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Research Article

Flipped Instructional Strategy: Its Interaction Effect on Students Achievement And Engagement In High School Test And Measurement Course

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ABSTRACT

Flipped instructional strategy involves organizing learning activities outside of the classroom before or after the lesson period with the aid of technology-based devices so that the instruction period is used for another activity. We investigated the interaction effect of flipped instructional strategy on 3rd year Nigeria Certificate in Education Integrated Science Education students` achievement and engagement in Test and Measurement Course in higher institutions of learning. Pretest, post-test non-equivalent group quasi-experimental research design was employed for the study. The subjects of the study comprised of 60 male and 60 female integrated science Nigeria Certificate in Education (NCE) 3rd year students offering Test and Measurement Course involving simple random and purposive random sampling techniques. Test and Measurement Achievement Test (TMAT) and Test and Measurement Academic Engagement Scale (TMAES) instruments were used for data collection. The two instruments were trial tested and the reliability indices were determined to be 0.73 and 0.88 using Kuder-Richardson formula K-R_{20} and Cronbach alpha methods respectively. The data collected in this study were subjected to statistical analysis using the Statistical Package for Social Sciences version 23. Descriptive statistics of Mean and standard deviation were used to answer the research questions while ANCOVA was used to test the hypotheses. The result shows that male students achieve higher than females when taught using flipped instructional strategy in the test and measurement course. The result also revealed that the interaction effects of instructional strategies and gender on the academic engagement of students in Test and Measurement course was not significant. The results of our study thus represent an important contribution to the field of pedagogy and general didactics at tertiary education levels.

Keywords: academic achievement, flipped instructional strategy, students engagement, test and measurement course, high school

1. Introduction

Educators are reconsidering methodological strategies fostering active learning strategies instead of direct instruction. Among active learning strategies we find Flipped Classroom, which switch's traditional learning order. Direct instruction is transferred out to the class and in class time is dedicated to tasks, discussions or problems solving (Herrera Sierra & Prendes Espinosa, 2019). The flipped classroom instructional technique has been considered a boost to the field of education. The flipped classroom, as described by Elian and Hamaidi (2018), is a teaching method in which students are given content outside of class time using technology-based resources like films that the teacher generates to explain concepts or information

connected to the lesson. Alzwekh (2014) defined the flipped classroom as a type of contemporary teaching methodology that cleverly and amusingly employs cutting-edge tools in order to suit the demands of students. The author continued by saying that the fundamental idea behind a flipped classroom is to flip learning activities between the classroom and the student's home through the efficient use of contemporary technological resources.

DeLozier and Rhodes (2017), flipped classroom refers to a teaching strategy where teachers assign lessons outside of class and use class time for a range of learning activities. In keeping with the aforementioned, a teaching strategy known as "flipping the classroom" refers to organizing learning activities outside of the classroom before or after the lesson period with the aid of technology-based devices so that the instruction period is used for another activity. The above information is a reflection of the flexibility of flipped classroom instructional approach. Bergmann and Sams (2012) further referred to flipped classroom as an inverted classroom or reverse instruction stated that the activities of flipped classroom involve 5 minutes warm-up activity, 10 minutes question and answer time on video, and 75 minutes of practice and laboratory activities whereas, the traditional classroom consists of 5 minutes warm-up activity, 20 minutes review, 30 minutes lecture and 20 minutes practice or laboratory activities. This means that the flipped classroom creates more room for students` participation and practices at the end of instruction. This could be the reason why it has been regarded to simulate learning easily. Tucker (2012) claims that students view instructional films at home and work on problems in class. This suggests that adopting a flipped classroom makes the learning experience more engaging. Perhaps for this reason, Lai and Hwang (2016) also noted that the flipped classroom alternates between in-class and out-of-class time to promote more interactions between the teacher and students.

2. LITERATURE REVIEW

It is necessary to adhere to specific methodological guidelines when implementing the flipped classroom. Before beginning to use the flipped classroom, the instructor must define these processes. Castillo (2020) lists these processes as defining the goals, organizing how the model or technique will be used, and instructing students on how to use the flipped classroom. Before using the flipped classroom strategy, all of these procedures must be properly completed. According to Blair et al. (2015), these give the students lots of chances to apply, illustrate, and understand the subject matter.

With all of its comprehensive advantages, the flipped classroom has also been found to be quite effective at raising students' academic achievement, interest, and engagement in their studies. Ugwoke, et al. (2018) show that flipped classrooms are quite effective at raising students' attention and achievement. The study of Holik (2019) further emphasized the effectiveness of the flipped classroom in raising students' involvement in their learning. The information above suggests that when students have a strong interest in a subject, they may become very engaged in studying it and so improve their academic performance. Contrarily, the findings of Cabi (2018) showed that the flipped classroom has no appreciable impact on students' academic performance. Strayer (2012) and Sparks (2013) also found that the flipped classroom was not more efficient than conventional methods, corroborating Cabi's (2018) findings. The aforementioned results show that there is still disagreement among researchers regarding the efficacy of the flipped classroom teaching method. Therefore, greater research on the impact of the flipped classroom teaching method on students' engagement, and academic achievement is necessary to settle the argument. To ascertain the effectiveness of flipped classroom learning on students' engagement, and academic achievement in test and measurement course.

The lecture method, also referred to as the "chalk-and-talk" approach, involves the instructor attempting to communicate the subject-matter or curriculum-related material orally to the student. Because it calls on the verbal presentation of ideas, concepts, generalizations, and facts, this traditional method of instruction is viewed as outdated by many scientific educators (Offorma et al., 2019). In the lecture method of instruction, a test and measurement lecturer would typically enter the classroom, take a commanding position in front of the students, introduce the topic, explain what the topic is about, and ask the students if they have any questions. The teacher would then hand out notes for the students to copy. With this method of instruction, the teacher directs all classroom activities while the students only watch, copy, and listen. The lecturing method relies heavily on the teachers to impart knowledge to the students (Rhadika, 2020). It is required of the students that they listen to what the teacher says and understand it. In the lecture method of instruction, lecturers and students converse directly with one another in a classroom context. It just concentrates on comprehending the material in textbooks and notes (Weili, 2016). In this teaching method, the instructor controls the classroom while the students merely passively absorb and repeat the information. The lecture method places more emphasis on the usage of textbook examples by the instructor (Daluba, 2012). Despite the method's harsh criticism, Moemeke (2016) stated that it has advantages of its own. For example, it is efficient in terms of teaching time because a lot of content is covered in a short amount of time. And it requires only a few materials in terms of composition.

However, its shortcomings are clear. According to Okoli (2012), the lecture format makes the students extremely passive as they only absorb the information in order to pass examinations. It is obvious that students in the 21st century, especially those studying science, cannot learn well through lectures. Agashi

(2012) contends that progressive psychologists have harshly criticized the conventional approach to training, emphasizing that the lecture method of instruction places a great emphasis on the teacher. The author makes the case that these psychologists are in favor of the notion that effective learning is unlikely to take place in a circumstance like this where the lecture approach is employed most frequently. More so, it is regarded not to stimulate interaction between students and the instructors. This means that students are likely to achieve poorly and become less engaged in learning when the lecture method becomes predominantly used. It therefore calls for the integration of the flipped classroom technique which is a student-centered and technology driven approach that will enhance students` achievement and engagement.

Test and Measurement (T&M) course is primarily set up for exposing students to the rudiments of research and educational testing as well as program evaluation. It is a course that introduces students to statistics, research knowledge, and their application to the field of education, according to Oguguo et al. (2021). The authors continued by saying that students are exposed to numerous notions of educational research, testing, educational objectives, and descriptions of learning domains and educational taxonomy in test and measurement courses. The course "Test and Measurement" is designed to give teachers and students a broad understanding of educational goals, test design and administration, and test quality (National Open University of Nigeria: NOUN, 2006).

The course whichmparts knowledge and u"ders'anding of measurement and test development in the field of education (Oguguo et al., 2021). The overwhelming significance of measurement and assessment highlights why the field of education at the university level is giving it so much attention. Due to the fact that this information is a requirement for their studies and growth in the fields of research and data analysis, among others, students are expected to achieve a high level of accomplishment in the course. However, the report of Alkharusi (2009), and Oguguo et al. (2020) showed that student's achievement in the course is poor due to its statistical and mathematical components which has made it difficult for students to understand. As the authors noted, the reason for the difficulty in understanding the course has been mainly due to the use of grossly inadequate and conventional teaching technique such as the lecture method. The implication of the foregoing could mean that students may continue to achieve poor in test and measurement course if due attention is not given to it.

The field of education and academi" ach'evement are inseparable. Academic achievement, according to Ezema (2012), comprises pursuing and achieving an academic target or goal that has been established or achieved. According to Ezema's definition, academic achievement is solely focused on academic performance. Academic achievement is defined as the knowledge, abilities, and ideas that students acquire as a result of their learning, whether that learning takes place inside or outside of a classroom (Okorie, 2014). Academic achievement is regarded by Omenka (2019) as an educational variable that demonstrates the degree of success or failure of the teaching and learning process. Based on the above definitions, academic achievement may be defined as one` ability, relative standing or position in an academic endeavour.

The aforementioned shows that academic achievement affects how much teaching and learning has occurred. Maybe one might say that academic success is a measure of how well behavioral or educational goals are being met. It is impossible to overstate the importance of academic achievement in the world of education. This is so that it illustrates how well the teaching and learning process is working (Nwogu, 2015). Nworgu continued by saying that academic achievement enables a variety of processes, including social integration, entrance to colleges and universities, career advancement, instructional adjustments, and employment opportunities. The above is an indication of the relevance of academic achievement, as such, students must strive at all time to ensure that they earn a good academic achievement especially in Test and Measurement course.

The situation with regard to students` achievement whichn Test and Measurement course has been highlighted by academic studies. The academic achievement of students in test and measurement course has been extremely low over the years, according to the report of (Oguguo et al., 2020). The findings of Alkharusi (2009), which show that students' academic achievement in Test and Measurement course is low, provide additional support for this report. This undesirable state of affairs is as a result of the students' poor achievement in the course. In order to save students' academic performance in the course, efforts must be made. In light of the foregoing, it is urgent to determine whether cutting-edge teaching methods, like the flipped classroom, could be used to enhance students' achievement as well as engagement in Test and Measurement course.

The activities of teaching and learning have been thought to be greatly aided by the engagement of the students. Engagement comprises a variety of activities carried out by students in order to move from not know or lack of skills in understanding to understanding and achievement (Reeve, 2013). Student engagement also refers to the level of focus, curiosity, and interest that students exhibit at the point of learning, whether that be within or outside of the classroom (Sousa as cited in Toth, 2021). Students are engaged when they arrive at class excited to learn, participate in the lesson, and have a positive attitude (Kampen, 2020). Students' engagement was defined by Great School Partnership (2021) as the level of focus, curiosity, interest, optimism, and passion that students exhibit when learning or being taught, which also includes the degree of motivation they have acquired and the advancement of their education. According to

the aforementioned criteria, student engagement is any action aimed at raising a student's general academic performance.

This means that one may define student engagement as the mental, behavioral, emotional, and psychologically based behavior demonstrated by students at the point of learning with the intention of enhancing learning. Students` academic engagement has three aspects, this includes the behavioural, emotional and cognitive aspect (Kampen, 2020). Reeve (2013) however identified four aspects of academic engagement to include behavioural, emotional, cognitive and agentic. Behavioral engagement is linked to students' satisfaction and achievement, time spent on task, the integration of social and academic learning, and instructional strategies (Kahu, 2013). This level of involvement, in accordance with Jamaludin and Osman (2014), promotes active learning. Effective communication, demonstrating a caring attitude toward students' learning, offering opportunities for active learning, and utilizing cooperative learning strategies can all help to increase this type of engagement.

Emotional engagement on the other hand allows students to assume responsibility towards one another as well as motivate them to complete tasks. Talyor and Satler (2013) claim that this kind of engagement is encouraged by using educational resources that promotes students` interaction and provide feedback on the content. In light of this, emotional involvement considers course material to be a key factor in students' emotions. Another type of engagement is the cognitive engagement which is also termed intellectual engagement. Students that participate in this kind of engagement are eager to learn and have thoughtful discussions about the material. As a result, when completing projects, students frequently delve further and ask probing questions. According to Smart and Marshall (2012), cognitive engagement occurs when students elaborate on an idea in the form of an answer after a teacher asks a question. This means that anytime a teacher asks a question and a student is secure enough to respond, there is cognitive engagement among the class. This suggests that active learning might be facilitated by cognitive involvement. The last type of engagement is the agentic engagement. This engagement gives students the chance to design a more inspiring and encouraging learning environment for themselves, this engagement style enables educators to support students' efforts to engage themselves (Reeve, 2013). Therefore, a self-regulated learning environment is necessary for this kind of engagement. As a result, both educators and pupils must be able to handle difficult situations. Reeve asserts that students who are actively involved typically exhibit higher levels of learning and more motivational support.

Scholars have emphasized a number of strategies for fostering student Engagement. According to Kampen (2020), implementing effective classroom management techniques, integrating technology into teaching and learning activities, encouraging active learning, reciprocal teaching, requiring class participation, cooperative learning, inquiry-based learning, and other strategies are some ways to increase students' engagement. The Center for Teaching and Learning, University of Washington (CTLUW, 2021) added that there are additional ways to encourage student engagement in the classroom, including active learning techniques like short Q & A sessions, discussions woven into lectures, hands-on activities, and experiential learning activities. It has been determined that engaging students in their learning is of overwhelmingly great value. In their study, Jamaludin and Osman (2014) found that student engagement fosters active learning and improved academic achievement. Similar to this, Kampen (2020) noted that students`engagement raises academic performance. According to CTLWU (2021), including students in the learning process improves their concentration and attention spans, inspires them to use more sophisticated critical thinking techniques, and fosters enriching educational opportunities. Similar to this, Toth (2021) said that students` academic achievement is likely to rise when they are actively engaged. The advantages of student engagement are shown in the foregoing. This implies that active student interaction can improve the teaching and learning of Test and Measurement course.

Gender refers to the responsibilities and rights that men and women are accorded in families, societies, and cultures. Ogunkunle (2014) asserts that gender is dynamic and culturally defined by the tasks assigned to both male and female children. Ogunkunle further defines gender as the characteristics, behaviors, and responsibilities that society has allocated to males and females. Gender is seen as socially prescribed position, roles, and behavior that distinguishes men from women (Edo, 2016). Fink (2016) holds that gender is a cultural construct that creates distinctions between male and female roles, behaviors, and mental and emotional qualities. It is possible to argue that gender has gained importance in both society and the educational system. Gender determines an individual's social roles and responsibilities in a culture that is built on male and female roles. These responsibilities and roles have a bigger effect on how people act, think, and decide. The way that gender influences the general behaviour of both students and teachers as well as the curriculum, instructional strategies, and career choices suggests that gender has long played a role in the educational system. In the home, in society at large, and in science education, this gender idea is proliferating. Over time, specialists have been unable to reach a consensus regarding the academic performance of male and female students. In essence, a student's gender may have an impact on their academic achievement and engagement. Effiom and Abdullahi (2021) assert that gender has a significant influence on students' academic progress. According to a study by Uwaleke (2013), female secondary school students did better in chemistry than male students, especially in the quantitative section. Offiah and Egolum (2017) stated that

male students achieve better than female students in Chemistry. Contradicting all the above reports, Osuafor and Orji (2017) reported that gender does not influence students` academic achievement.
Furthermore, the study of Amir et al. (2014) as well as Hartono et al. (2019) separately reported that gender influences the level of academic engagement of students in favour of female students. However, Appiah-Kubi et al. (2022) reported that gender has no influence on the level of academic engagement of students. The foregoing is an indication of the level of inconclusiveness on studies relating to gender and students` achievement as well as engagement. It is important to note that the level of academic achievement as well as engagement of students in test and measurement course can be influenced by such socially construct variable as gender. According to Offorma (2016), gender is a social construct that is allocated to people as either male or female. Ogunkunle (2014) asserts that gender is culturally defined by the tasks assigned to both males and females. Ogunkunle further defines gender as the characteristics, behaviors, and responsibilities that society has allocated to males and females. Thus, gender refers to the responsibilities and rights that men and women are accorded in families, societies, and cultures. Essentially, gender is a socially constructed element that can affect how people act, interpret events, and behave.
In essence, a student's achievement and engagement in measurement and evaluation could be affected by their gender. According to Effiom and Abdullahi (2021), gender has a big influence on students` academic achievement. In contrast, Osuafor and Orji (2017) discovered that gender has no impact on students' achievement. In the same way, King (2016) and Lietaert et al. (2015) found that gender significantly influence students` engagement in favour of female students, whereas, the study of Appiah-Kubi et al. (2022) reported that gender does not influence the level of engagement of students. These reports show inconsistencies in findings of scholars. It is on this basis that this study seeks to determine the effect of flipped classroom technique on Integrated Science Students achievement and engagement in test and measurement course while examining the influence of gender.

2.1 THEORETICAL FRAMEWORK

This study is anchored on Engagement theory by Kearsley and Shneiderman in 1998. The Engagement theory was considered as a model for learning in a technologically driven environment. According to the engagement theory, learning must be actively pursued by students in order for it to be successful. There are three main ways to achieve engagement. They emphasize collaboration, project-based learning, and other areas other than academics. The theorists believe that these three approaches result in authentic, meaningful, and creative learning. According to this principle, technology should make all forms of involvement easier. As a result, utilizing digital resources like audio, films, etc. improves the volume and quality of interaction among all participants as well as information availability. According to engagement theory, the vast collection of digital tools for planning, problem-solving and making presentations make students to engage in complex tasks. Technology thus, provides an electronic learning environment that fosters the kind of creativity and communication needed to nourish engagement. This theory is therefore believed to represent a new paradigm for learning and teaching in the information age, emphasizing the positive role that technology can play in human interaction and evolution.
The use of flipped classroom teaching strategy whichn this study, whichh necessitates the use of technology gadgets, makes this theory relevant to it. This is an important part of the idea. Additionally, this study made use of learner interaction and learning tools designed to engage students, which is the theory's main point of attention. As a result, this study used the flipped classroom strategy to increase students' engagement and achievement. This study investigated the interaction effect of flipped instructional strategy on academic achievement and engagement of students in test and measurement course. Specifically, the study addressed the following issues;

1. What is the influence of gender on the mean achievement score of students?
2. What is the influence of gender on the mean engagement score of students?
3. What is the interaction effect of instructional strategies and gender on students` achievement?
4. What is the interaction effect of instructional strategies and gender on students` engagement?

Hypotheses

Ho_1: There is no significant influence of gender on the mean achievement scores of student in test and measurement course
Ho_2: There is no significant influence of gender on the mean engagement score of students in test and measurement course
Ho_3: There is no significant interaction effect of instructional strategies and gender on students` achievement in test and measurement course
Ho_4: There is no significant interaction effect of instructional strategies and gender on students` engagement in test and measurement course

3. Method

3.1 Design

A quasi-experimental research design was employed involving pretest post-test non-equivalent group design. Quasi-experimental design is used in settings where the experimental and control groups are naturally assembled in intact classes so as not to disrupt the academic programme of the schools involved in the study (Nworgu, 2015). The design is considered appropriate for this study because the researcher will be using intact classes (non-randomized group).

3.2 Setting and Participants

The population comprise third year NCE students in the 8 colleges of education in the area for 2022/2023 academic session. This population comprise of all 3rd year NCE students in Colleges of Education in Enugu State, Nigeria. 60 male and 60 Female of Integrated Science students offering Test and Measurement course participated in the study. Simple random sampling technique involving balloting with replacement and purposive sampling technique guided the sampling procedures. The researchers selected 60 males and 60 females respectively from the intact classes. This is because, gender is of interest in the study. The sample schools will be randomly assigned to experimental groups and control groups. 30 male and 30 female students were in the experimental group while 30 male and 30 female students were in the control group.

3.4 Data Collection

Test and Measurement Achievement Test (TMAT) and Test and Measurement Academic Engagement Scale (TMAES) were instruments used for data collection. The TMAT instrument was developed by the researchers. Section A captured bio-data information such as gender while section B which measure students` achievement in test and measurement course contained 20 multiple-choice test items. The TMAT instrument was developed based on the guideline of test blue print (TBP). The construction of the test blue print was guided by the objectives of the content areas covered in this study which was derived from the Test and Measurement course outline. The Test and Measurement Academic Engagement Scale (TMAES) was designed by the researchers and it contains 15 items measuring students` academic engagement in Test and Measurement. The TMAES instrument was structured into two (2) sections, A and B. Section A provided information on students` personal data such as gender, while section B contained items on students` engagement in Test and Measurement course. The items of TMAES were positively and negatively cued to avoid response set. Each item on the TMAES instrument has a response option of strongly agreed, agreed, disagreed and strongly disagreed with a scale rating of 4, 3, 2, and 1 respectively. Both TMAT and TMAES instruments was used for pretest and reshuffled for post-test.

3.5 Validation of the Instrument

The instruments (TMAT and TMAES) were face validated by experts. The experts were requested to check for the appropriateness of the instruments in line with the purposes of the study, clarity of items, sentence structure, spelling errors, proper numbering, ambiguity of the items in relation to the students` level of understanding, and to ensure that no item was double-barreled, among others. The content validity of TMAT was determine using test blue print, the researchers constructed the test blue print using the topics for the study. This was done using the modified Bloom`s taxonomy (remembering, understanding, applying, analyzing, evaluating and creating) and in line with the stated objectives of the topics for the study.

3.6 Reliability of the Instrument

The reliability indices of the instruments were determined by trial testing and administering of the two instruments to 30 students in schools outside the main sampled schools used for this study. The results of the administered instruments were recorded and subjected to analysis involving Kuder-Richardson formula 20 and Cronbach alpha method. The KR-20 formula was used to establish the internal consistency reliability index of the TMAT instrument and it yielded and estimate of 0.73. The choice of KR_{20} formula was because the instrument is dichotomously scored. K-R_{20} was used since it is most suitable for measuring the internal consistency reliability of instruments that are dichotomous in response. Whereas, the internal consistency reliability index of TMAES was determined to be 0.88 using Cronbach-alpha. The choice of Cronbach alpha is because, it is most reliable for instruments that are on continuous rating (polytomously scored).

3.7 Experimental Procedure

In a bid to ensure that the experimental process is seamless, we obtained consent from the Head of Department (HOD) of education in each selected school. A pedagogical experiment was conducted to collect data. The experiment was conducted during Test and Measurement class, where the topics were discussed.

3.7.1 Control of Extraneous Variables

The procedures outlined below were employed in order to control for extraneous variables in this study.

Teacher Variables: Teachers` difference is bound to arise, in order to control for this effect or on students` achievement and engagement in Test and Measurement course, the regular lecturer of research in the sampled schools were trained and used in this study. This approach is intended to minimize the effect of teacher variable such as newness. The teachers were subjected to training regarding the instructional procedures and the experimental procedures before the commencement of the experiment.

Inter Group Variables: Since intact classes were used, there is bound to be error due to non-randomization of participants. In order to eliminate this error, the data collected during the course of this study was subjected to statistical analysis involving Analysis of Covariance (ANCOVA). This helped to control for initial group variations.
Instructional Situation Variable: An instructional guide (lesson plan) was prepared by the researchers and used by the research assistants throughout the period of the study. This served as guide and helped to control for instructional situation variable.
Effect of Pretest on Post-test: In order to reduce the effect of pretesting on the post-test, the administration gap was four weeks and after the pretest, the items of the instrument (TMAT) was reshuffled. This made it difficult for the students to be familiar with the items on the test instrument.
Subject Interaction: The use of two colleges of education controlled for the extraneous variable which may be due to the interaction effect of both the treatment groups as well as diffusion. This equally eliminate Hawthorne effect which occurs when the behaviour of the subject is influenced not just by the treatment but also by the fact that they are aware of the purpose of this study and the activities taking place in the various experimental groups.

3.8 Method of Data Analysis

The data collected in this study were subjected to statistical analysis using the Statistical Package for Social Sciences version 23. Research questions were answered using mean and standard deviation while the hypotheses were tested using Analysis of Covariance (ANCOVA) at level of significance of 0.05. The choice of ANCOVA is to control for initial group variations since the intact classes are not equivalent. The effect of the pretest on the post-test were adjusted. If the associated exact probability value (p-value) obtained is less than 0.05 level of significance, the null hypothesis will be rejected, otherwise, not rejected.

4. Results

The result in Table 1 shows the mean and standard deviation on the influence of gender on ISE students` academic achievement in Test and Measurement course. The result shows that male students taught Test and Measurement had a pretest mean achievement score of (n=60, $\bar{X}$= 31.23, SD=5.89) and post-test (n=60, $\bar{X}$= 71.67, SD=14.81) with a mean gain of 40.44 while female students taught Test and Measurement had a pretest mean achievement score of (n=60, $\bar{X}$= 38.27, SD=8.64) and post-test (n= 60, $\bar{X}$= 67.00, SD=10.18) with a mean gain of 28.73. The result equally showed a mean difference of 11.71 obtained. The result means that the mean academic achievement score of male students taught Test and Measurement was higher than that of their female counterparts.

Table 1. Influence of gender on students` achievement in Test and Measurement course

		Pretest		Post-Test			
Gender	**N**	$\bar{X}$	**SD**	$\bar{X}$	**SD**	**Mean Gain**	**Mean Difference**
Male	60	31.23	5.89	71.67	14.81	40.44	11.71
Female	60	38.27	8.64	67.00	10.18	28.73	

The result in Table 2 on the significance influence of gender on the mean academic achievement scores of ISE students in Test and Measurement course shows that the F-ratio of 16.714 obtained is associated to an exact probability value of 0.000. Since the p-value of 0.000 obtained is less than 0.05 level of significance set for decision making, the null hypothesis was rejected. Based on the result, conclusion drawn is that there is a significant influence of gender on the mean achievement scores of ISE students in Test and Measurement course. The result shows a partial eta square (η^2_p) of 0.127. This means that 12.7% of the increase in the mean academic achievement scores of students in Test and Measurement course was due to the influence of gender.

Table 2. ANCOVA result on the significant difference in the mean achievement scores of students taught T & M using flipped classroom strategy and lecture method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	13050.416[a]	4	3262.604	56.453	.000	.663
Intercept	17069.121	1	17069.121	295.347	.000	.720
Pretest	335.416	1	335.416	5.804	.018	.048
Strategy	9719.611	1	9719.611	168.178	.000	.594
Gender	965.984	1	965.984	16.714	.000	.127
Strategy * Gender	2271.821	1	2271.821	39.309	.000	.255
Error	6646.251	115	57.793			
Total	596550.000	120				

Corrected Total	19696.667	119

a. *R Squared = .663 (Adjusted R Squared = .651)*

Table 3 shows the mean and standard deviation on the influence of gender on ISE students` academic engagement in Test and Measurement course. The result shows that male students taught Test and Measurement had a pretest mean academic engagement score of (n=60, $\bar{X}$= 24.60, SD=6.06) and post-test (n=60, $\bar{X}$= 49.62, SD=5.82) with a mean gain of 25.02 while female students taught M & E had a pretest mean academic engagement score of (n=60, $\bar{X}$= 28.02, SD=4.74) and post-test (n= 60, $\bar{X}$= 47.25, SD=6.39) with a mean gain of 29.23. The result equally showed a mean difference of 19.23. The result means that the mean academic engagement score of male students taught Test and Measurement was higher than that of their female counterparts.

Table 3. Mean and standard deviation on the influence of gender on students` academic engagement in M & E course

		Pretest		Post-Test			
Gender	**N**	$\bar{X}$	**SD**	$\bar{X}$	**SD**	**Mean Gain**	**Mean Difference**
Male	60	24.60	6.06	49.62	5.83	25.02	5.79
Female	60	28.02	4.74	47.25	6.39	19.23	

Table 4 shows the ANCOVA result for the significance influence of gender on the mean academic engagement scores of ISE students taught Test and Measurement. The result shows that an F-ratio (1, 115) =5.966, p<0.000 was obtained. The associated exact probability value of 0.016 obtained is less than 0.05 level of significance set for decision making. Therefore, the null hypothesis was rejected. Inference, drawn was that, there is significant influence of gender on the mean academic engagement score of ISE students in Test and Measurement course. The result also shows a partial eta square (η^2_p) of 0.049. This means that 4.9% of the increase in the mean academic engagement scores of students in Test and Measurement course was due to the influence of gender.

Table 4. ANCOVA result on the significant difference in the mean academic engagement scores of students taught T & M using flipped classroom strategy and lecture method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1019.891[a]	4	254.973	8.228	.000	.223
Intercept	7459.335	1	7459.335	240.720	.000	.677
PreEngage	17.291	1	17.291	.558	.457	.005
Strategy	661.878	1	661.878	21.359	.000	.157
Gender	184.887	1	184.887	5.966	.016	.049
Strategy * Gender	77.709	1	77.709	2.508	.116	.021
Error	3563.576	115	30.988			
Total	286078.000	120				
Corrected Total	4583.467	119				

a. R Squared = .223 (Adjusted R Squared = .195)

Result in Table 5 shows the interaction effect of instructional strategies and gender on students` achievement in Test and Measurement course. The result shows that male students taught Test and Measurement course using flipped classroom strategy had a mean achievement score of (n= 30, $\bar{X}$= 29.83, SD=5.80) for pretest and (n= 30, $\bar{X}$= 85.17, SD=6.88) for post-test with a mean gain of 55.34 while their female counterparts had a mean score of (n= 30, $\bar{X}$= 34.20, SD=7.87) for pretest and (n= 30, $\bar{X}$=71.33, SD=10.25) for post-test with a mean gain of 36.13 and a mean difference of 19.21. The result showed that male students exposed to flipped classroom strategy scored higher when compared to their female counterparts. The result in Table 7 further shows that male students under lecture method had a mean achievement score of (n= 30, $\bar{X}$= 32.62, SD=5.73) for pretest and (n= 30, $\bar{X}$= 58.17, SD=4.64) for post-test with a mean gain of 25.54 while female students exposed to the same treatment had a mean achievement score of (n= 30, $\bar{X}$= 41.33, SD=8.40) for pretest and (n= 30, $\bar{X}$= 62.67, SD=8.17) for post-test with a mean gain of 21.34 and a mean difference of 4.20. This result implies that male students under lecture had a higher mean achievement score in Test and Measurement course when compared to the females.

Table 5. Interaction effect of instructional strategies and gender on students` achievement in T & M Course

			Pretest		Post-Test			
Instructional Strategies	**Gender**	**N**	$\bar{X}$	**SD**	$\bar{X}$	**SD**	**Mean Gain**	**Mean Difference**
Flipped Classroom	Male	30	29.83	5.80	85.17	6.88	55.34	19.21
	Female	30	35.20	7.87	71.33	10.25	36.13	

Lecture Method	Male	30	32.63	5.73	58.17	4.64	25.54	
	Female	30	41.33	8.40	62.67	8.17	21.34	4.20

The result present in Table 2 on the significant of the interaction effect of instructional strategies and gender on the mean achievement scores of students in Test and Measurement course shows that the F-value of 39.309 obtained has an associated exact probability value of 0.000. This p-value of 0.000 is less than 0.05 level of significance, hence, the null hypothesis was rejected. Inference drawn is that there is significant interaction effect of instructional strategies and gender on ISE students` achievement in test and measurement course. The result further shows that a partial eta square, η_p^2 (effect size) of 0.255 was obtained. This is an indication that only 25.5% of the variance increase in the mean achievement scores of students in Test and Measurement course was due to the interaction effect of instructional strategies and gender. This result is supported and explained by the interaction graph in Figure 1, which shows that there is significant interaction effect of instructional strategies and gender because the interaction lines intercepted at point as shown in Fig. 1.

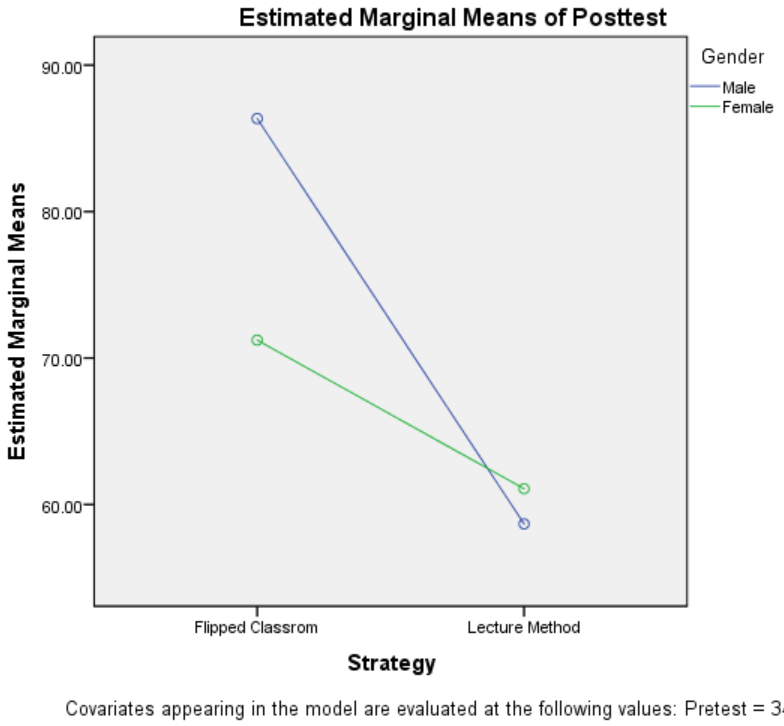

Figure 1. Graph of dis-ordinal interaction effect of instructional strategies and gender on students` achievement in Test and Measurement course.

Result in Table 6 shows the interaction effect of instructional strategies and gender on students` academic engagement in Test and Measurement course. The result shows that male students taught Test and Measurement course using flipped classroom strategy had a mean academic engagement score of (n= 30, $\bar{X}$= 20.53, SD=5.58) for pretest and (n= 30, $\bar{X}$= 51.03, SD=3.29) for post-test with a mean gain of 30.50 while their female counterparts had a mean score of (n= 30, $\bar{X}$= 27.57, SD=4.45) for pretest and (n= 30, $\bar{X}$=50.70, SD=5.82) for post-test with a mean gain of 23.13 and a mean difference of 7.37. The result showed that male students exposed to flipped classroom strategy scored higher when compared to their female counterparts. The result further shows that male students under lecture method had a mean academic engagement score of (n= 30, $\bar{X}$= 28.67, SD=6.06) for pretest and (n= 30, $\bar{X}$= 48.20, SD=7.36)for post-test with a mean gain of 19.53 while female students exposed to the same treatment had a mean achievement score of (n= 30, $\bar{X}$= 28.47, SD=4.74) for pretest and (n= 30, $\bar{X}$= 43.80, SD=4.96) for post-test with a mean gain of 15.33 and a mean difference of 4.20. This result implies that male students under lecture had a higher mean academic engagement score in Test and Measurement course when compared to the females.

Table 6. Interaction effect of instructional strategies and gender on students` academic engagement in T & M Course

			Pretest		Post-Test			
Instructional Strategies	**Gender**	**N**	$\bar{X}$	**SD**	$\bar{X}$	**SD**	**Mean Gain**	**Mean Difference**
Flipped Classroom	Male	30	20.53	5.58	51.03	3.29	30.50	7.37
	Female	30	27.57	4.45	50.70	5.82	23.13	

Lecture Method	Male	30	28.67	6.06	48.20	7.36	19.53	
	Female	30	28.47	4.74	43.80	4.96	15.33	4.20

Table 4 on the significant of the interaction effect of instructional strategies and gender on the mean academic engagement scores of ISE students in test and measurement course shows that the F-value (1, 115) = 2.508, p>0.05 were obtained. This p-value of 0.116 is greater than 0.05 level of significance set for decision making, hence, the null hypothesis was not rejected. Inference drawn is that there is no significant interaction effect of instructional strategies and gender on ISE students` academic engagement in test and measurement course. The result further shows that a partial eta square, η_p^2 (effect size) of 0.021 was obtained. This is an indication that only 0.21% of the variance increase in the mean academic engagement scores of students in test and measurement course was due to the interaction effect of instructional strategies and gender. This result is supported and explained by the interaction graph in Figure 2, which shows no significant interaction effect of instructional strategies and gender because the interaction lines did not intercept at any point as shown in Fig. 2.

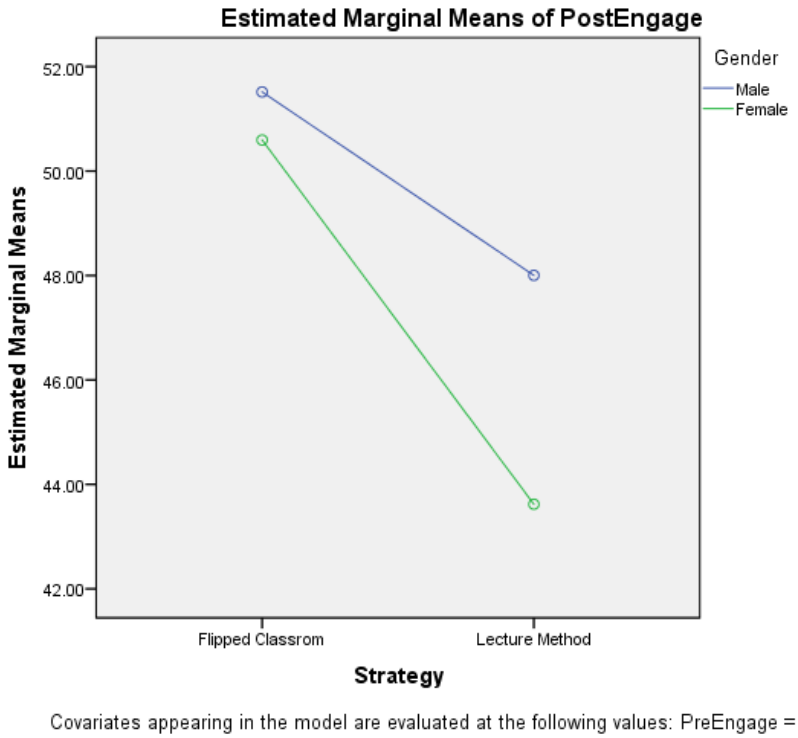

Figure 2. Graph of dis-ordinal interaction effect of instructional strategies and gender on students` academic engagement in T & M course.

5. Discussion

INFLUENCE OF GENDER ON STUDENTS ACADEMIC ACHIEVEMENT IN TEST AND MEASUREMENT COURSE

The findings shows that the mean academic achievement score of male ISE students was significantly higher than that of the female students in Test and Measurement course. This shows that male students achieve higher than females in the course. This result is plausible since male students tend to be more technology inclined than the females and since the use of flipped classroom requires that students engage more in their learning and make use of ICT-based devices. This could have increased the academic achievement of the male students over the female students. This supports the findings of Akala (2010) that gender significantly relates to students` academic achievement. More so, the study agrees with the report of Aina and Akintunde (2013) that gender as a variable influence students' academic achievement. These results are indicative of the fact that gender determines students` academic achievement in Test and Measurement course.

ACADEMIC ENGAGEMENT SCORES OF MALE AND FEMALE STUDENTS IN TEST AND MEASUREMENT COURSE

We discovered that instructional strategies improves the academic achievement of male and female ISE students in Test and Measurement course. However, the result equally shows that the mean academic engagement of male students was significantly higher than that of the female students in Test and Measurement course. This means that male students tend to become more actively involved in their learning

of Test and Measurement course whenever they are taught using flipped classroom. This result is like this because the use of flipped classroom involves students in learning both in and outside the classroom using varieties of technology-based resources. Since male students tend to be more technology inclined, it could have made them to be more involved than the females, thereby, leading to high academic engagement among them. This result is consistent with the findings of Amir et al. (2014) as well as the study of Akpaghol et al. (2016) that gender significantly influence students` academic engagement. The study however, disagreed with the findings of Appiah-Kubi et al. (2020) that gender has no influence on students` academic engagement. These disparities may be due to the location of the study and the kind of instructional strategy used.

INTERACTION EFFECT OF INSTRUCTIONAL STRATEGIES AND GENDER ON STUDENTS` ACHIEVEMENT IN TEST AND MEASUREMENT COURSE

The findings further revealed an interaction effects of instructional strategies and gender on ISE students` academic achievement in Test and Measurement course. From the result, the interaction effect was found to be significant. This is indicative of the fact that the instructional strategies were gender biased with respect to students` academic achievement in Test and Measurement course in favour of the males. This result is not surprising because Test and Measurement course is statistical and mathematical in nature, the phobia of mathematics could have made the female students achieve lower than the males, thereby, leading to improvement in their academic achievement when compared to the female students. This result agrees with the findings of Aina and Akintunde (2013) that gender influences students` academic achievement. This equally aligns with the report of Akpoghol et al. (2016) that students` academic achievement is influenced by their gender.

INTERACTION EFFECT OF INSTRUCTIONAL STRATEGIES AND GENDER ON STUDENTS` ACADEMIC ENGAGEMENT IN TEST AND MEASUREMENT COURSE

The result of this study shows that there exist no significant interaction effect of instructional strategy and gender on students` academic engagement in Test and Measurement course. In essence, the instructional strategies were not gender sensitive in terms of students` academic engagement. This result is possible because both male and female students could find the instructional strategies to be appealing with respect to their academic engagement. As a result, the students could have actively participated and were fully involved in the process of learning in and outside the classroom using technology-based resources. Thereby, leading to improvement in academic engagement of both male and female students. This finding agrees with the report of Appiah-Kubi et al. (2020) that gender has no influence on students` academic engagement. However, the report of Hartono et al. (2019) disagreed, stating that gender influences students` academic engagement. The findings also disagreed with the report of Fernández-Carballo (2022) who found an improvement in attitude, motivation, and interest towards the subject, as well as an increase in students' autonomy and in the interactions among students themselves and between students and the teacher. These observed differences may be due to location and the type of instructional approach used.

6. Conclusions, Limitations, and Future Research

The use of flipped classroom strategy was potent in improving students` achievement and academic engagement in Test and Measurement course. This goes on to say that if teachers do not use this strategy, students may not achieve high in Test and Measurement course and will as well have a low academic engagement. Therefore, lecturers should ensure that their students are taught Test and Measurement using flipped classroom strategy and they are made to participate actively in the study of Test and Measurement both in school and at home using variety of resources such as ICT based resources. This will enable the students to improve in their achievement and academic engagement. Efforts should be made by educational stakeholders so as to bridge the gender gap in the achievement and engagement of students in Test and Measurement course. This could help both male and female students become more responsible towards their studies. Hence, leading to improved achievement and academic engagement in Test and Measurement course. Curriculum planners should ensure that effective teaching methods such as the flipped classroom instructional strategy is incorporated into the university curriculum so as to facilitate students` achievement and engagement in Test and Measurement course.

The research assistants might not ”ave ’roperly understood or mastered the appropriate steps on how to apply the teaching methods because of the short period of training. Thus, the administrations of the teaching methods may not be effective enough, this could have affected the result of this finding. This study can also be replicated using other subject areas such as English language, Mathematics, Physics, among others at the secondary school level.

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