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INFLUENCE OF FLIPPED CLASSROOM MODELS ON PRE-SERVICE TEACHERS' ATTITUDE TOWARDS CHEMISTRY IN COLLEGES OF EDUCATION IN NORTH-CENTRAL, NIGERIA

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Abstract
The study assessed the influence of flipped classroom models on pre-service teachers' attitude towards chemistry in colleges of education, north central, Nigeria. The study adopted a descriptive survey design. A sample of 350 pre-service chemistry teachers was selected using purposive sampling technique. A researcher-designed structured questionnaire was used for data collection that was validated by three experts. The questionnaire was pilot tested and the data obtained were analysed and reliability coefficients of 0.80 was obtained. One-way ANOVA reported that $F_{(2,347)}= 8.863$, $p = 0.000$. $p<0.05$ indicating a significant difference in the mean attitude rating response of pre-service chemistry teachers. The p-value is less than the level of significance, hence hypothesis one is rejected. A Sidak post-hoc analysis was done to identify the direction of the difference among the treatment groups and a significant difference occur between the mean attitude of pre-service teachers taught Chemistry using standard-inverted and virtual flipped classroom models. However, no significant difference was observed between the mean attitude of pre-service teachers taught Chemistry using standard-inverted and demonstration based flipped classroom models. The study concluded that pre-service teachers taught Chemistry using standard-inverted flipped classroom had higher mean attitude ratings than those taught using demonstration based and virtual flipped classroom models respectively. In the light of these findings, it was

recommended among others that the standard inverted flipped and demonstration based flipped classroom.

Keywords: Attitude, Chemistry, demonstrated, standard-inverted, virtual, flipped classroom models and influence.

Introduction

The 21st century technological revolution has disruptively broken the walls bounding the classroom given rise to the emergence of several instructional strategies for teaching and learning process like the Massive Open Online Course (MOOCs), e-learning, blended learning and Flipped classroom models (Espin *et al.*, 2022). ICT integration into the educational sector empowers learners, improves educational outcomes through Massive Open Online Course (MOOCs), e-learning, blended learning and Flipped classroom models. The flipped classroom model is seen as an innovative approach to teaching and learning, with the potential to enhance student engagement and learning outcomes. The concept of flipped classroom gained momentum in the early 2000s, when new technologies, such as screen casting software, rise of social media and online video platforms made it easier for teachers to record and share their educational content online. Since then, the flipped classroom model has gained popularity worldwide, and numerous studies have been conducted to evaluate its effectiveness.

The FC or inverted classroom is a new teaching style that brings basic content out of the planned class time for learners to study freely, allowing educator to involve students in group discussions and interactive learning activities during the lesson period in the class for a higher-level thinking (Bergmann and Sams, 2012). The pioneers of the flipped classroom were quick to recognize that the idea of a flipped classroom is a mindset, a methodology, not a mold that classrooms can be placed into. Flipped classroom according to Ismaila and Abdullahi (2019) is a personalized learning strategy that inverts classroom activities where pre-recorded lectures or lessons are provided to students in a video, audio or printed form for self-study outside the classroom followed by activities like clarifications, question and answer sessions, discussions, exercises in the class. In a traditional classroom, students listen to lectures and receive instruction from the teachers during class time and then complete homework assignments outside classroom while in a flipped classroom, this model is reversed, students watch recorded lectures or other instructional materials online or offline outside classroom and then come to class to work on activities from the lesson, solve problems, and collaborate with other learners under the guidance of the teacher (Haruna, *et al.*, 2023).

In the flipped classroom, the roles and expectations of students and teachers changes, students take more responsibility for their own learning and study core content either individually or in groups before class and then apply knowledge and

skills to a range of activities using higher order thinking, teachers focus more on facilitation and moderation than lecturing (Tan and Wong, 2020). Significant learning opportunities can be gained through facilitating active learning, engaging students, guiding learning, correcting misunderstandings and providing timely feedback using a variety of pedagogical strategies.

There are several FC models, each having it approach to organizing instructional activities according to Lestari *et al.* (2024) who posited that there is no single specific way to flip a classroom; he established that the idea of FC is a mindset, a methodology, not a mold that classrooms can be placed into. The most suitable flipped classroom models for studies involving science subjects according to Bergmann and Sams, (2012) are the standard inverted flipped classroom model; demonstration based flipped classroom model and virtual flipped classroom model. As such, these three flipped classroom models were considered most relevant to teaching science subjects. There is a greater focus on concept exploration, meaning making and demonstration or application of knowledge in the flipped classroom to improve learning outcomes and positive attitude towards chemistry as a subject.

Chemistry is a required subject in secondary schools in Nigeria which must be passed at credit level by science students seeking admission into higher institutions especially in universities and Colleges of Education. According to Achimugu and Muftawu (2019) basic infrastructures like electricity, pipe-borne water, and technical resources, safe and secure facilities that are essential to successful educational programs contributed to students' negative attitude which in turn results to low students' achievement. Most students have unpleasant belief that learning of Chemistry is an unachievable mission and lack interest in the subject from their tender age. A large number of students have the notion that competence in Chemistry is retained for a particular set of students. Nigerian adults are fond of declaring their incompetent in Chemistry openly without shame. Ogundeji and Oke (2019) noted that the factors affecting the learning of Chemistry in Nigeria especially at both secondary and tertiary level are historical, political, social and academic problems. Academic problems include students' unparalleled revulsion, apathy and bad attitude towards Chemistry.

Attitude in the context of this research refers to a student beliefs, feelings, and disposition towards chemistry as a subject (Anderson and Green, 2021). Attitudes are formed by people as a result of some kinds of learning experience, if the experience is favorable a positive attitude is found and vice versa (Ahmad and Roberts, 2020). Some attitudes are based on people's experience, knowledge and skills and some are gained from other sources. Research has shown that students' attitude towards science subjects is influenced by the quality of exposure, the learning environment, and teaching methods they are exposed to (Green and Johnson, 2020). If students have negative attitude towards science subjects, this

may affect their interest to the courses and the teachers. Students' attitude towards science is more likely to influence achievement in science courses than achievement influencing attitude (Green and Johnson, 2020). Similar results were obtained by Harper and Nguyen (2019) who found that students need to have a positive attitude towards problem solving to be successful, and this problem-solving requires students' knowledge and problem-solving skills to overcome risks. The study conducted by Bektaş *et al.* (2017) also Johnson and Clarke (2020) affirmed that attitude, whether positive or negative, affect learning in sciences. However, a negative attitude towards a certain subject makes learning and retention difficult. Therefore, understanding student attitude becomes an important aspect of this research to ensure a better learning outcome irrespective of gender.

Gender is a social-cultural phenomenon that divides individual into various categories such as males and females with each having associated stereotypes', roles and dress. Similarly, Ojo, *et al.,* (2013) sees gender to have predominantly affected achievement and attitude of learners towards chemistry, to the contrary many other researchers opined that gender issues in science education is inconclusive.

Statement of the Research Problem

In recent years, the flipped classroom model has gained attention as an innovative way to shift learning from passive listening to active participation. Instead of the usual lecture-driven format, students in flipped classrooms engage with new material at home and then apply it in interactive, hands-on ways during class time. Research from around the world shows that this approach can positively impact students' attitudes and learning outcomes across various subjects. However, little is known about how these models might affect pre-service teachers in North Central Nigeria, particularly in a subject like chemistry, which many students often find challenging or disengaging. Most Colleges of education in this region still rely heavily on traditional lecture methods, which can contribute to low enthusiasm and negative attitudes toward chemistry among future educators. Investigating how a flipped classroom approach might change these attitudes could not only improve pre-service teachers' experience but also inspire more effective, engaging teaching methods in the long run. This research has the potential to offer insights that could reshape chemistry education in ways that are more appealing and impactful for future educators in this region. Hence, the need for this research on the influence of flipped classroom models on pre-service teachers' attitude towards chemistry in colleges of education, north central, Nigeria.

Research Objectives

The following research questions were raised and answered in this study:

i. Identify the attitude of pre-service teachers taught Chemistry with standard-inverted, virtual and demonstration based flipped classroom models.
ii. Determine the attitude of male and female pre-service teachers taught Chemistry with standard-inverted, virtual and demonstration based flipped classroom models.

Research Questions

i. What is the mean attitude ratings of pre-service teachers taught Chemistry with standard-inverted, virtual and demonstration based flipped classroom models?
ii. What is the mean attitude of male and female pre-service teachers taught Chemistry with standard-inverted, virtual and demonstration based flipped classroom models?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance:

$H0_1$: There is no significant difference in the mean attitude ratings of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models

$H0_2$: There is no significant difference in the mean attitude ratings of male and female pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models.

Literature Review

This study was conducted by Bektaş *et al.* (2017) to investigate the effects of the implementation of the Flipped Classroom (FC) model and Just-in-Time-Teaching (JiTT) model on students' academic achievement and their attitudes towards the course in Chemistry lessons. The study is causal-comparative research. One hundred and seventy-nine students who study in a high school in Turkey participated in this study. A total of 89 students in the 10th grade were assigned to the FC group, and 90 students in the 10th grade were assigned to the JiTT group. The study revealed that the students in the FC group had statistically significantly higher academic achievement and positive attitudes towards the course than those in the JiTT group. It was also found that there was a significant relationship between achievement and attitudes in the FC group while there was no such relationship in the JiTT group. The research findings revealed that the FC model was more effective than the JiTT model. It was also revealed that academic achievement and attitudes towards Chemistry course were significantly different among students with different socio-economic backgrounds.

Vosburg *et al.* (2016) carried out research on effect of flipped classroom on students' learning gains and attitudes in upper-division Biochemistry laboratory courses." This study was conducted by the results of the study revealed that, when

compared to students who participated in a traditional Biochemistry laboratory; students in the flipped laboratory achieved a significantly higher average overall course grade and had more positive attitudes toward laboratory work. The results showed that although both groups achieved comparable learning gains on conceptual content material, students in the flipped laboratory group demonstrated greater learning gains on data analysis, experimental skills, and understanding of connections to course content.

Zhao and Smith (2015) conducted research on the area of cognitive, emotional, behavioral and argentic in order to monitor students' attitude to flipped classroom in all areas of learning for better retention. This study was based on the researcher-designed package that measured the students' Achievement, retention, and attitude in relation to gender and students' ability in a flipped classroom environment to enhance overall students' Achievement. In this study also, the researcher compared the use of FC package to a traditional method of teaching as the primary independent variables in measuring students' achievement in Chemistry which is the major dependent variable through students' retention, post-test Achievement, and attitude. While the intervening and moderating variables which are the secondary independent variables, on the other hand, are the students' ability levels and gender respectively. In the application of a developed FC package, students were engaged in all areas of learning, that is, behavioural, emotional, cognitive and argentic. The research found that FC increased student satisfaction, improved communication skill, and consequently, enhanced the learning experience of the student.

These group of scholars, Yuli *et al.* (2018) investigated on the effect of Cooperative Learning type TPS with Autograph to the students Mathematical Representation Ability and the effect of Cooperative Learning model type TPS with Autograph helping to the students Self-Efficacy. The research samples comprised 36 XI 5 graders (experiment I class) and 36 XI 6 graders (experiment II class) from a Senior High School (SMA) in Medan. They used a quasi-experimental design with Cooperative Learning type TPS with Autograph and Cooperative Learning type TPS without Autograph as the independent variables. The 78 dependent variables included the mathematical representation ability and students self-efficacy. The instrument used consisting of the initial mathematical abilities (KAM) test, mathematical representation ability test and self-efficacy questionnaire. The analysis used two-way ANOVA. The research findings indicate that there is a significant effect of Cooperative Learning model type TPS with Autograph to the students' mathematical representation ability and there is a significant effect of Cooperative Learning model type TPS with Autograph to the students of self-efficacy. The similarity between both studies is that both studies concentrate attitude of students in Chemistry, the difference between both studies uses quai-experimental design, that the former investigated on the effect of Cooperative

Learning type TPS with Autograph to the students Mathematical Representation Ability and the effect of Cooperative Learning model type TPS with Autograph helping to the students Self-Efficacy

On the other hand, Adolphus and Omeodu (2016) investigated on the effect of gender and collaborative learning approach on students' conceptual understanding of electromagnetic induction in Secondary Schools in Nigeria. Three research questions and 2 hypotheses were formulated to guide the research. The research design adopted for this study is the quasi-experimental design. In particular, the design is the non-randomized, pretest-posttest, control group design. The population of the study is made up of the 323 Senior Secondary III Physics students in all 6 public co-educational Senior Secondary schools in Port Harcourt local Government area. A sample of 90 students, comprising of 60 male and 30 females were selected for the study. The research instrument developed and used for this study is the Test on Electromagnetic Induction (TOEI). The instrument is composed of 50 questions covering 87 the content area and testing the various levels of understanding. Simple means, standard deviation and variance were used to answer research questions while inferential statistics such as t-test, Analysis of variance (ANOVA) and 2x2 factorial analysis of variance were utilized for the testing of the hypotheses. The results show that gender does not significantly affect the understanding of students in electromagnetic induction when taught with collaborative teaching approach. The study also showed that gender and teaching approaches do not jointly affect students' conceptual understanding of electromagnetic induction at the secondary school level.

Methodology

The research design that was adopted for this study is descriptive survey research design. Rahi (2017) defined descriptive survey design as a popular research design in social sciences that is associated with a deductive research approach where strategic information is collected using a pre-designed questionnaire. Since questionnaires were used to collect the needed and valuable data from the respondents (pre-service chemistry teachers) on their attitude towards chemistry with the influence of flipped classroom; therefore, descriptive survey research design was appropriate for this study. The population of this study comprises of all the pre-service Chemistry teachers' in the four (4) Federal Colleges of Education in the six North-central states (Benue, Kogi, Kwara, Nassarawa, Niger & Plateau and the Federal Capital Territory Abuja, Nigeria (NCCE Digest, 2022). The targeted population of this study was the first-year pre-service Chemistry teachers in the 2023/2024 academic session in North-central, Nigeria. A structured questionnaire developed by the researcher was used for data collection. The questionnaire titled Pre-service Teachers' Attitude towards Chemistry Questionnaire (PTACQ) consisted of two sections; Section A solicited the Bio-data of the respondents while Section B contained 15 items constructed questions by the

researcher used to elicit responses from pre-service teachers with respect to their attitude towards Chemistry as a subject. It contained 5 Point Likert scale ranked and was scored as: 5 for Strongly Agree (SA), 4 for Agree (A), 3 for Undecided (U) 2 for Disagree (D) and 1 for Strongly Disagree (SD) respectively. The decision rule for research questions on attitude rating was tagged at an average mean of 3.0 and above and 2.90 below was considered disagreed. The questionnaire was validated by three experts and a pilot test was conducted at the College of Education, Ankpa on 20 pre-service chemistry teachers. The data were subjected to statistical analysis using Cronbach Alpha Correlation Formula, to determine the internal consistency of the instrument at a reliability coefficient of 0.87 was obtained. Hence, the instrument was considered reliable to collect the needed data. Descriptive statistics of Mean and Standard Deviation were used to answer the two research questions and ANOVA (Analysis of Variance) was used to test hypothesis one and two.

Research Question One

What are the mean attitude ratings of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models?

In answering research question one, the mean attitude ratings of pre-service teachers towards Chemistry using standard-inverted, virtual and demonstration based flipped classroom models were analyzed using mean and standard deviation as shown in Table 1

Table 1

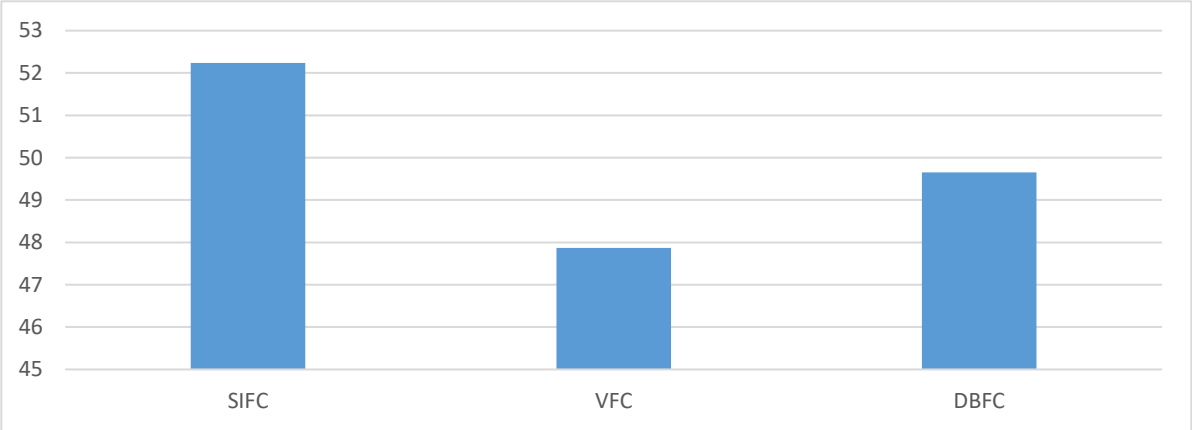
Mean and Standard Deviation on attitude of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models

GROUP	N	Mean	Std. Deviation
SIFC	105	52.24	10.14
VFC	125	47.87	15.38
DBFC	120	49.65	18.01

Table 1 shows the mean and standard deviation on mean attitude ratings of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models. From the result, the mean and standard deviation of pre-service teachers taught Chemistry using standard-inverted flipped classroom model were $\bar{X}$ = 52.24 with SD = 10.14, while the mean and standard deviation of pre-service teachers taught Chemistry using virtual flipped classroom model were $\bar{X}$ = 47.87 with SD = 15.38. Also, pre-service teachers taught Chemistry using demonstration based flipped classroom model were $\bar{X}$ = 49.65 with SD = 18.01. This shows that pre-service teachers taught Chemistry using standard-inverted flipped classroom model had the highest mean attitude than those

taught using demonstration based and virtual flipped classroom models. The graphical representation of the pre-service mean attitude score is illustrated in Figure 1

Figure 1
Graphical illustration on attitude of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models



Research Question Two
What are the mean attitude ratings of male and female pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models?
In answering research question two, the mean attitude ratings of male and female pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models were analyzed using mean and standard deviation as shown in Table 2

Table 2:
Mean and Standard Deviation on attitude of male and pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models

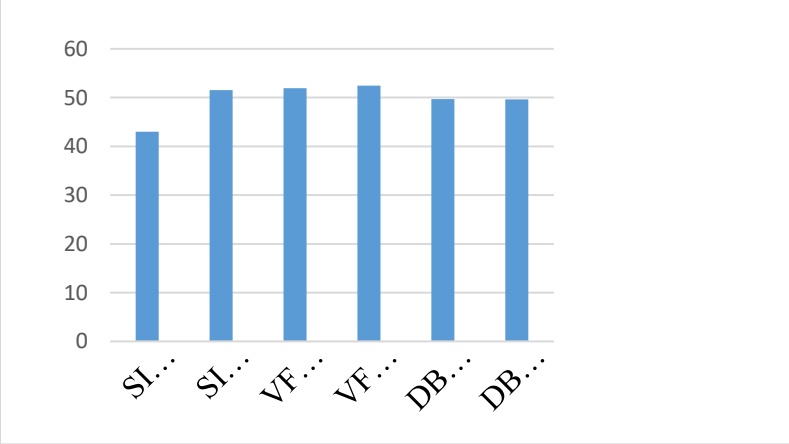
Groups	N	**Mean**	**Std. Deviation**
SIFC Male	45	43.00	12.12
SIFC Female	60	51.52	6.33
VFC Male	50	51.96	5.48
VFC Female	75	52.43	5.34

DBFC Male	48	49.71	7.77
DBFC Female	72	49.61	8.21

Table 2.2 shows the mean and standard deviation on mean attitude ratings of male and female pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models. From the result, the mean and standard deviation of male pre-service teachers taught Chemistry using standard-inverted flipped classroom model were $\bar{X}$ = 43.00 with SD = 12.12, while the mean and standard deviation of female pre-service teachers taught Chemistry using standard-inverted flipped classroom model were $\bar{X}$ = 51.52 with SD = 6.33. Also, the mean and standard deviation of male pre-service teachers taught Chemistry using virtual flipped classroom model were $\bar{X}$ =51.96 with SD = 5.48, while the mean and standard deviation of female pre-service teachers taught Chemistry using standard-inverted flipped classroom model were $\bar{X}$ = 52.43 with SD = 5.34. The result also shows that male pre-service teachers taught Chemistry using demonstration based flipped classroom model were $\bar{X}$ = 49.71 with SD = 7.77, female pre-service teachers taught Chemistry using demonstration based flipped classroom model were $\bar{X}$ = 49.61 with SD = 8.21. This shows that female pre-service teachers taught Chemistry using virtual flipped classroom model had the highest mean attitude than male pre-service teachers taught Chemistry using virtual flipped classroom model and male and female students taught using demonstration based and virtual flipped classroom models. The graphical representation of male pre-service mean attitude score is illustrated in Figure 2

Figure 2

Graphical illustration on attitude of male and female pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models



Hypothesis One

There is no significant difference in the mean attitude ratings of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models.

In testing hypothesis one, the mean attitude ratings of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models was analysed using One-way ANOVA as presented in Table 3

Table 3

One-way ANOVA on the mean attitude ratings of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models

Sources of Variation	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	1119.207	2	559.603	8.863	.000*
Within Groups	21910.233	347	63.142		
Total	23029.440	349			

*: **Significant at 0.05**

Table 3 shows the One-way ANOVA on the mean attitude ratings of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models. From the table, $F_{(2,347)}= 8.863$, $p = 0.000$. The p-value is less than the level of significance, hence hypothesis one is rejected. This indicates that there is a significant difference in the mean attitude ratings of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models. A Sidak post-hoc analysis was done to identify the direction of the difference among the treatment groups as shown in Table 4

Table 4

Sidak post hoc analysis on the mean attitude ratings of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
SIFC	VFC	4.37333*	1.05190	.000	-6.8972	-1.8495
	DBFC	-1.78333	1.06185	.256	-4.3311	.7644
VFC	SIFC	-4.37333*	1.05190	.000	1.8495	6.8972
	DBFC	-2.59000*	1.01554	.033	.1534	5.0266
DBFC	SIFC	1.78333	1.06185	.256	-.7644	4.3311
	VFC	2.59000*	1.01554	.033	-5.0266	-.1534

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

Table 4 shows the Sidak post hoc analysis on the mean attitude ratings of pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models. The table shows a significant difference between the mean attitude of pre-service teachers taught Chemistry using standard-inverted and virtual flipped classroom models. However, no significant difference was observed between the mean attitude of pre-service teachers taught Chemistry using standard-inverted and demonstration based flipped classroom models. Also, a significant difference was revealed between the mean attitude of pre-service teachers taught Chemistry using virtual and demonstration based flipped classroom models.

Hypothesis Two

There is no significant difference in the mean attitude ratings of male and female pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models.

In testing hypothesis two, the mean attitude ratings of male and female pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models was analysed using One-way ANOVA as presented in Table 5

Table 5

One-way ANOVA on the mean attitude ratings of male and female pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2991.162	5	598.232	10.270	.000*
Within Groups	20038.278	344	58.251		
Total	23029.440	349			

*: Significant at 0.05

Table 5 shows the One-way ANOVA on the mean attitude ratings of male and female pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models. From the table, $F_{(5,344)}$= 10.270, p = 0.000. The p-value is less than the level of significance, hence hypothesis two is rejected. This indicates that there is a significant difference in the mean attitude ratings of male and female pre-service teachers taught Chemistry using standard-

inverted, virtual and demonstration based flipped classroom models. A Sidak post-hoc analysis was done to identify the direction of the difference among the treatment groups as shown in Table 6

Table 6

Sidak post-hoc analysis on the mean attitude ratings of male and female pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models

(I) Treatment	(J) Treatment	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	Upper Bound
SIFC Male	SIFC Female	-8.51667*	1.50509	.000	-13.5539	-3.4794
	VFC Male	-8.96000*	1.56827	.000	-14.2087	-3.7113
	VFC Female	-9.42667*	1.43915	.000	-14.2432	-4.6101
	DBFC Male	-6.70833*	1.58367	.004	-12.0086	-1.4081
	DBFC Female	-6.61111*	1.45035	.001	-11.4651	-1.7571
SIFC Female	SIFC Male	8.51667*	1.50509	.000	3.4794	13.5539
	VFC Male	-.44333	1.46146	1.000	-5.3346	4.4479
	VFC Female	-.91000	1.32194	.993	-5.3343	3.5143
	DBFC Male	1.80833	1.47797	.913	-3.1382	6.7548
	DBFC Female	1.90556	1.33412	.843	-2.5595	6.3706
VFC Male	SIFC Male	8.96000*	1.56827	.000	3.7113	14.2087
	SIFC Female	.44333	1.46146	1.000	-4.4479	5.3346
	VFC Female	-.46667	1.39345	1.000	-5.1303	4.1969
	DBFC Male	2.25167	1.54226	.830	-2.9100	7.4133
	DBFC Female	2.34889	1.40501	.731	-2.3534	7.0512
VFC Female	SIFC Male	9.42667*	1.43915	.000	4.6101	14.2432
	SIFC Female	.91000	1.32194	.993	-3.5143	5.3343
	VFC Male	.46667	1.39345	1.000	-4.1969	5.1303
	DBFC Male	2.71833	1.41076	.592	-2.0032	7.4399
	DBFC Female	2.81556	1.25925	.418	-1.3989	7.0300
DBFC Male	SIFC Male	6.70833*	1.58367	.004	1.4081	12.0086
	SIFC Female	-1.80833	1.47797	.913	-6.7548	3.1382
	VFC Male	-2.25167	1.54226	.830	-7.4133	2.9100
	VFC Female	-2.71833	1.41076	.592	-7.4399	2.0032
	DBFC Female	.09722	1.42218	1.000	-4.6625	4.8570
DBFC Female	SIFC Male	6.61111*	1.45035	.001	1.7571	11.4651
	SIFC Female	-1.90556	1.33412	.843	-6.3706	2.5595
	VFC Male	-2.34889	1.40501	.731	-7.0512	2.3534
	VFC Female	-2.81556	1.25925	.418	-7.0300	1.3989
	DBFC Male	-.09722	1.42218	1.000	-4.8570	4.6625

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

Table 6 shows the Sidak post hoc analysis on the mean attitude ratings of male and female pre-service teachers taught Chemistry using standard-inverted, virtual and demonstration based flipped classroom models. The table shows a significant difference between the mean attitude of male and female pre-service teachers taught Chemistry using standard-inverted flipped classroom model. A significant difference was also observed between the mean attitude of male pre-service teachers taught Chemistry using standard-inverted flipped classroom model and male and female pre-service teachers taught Chemistry using virtual flipped classroom models. Also, a significant difference was observed between the mean attitude of male pre-service teachers taught Chemistry using standard-inverted and male and female pre-service teachers taught using demonstration based flipped classroom models.

Result from the table revealed no significant difference between the mean attitude of female pre-service teachers taught Chemistry using standard-inverted flipped classroom model and male and female pre-service teachers taught Chemistry using virtual flipped classroom models. Also, no significant difference was observed between the mean attitude of female pre-service teachers taught Chemistry using standard-inverted and male and female pre-service teachers taught using demonstration based flipped classroom models. No significant difference between the mean attitude of male and female pre-service teachers taught Chemistry using virtual flipped classroom model. Also, no significant difference was observed between the mean attitude of male pre-service teachers taught Chemistry using virtual flipped classroom model and male and female pre-service teachers taught Chemistry using demonstration based flipped classroom models. The table also revealed no significant difference between the mean attitude of female pre-service teachers taught Chemistry using virtual flipped classroom and male and female pre-service teachers taught Chemistry using demonstration-based flipped classroom models. More so, no significant difference was observed between the mean attitude of male and female pre-service teachers taught Chemistry using demonstration based flipped classroom model.

Discussion of Findings

Pre-service teachers taught Chemistry using standard-inverted flipped classroom had higher mean attitude ratings than those taught using demonstration based and virtual flipped classroom models respectively. Finding emanating from the study also revealed that pre-service teachers taught Chemistry using standard-inverted flipped classroom had higher mean attitude ratings than those taught using demonstration based and virtual flipped classroom models respectively. Supporting this finding, study by Bektaş *et al.* (2017) revealed that the students in the FC group had statistically significantly higher positive attitudes towards the course than those in the Just-in-Time-Teaching group. The finding disagrees with that of Vosburg *et*

al. (2016) whose study revealed no significant differences after the treatment were found between the control group and the experimental group responses related to their attitudes towards two models.

Female pre-service teachers taught Chemistry using virtual flipped classroom had higher mean attitude ratings than male pre-service teachers taught Chemistry using virtual flipped classroom and male and female pre-service teachers taught using demonstration based and standard-inverted flipped classroom models respectively.

Conclusion

1. The study found that pre-service teachers had noticeably different attitudes depending on the flipped classroom model used. Those who learned through the standard-inverted model tended to have the most positive feelings about their experience compared to those taught using virtual or demonstration-based models.
2. The research also showed that there were significant differences in attitudes between male and female pre-service teachers. Specifically, gender seems to influence how these teaching methods are perceived, with female pre-service teachers generally having more positive attitudes in certain contexts.

Recommendations

1. Since the standard-inverted flipped classroom model received such positive feedback, it would be beneficial for educators and curriculum designers to emphasize this approach. They could enhance it further by adding more interactive and collaborative elements to engage students even more.
2. Because the study found that male and female pre-service teachers responded differently to these teaching methods, it's important for instructional strategies to reflect those differences. Developing gender-sensitive approaches can help ensure that all students feel engaged and motivated in their learning.

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