple comparisons also revealed that there was no significant difference between low and medium scorers ($p = 0.34$); low and high scorers ($p= 0.16$); and medium and high scorers ($p = 0.84$), respectively.

Table 6. Analysis of Variance (ANOVA) of Performance Among Low, Medium, and High-Scoring Students

Scores	Sum of Squares	df	Mean Square	*F*	Sig	Remark
Between Groups	13.43	2	6.71			
Within Groups	160.89	42	3.83	1.75	0.19	Not Significant
Total	174.31	44				

H_{O4}: There is no significant difference in the interactive effect of treatment, gender, and score levels on students' performance when taught simple harmonic motion using a flipped classroom instructional strategy.

Table 7 presents the results of the two-way analysis of covariance (ANCOVA) on the interaction effect of the treatment, gender, and score levels of senior school students when taught simple harmonic motion using a flipped classroom instructional strategy. As can be seen from Table 7, the p-value for the interaction effect of gender and score levels is 0.37 (i.e., $p = 0.37$). Since 0.37 is greater than the 0.05 level of alpha ($p > 0.05$), hypothesis four was rejected. Therefore, this means that there is a statistically significant two-way interaction effect between gender and score level when students are taught simple harmonic motion using a flipped classroom instructional strategy, ($F(2,38) = 1.03$, $p = 0.37$, partial eta squared = 0.05).

Table 7. Analysis of Covariance (ANCOVA) of the Interaction Effect of Treatment, Gender, and Score Level on Students' Performance When Taught Physics Using a Flipped Classroom Instructional Strategy

Source	SS	df	MS	*F*	Sig.	η^2
Corrected Model	22.03[a]	6				
Intercept	54.32	1	3.67	.92	.49	.13
Pretest	.30	1	54.32	13.55	.00	.26
Score Level	3.85	2	.30	.07	.79	.00
Gender	.63	1	1.92	.48	.62	.03
Score level * Gender	8.27	2	.63	.16	.69	.01
Error	152.28	38	4.13	1.03	.37	.05
Total	8201.00	45	4.01			
Corrected Total	174.31	44				

a. R Squared = .126 (Adjusted R Squared = -.012)

Discussion

The finding of Hypothesis One revealed that there was no significant difference between the performance of students when taught simple harmonic motion using a flipped classroom instructional strategy and those taught using the conventional lecture method. The finding is in line with the findings of (Bell et al., 2020; Memler, 2017) who concluded that there was no statistically significant difference between the two methods of teaching unit tests in physics. Also, Dixon (2017) reported that there was no statistically significant difference in the academic achievement of high school science students in the flipped classroom as compared to students in the traditional classroom. However, this finding is in contrast with those of (Ihekoronye, et al., 2015; Shao & Liu, 2021; Sheeren & Diala, 2018), who reported that students performed better in the flipped classroom than in conventional methods in physics and sciences, respectively. It was observed that the mean scores of students in both the experimental and control groups in the post-test were approximately very close, with a little or no meaningful difference of 0.40 in favour of the students in the flipped classroom. This mean difference between the two groups was rather too small to make a statistically significant difference.

The finding of Hypothesis One implies that in the teaching of simple harmonic motion in physics, the flipped classroom method of instruction has no significant effect on students' performance when compared with the conventional lecture (chalk-and-talk) method. This is so because most innovative instructional strategies for science education are topic/subject-sensitive, as students can still learn certain topics in physics irrespective of any instructional approach a teacher adopts. However, there is no singular method of instruction that is capable of yielding all the desired results in terms of students' learning. A lot of other factors, apart from teaching methods, are also responsible for students' success after certain class instruction. Factors such as students' interest in the topic, the quality of the instructor and the instruction, foundational knowledge of concepts in the subject, and many more can have a significant effect on students' achievement in physics. After all, the flipped classroom is an ICT-based approach to instruction, and there might have been students in the flipped classroom who experienced challenges in watching the video lessons before class instructions, and/or some students may have been distracted by using their ICT gadgets for gaming or social media instead of studying the video clips of a lesson on simple harmonic motion.

The finding of Hypothesis Two revealed that there was no significant difference in the performance of male and female students when taught simple harmonic motion using a flipped classroom instructional strategy. This finding aligns with the findings of several studies that reported that there is no significant difference between the performance of male and female students in physics and that gender has no significant effect on students' achievements when taught with different instructional approaches (Agbaje & Awodun, 2014; Gambari & Yusuf, 2014; Garuma & Tesfaye, 2012; Ihekoronye, et al., 2015; Kutigi, et al., 2022; Makinde & Yusuf, 2017; Odewumi & Yusuf, 2018; Okonwo, 2015). On the contrary, other studies reported a significant difference in male and female students' performance in favour of males (Amunga et al., 2011; Enwere et al., 2021; Ugwu, 2011; Wanbugu, et.al., 2013). An effective, innovative instructional strategy that is implemented in the same environment and under the same learning conditions is expected to bring about equal learning outcomes irrespective of students' gender. This finding implied that when male and female students are taught simple harmonic motion in physics using a flipped classroom instructional strategy, both males and females are not different in terms of their test scores because the flipped classroom is not a gender-sensitive instructional strategy. Since male and female students in the flipped classroom have equal learning opportunities, equal learning materials (same video clips), and equal discussion opportunities with the teacher and peers in the flipped classroom, their final learning outcomes were not significantly different.

Although male students' posttest mean score in physics was just a little above that of their female counterparts in the flipped classroom, such a difference was not significant. The findings of this study revealed that flipped classrooms are the kind of instructional strategy that should be encouraged in science education, especially physics, to bridge the long-discovered gender gap between male and female students in physics. When implemented, male students did not outperform female students, and neither did female students outperform their male counterparts in the flipped classroom. The finding of Hypothesis Three revealed that there was no significant difference in the performance of high, medium, and low-scoring students when taught simple harmonic motion using a flipped classroom instructional strategy. The finding is in one way in tandem with that of Anyanwu, et al., (2014). Conversely, studies by (Garuma & Tesfaye, 2012; Omiola, et al., 2012) established that there was a significant difference in the post-test mean score of high, medium, and low achievers. This implies that the student's achievement has a strong relationship with their background performance levels (high, medium, and low) besides the effect of the instructional methods. The study is an indication of the fact that a flipped classroom is an all-inclusive and all-encompassing instructional strategy that favours all categories of learners equally. This implies that the effect of a flipped classroom is felt equally by low-achieving students, just as it is felt by medium and high-achieving students, respectively. Invariably, flipped classroom instructional strategies are effective strategies that work well for students with low levels of assimilation as well as students with medium and high learning abilities. Although simple harmonic motion has several difficult concepts and challenging calculations, when students watch the video instruction at home, they learn at their own pace, and are therefore, able to assimilate the instructional contents equally since they are not under any pressure to learn quickly and at the same time with other students. Finally, the finding from Hypothesis Four revealed that there is a significant interaction effect between gender and score levels of students when they are taught simple harmonic motion using a flipped classroom instructional strategy. This finding was in line with that of Ihekoronye et al. (2015) who reported a significant interaction effect of treatment and gender on students' achievement in physics. This implies that the effect of the flipped classroom instructional strategy on students' performance in simple harmonic motion (physics) does not depend on gender or students' score levels as determined by the pretest scores. Alternatively, just because a student is male or female does not guarantee the student's level of achievement (low, medium, and high achievers) when taught simple harmonic motion using flipped classrooms. Therefore, gender and score levels are independently related to students' scores in physics when flipped classrooms are implemented in teaching senior secondary school physics.

Conclusion

Based on the findings of this study, it was concluded that the flipped classroom instructional strategy is an effective strategy for teaching school subjects, but its effect is not gender biased, it transcends students' score levels, and it is not significantly different from the conventional teaching method. The implication of this is that students who are fast learners would spend less time at home watching the video clips, while slow learners would spend a long time completing the same clips for optimal understanding of the topic.

Recommendations

The following recommendations were made:

1. The flipped classroom should be implemented in teaching other topics in physics, such as waves, equilibrium of forces, conservation of linear momentum, etc.
2. Flipped classrooms should be encouraged to bridge the long-discovered gender gap between male and female students in physics.
3. Teachers should always consider the ability levels of students when implementing a flipped classroom instructional strategy.

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