Comparative Effectiveness of Flipped Classroom and e-Learning Strategies on Digitalization of Tertiary in Rivers State

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Abstract

This study examined the comparative effectiveness of flipped classroom and e-learning teaching strategies on the academic performance of pre-degree science education students in Rivers State, Nigeria. The study was guided by three research questions, three hypotheses and adopted the pretest-postest non-randomized control group quasi-experimental design. The population which also served as the sample was 49 pre-degree science education students comprising 15 male and 34 female participants in their third year. The instrument used for data collection was a self-constructed 30-item Research Methods and Statistics Performance Test by the researchers which was validated by senior lecturers in Science Education and measurement and evaluation. The reliability coefficient of the instrument was 0.89 as determined by the test-retest method. Means and standard deviation were used to answer the research questions while the hypotheses were tested at 0.05 level of significance using Analysis of Covariance. Findings of the study revealed significant difference in the academic performance of undergraduate students subjected to flipped classroom teaching strategy and those in the lecture method classroom. Students in the flipped classroom performed better with higher performance test scores than those in lecture classroom environments. Further findings revealed a significant difference in the performance of pre-degree students subjected to flipped classroom teaching and those in lecture teaching method in favour of flipped classroom where students performed significantly better than those in the lecture. Similar trend was obtained in the e-learning approach, where students subjected to e-learning performed significantly better than their counterparts in lecture learning environment. It was recommended among others that the use of flipped classroom teaching strategy should be embraced by teachers mostly lecturers in tertiary institutions of learning and further studies on comparative study of effective teaching strategies should be carried out to provide the best teaching method out of the effective ones.

Key Words: Flipped, e-Learning, Performance.

Introduction

The unprecedented level of advancement in science and technology in this 21st century has modeled science pedagogy at all levels of education and ushered in new dimensions of lesson delivery and learning process through improvements in information and communication technology. One of the products is "digitalization of education to meet the demands of the modern products of advancement technology utilized in teaching and learning of science as well as research purposes. Accordingly, analogue systems of lesson presentation are being rapidly replaced by digital ones because of the comparative high level of effectiveness and convenience of digital electronic devices. Worldwide

based digital technologies which provide online platforms such as world wide web technologies, zoom, slack, google meet e-mail, google, WhatsApp, among others provide fast, easy and convenient means of sending, receiving and storing information from different sources and locations. Assignments can also be given to students and lessons delivered online. Flipped classroom and e-learning are typical examples of the recent teaching strategies which have been widely acknowledged to be effective in the education sector. Flipped classroom and e-learning strategies share the major commonality of utilizing technology-based platforms to provide information to students. Flipped classroom is an innovative learner-centered pedagogical approach where students work on assigned activities outside the classroom leaving the class time for knowledge building (Adams, 2016). According to Gayeta (2017), flipped classroom is a pedagogical model in which the typical lecture and homework/assignment elements of a course are reversed. Also, Muhammad, Ayub and Khan (2021) defined flipped classroom teaching as a new pedagogical technique that involves predetermined digital resources with students through a platform outside the classroom.

There are two major components of flipped classroom teaching and these are the use of computer technologies such as videos for lectures and the involvement of interactive learning activities. Moreover, in the flipped classroom, there is active participation and collaboration of ideas as the students take part in interactive problem-solving classroom activities and internalizing contents through a wide range of classroom tasks. This promotes critical thinking and problem-solving as the students are active in the class (Muhammad, Ayub & Khan, 2021; Bergmann & Sams, 2012).

The teacher, in a flipped classroom provides educational resources and materials with the course content to the students through digital platform before the actual classroom lecture. This encourages the students to take responsibility of their own learning and do more research to learn the assigned content at home. The learning environment is thus enriched with increased effectiveness as a result of individualized learning (Karadag & Keskin, 2017). This strategy combines two learning approaches-lecture and active learning, the use of which makes flipped learning an exciting new teaching approach and giving it an advantage over other online teaching strategies (Dusenbury & Olson, 2019). The teacher starts with evaluating the level of students' understanding and revising what has been learnt at home in the flipped classroom followed by presentation of activities, and group problem-based projects to be performed in the classroom. This process makes it easy for teacher to easily access and control content, usually, the theoretical/lecture component of the lesson. Also, it is possible for the teacher to move the traditional lecture approach which involves face-to-face interaction to video where students can access anywhere outside the classroom at their preferred and convenient time (Elian & Hamaidi, 2018; Gayeta, 2017). However, it is imperative for the teacher preparing for flipped classroom teaching to state the lesson objectives in clear and realizable terms, and also source for educational materials including videos and animations that will enhance the lesson delivery process (Al-Jarrah, et,al., 2021).

One of the important features of flipped teaching strategy is that it supports flexible restructuring of learning environment and time, considering individual and group expectations. This strategy adopts a learner-centered approach to create enriched learning opportunities and activities reflecting a particular learning culture for specific groups. It promotes regular keeping of track records of content difficulty levels, students' note and progress as well as application of active learning

strategies which encourage students' conceptual understanding. Finally, there is continuous monitoring of the students in the learning process and providing feed-backs and assessment by the teacher who is a professional (Muhammad, Ayub & Khan, 2021).

Flipped classroom teaching strategy is suitable for individualized learning through asynchronous systems since learning takes place outside the classroom and is individualized by means of technology. Asynchronous systems of learning are characterized by the instructor and learners engaging with the course content on-line through e-mail or discussion boards or other such media at different times. It is individually based, self-paced and less instructor-dependent (Fabriz, et al 2021). Teaching can also be done asynchronously through this outside platform and lecture time is devoted to exercises, projects, discussions, activities, practices and helping solve home assignments (Elian & Hamaidi, 2018). This allows students to obtain information anywhere and anytime outside the normal school classroom and library as students are offered the opportunities to access the lesson content for the next class and take responsibility of their own learning by creating a more transparent learning environment outside the school classroom setting (Karadag & Keskin, 2017). Flipped classroom teaching strategy has many advantages which has been widely acknowledge by researchers. Flipped classroom teaching creates opportunity for effective interaction between the teachers and learners with the help of technology tools and as such, it is informative and productive for the teacher and student. Furthermore, it offers teachers the opportunity to allocate classroom time for active learning practices such as question-answer, discussion, problem-solving activities (Khadjieva & Khadjikhanova, 2019). The use of flipped classroom in teaching facilitates transmission of pre-existing information which maybe misconceptions and is effective in creating conceptual change and richer learning opportunities (Gayeta, 2017). Flipped classroom also provides students the opportunities to learn new information ahead of time at home through several technology tools and educational websites prepared and shared by teachers (Elian & Hamaidi, 2018). Students have the exceptional privilege of learning any time at home with the help of smart phones or computer devices such as IPads. These technology tools enable students to play back educational videos several times in order to understand the new information.

E-learning is another innovative strategy of teaching. According to Aboderin (2015), e-learning encompasses an ample array of systems, from the teacher using visual effects to students accessing academic materials online and teaching delivered entirely with the use of computer. It involves the use of network technologies to create, foster, deliver and facilitate learning. Furthermore, Elena, Svetlana, Natalia and Yana, (2021) maintained that e-learning incorporates face-to-face, distance, mixed and blended delivery models that utilize electronic means and web-based technology such as Learning Management System (LMS) to deliver instructions and access educational curriculum outside the traditional classroom environment. It is a computer based educational system that enables learner to learn anywhere and at any time as both the teacher and student can access the information with the help of personal computers, portable PCs, mobile phones, radio, and others.

In e-learning approach, lessons are delivered through the internet, although in the past it was delivered using a blend of computer-based methods. Modern classrooms, whether online or schools-based, use e-learning tools and learning management systems that capture student cognition and engage them in the learning process while increasing their need for self-directedness (Aboderin,

2015; Epignosis, 2014). With the use of e-learning, teaching and learning becomes stimulating and appealing to students mostly in the tertiary institutions (where a large number of students attend lectures in halls) as it makes it easy and less cumbersome.

The relevance of flipped classroom as a teaching strategy, has attracted a lot of research interests in different disciplines in the educational sector. For instance, Sirakaya and Özdemir (2018) examined the effect of a flipped classroom model on students' academic achievement, self-directed learning readiness and motivation using 66 students who took the "Scientific Research Methods" course in the Faculty of Education at Ahi Evran University using Achievement Test, Self-directed Learning Readiness Scale and Motivation Scale as instruments. Study findings showed a significant difference between groups in terms of academic achievement, motivation and retention. The study of Dusenbury and Olson (2019) on the impact of flipped learning on student academic performance and perceptions using 109 students from a large Midwestern university representing 56 students in the flipped classroom and 52 students as sample showed that the students in flipped classroom did not perform better than the lecture classroom students.

In another study, Khadjieva and Khadjikhanova (2019) investigated the effects of flipped classroom strategy on students' achievement and motivation to learn Math and English Language among pre-foundation students at Westminster University in Tashkent. Findings of the study showed statistically significant differences in the average values on the academic achievement test credited to the flipped classroom teaching approach, in favour of learners in the experimental group exposed to flipped classroom. Gayeta (2017) investigated the effectiveness of flipped classroom and traditional classroom instruction in measuring conceptual change determined if flipped classroom would be an alternative method of teaching to traditional lecture method as an alternative strategy for teaching stoichiometry. Qualitative and quantitative research design was adopted using fifty 3rd year Bachelor of Education, Biological Sciences students as sample. Results of the study showed that, flipped classroom instruction can be used as an alternative method of teaching to the traditional lecture method while there was no significant difference in students' conceptual change on the concept of stoichiometry for students exposed to flipped and traditional classroom environments. Muhammad, Ayub and Khan (2021) examined the effect of flipped classroom model on students' academic achievement in lexical aspects of English language. True experimental pre/post-test equivalent group research design was used and the population comprised 850 students from 12th grade, out of which 80 students representing 40 students for FCG and NFCG respectively were selected to serve as sample of the study. The instrument was a-72 item MCQ prepared through textbook of English. The findings showed improved achievement of FCG after treatment. The higher order learning that involved application, evaluating and synthesis also increased. Furthermore, the use of videos in teaching aroused students' interest and promoted active participation and student-centered learning. Al-Jarrah, Ayasreh, Ahmad & Othman (2021) investigated the effect of using flipped learning strategy on the academic achievement of eighth grade students in Jordan. The research adopted quasi-experimental design using 50 eighth grade students in the English language subject in the Hashemite Kingdom of Jordan as sample.

The instruments were Achievement Test and a Questionnaire. Results of the study revealed statistically significant difference between the average scores of the group of students in the experimental and control group in favour of the experimental group. Karadag and Keskin (2017) examined the effects of activities based on 'flipped learning' approach on students' academic achievement and attitudes toward mathematics in mathematics lessons. A mixed method approach was used in this study and the sample comprised 26 Grade 8 students at Istanbul Sehit Ahmet Onay Elementary School. The instrument were Academic Achievement Test and Mathematical Attitude Scale. The qualitative data were obtained from the semi-structured interview form and the learning logs of the mathematics lessons that the students kept during the activities. Findings showed that flipped learning positively affect students' academic achievement and attitudes toward mathematics. Enekwechi and Okeke (2021) investigated the effect of flipped classroom instruction on students' interest, participation and academic achievement in chemistry, as well as how its effect varies across gender. Quasi-experimental, non-equivalent control group design was utilized. A sample of 124 students served as study participants. Findings of the study showed a significant effect of flipped classroom teaching on students' interest, participation and academic achievement in chemistry. The findings also indicated that both male and female students' interest, participation and academic achievement were enhanced with the use of FCI. Furthermore, there was no significant interaction between teaching approach and gender on chemistry students' participation and academic achievement, but there was an interaction in the case of students' interest. The study of Asad, Ali, Churi & Moreno-Guerror (2022) on the effect of flipped classroom on higher secondary grade students of the public school in Sukkur, Pakistan which adopted quantitative design and sample of 97 upper grade secondary students revealed enhanced student's academic performance favoured flipped classroom approach over traditional pedagogy. Elian and Hamaidi (2018) investigated the effect of flipped classroom strategy on the academic achievement in the subject of science among fourth grade students in Jordan. Pretest/posttest Quasi-Experimental design was adopted and the sample comprised 44 male and female students. Findings of the study showed that there was a statistically significant differences in the mean of the educational achievement test attributed to the teaching strategy, in favor of students in the experimental group. There were no statistically significant differences in the mean of academic achievement test attributed to gender.

e-Learning has also attracted researches at different levels of education. Findings of the study showed that information and communication technology have a major statistically favourable effect on the academic success of students in e-learning and a substantial positive effect on the total success of students in universities.

Banda, Tailoka and Muma (2021) for instance, examined the effect and challenges of e-learning on students at Mukuba University. The study employed quasi-experimental design. Sample for the study comprised 60 third year students of mathematics studying statistics. Self-made questionnaire and statistics performance tests were used to collect data for the study. Findings of the study revealed that e-Learning approach improved students' academic performance. Younas, Noor, N., Zhou, Menhas, and Xu, (2022) examined the online influencing components for learning among University students in Pakistan during the COVID-19 Pandemic. The population comprised Pakistani University Students in Punjab province who took e- online lessons throughout the epidemic while the instrument was

questionnaire survey. SmartPLS 3.0 was used to investigate the suggested study framework using structural equation modeling (SEM). Findings of the study linked e-learning satisfaction to academic success and Pakistani students who utilized e-learning throughout the outbreak reported higher levels of academic satisfaction and achievement.

Statement of the Problem

Every discipline is confronted with diverse problems seeking for solutions. In education, the process of proffering solutions to educational problems rests on educational researches which requires a good background knowledge in the process of conducting researches and using appropriate statistics to draw valid conclusions from the study. Learning in education is adjudged to occur when there is change in conception of the learner from the erroneous preconceived ideas to the generally accepted idea. Therefore, effective teaching requires careful lesson planning particularly, selection of appropriate learner-centered strategies of lesson delivery, use of instructional materials and the use of conducive learning environment. Through this process, the teacher can effectively guide the students towards construction of scientific knowledge from their preconceived erroneous ideas to generally acceptable ideas by the community of professionals thereby arriving at meaningful learning. Undoubtedly, the process of arriving at a suitable teaching strategy or strategies especially, for abstract concepts has always been challenging and poses a serious problem to teachers. This unwelcomed development has attracted the interest of researchers in different fields of study with a view to providing alternative teaching strategies for various concepts, mostly the abstract ones. In doing this, the effectiveness of innovative and technology-based teaching strategies when compared to the conventional lecture teaching method has been widely explored without recourse to the level of effectiveness of these technology-based strategies. This does not provide enough grounds to draw a valid conclusion on proffered solutions. Moreover, evidence from the reviewed study showed a dearth of studies on flipped classroom teaching strategy in Rivers State particularly. There is therefore, a need to find out he effective strategies creating a gap in knowledge which necessitates this study using flipped and e-learning approaches in Rivers State.

Objectives of the Study

This study examined the comparative effectiveness of flipped classroom and e-learning teaching strategies on undergraduate science education students in Ignatius Ajuru University of Education. Specifically, the study tends to determine the:

1. academic performance of pre-degree science education students exposed to flipped classroom teaching strategy and lecture teaching method.
2. academic performance of pre-degree science education students exposed to e-learning strategy and lecture teaching method
3. academic performance of pre-degree science education students exposed to flipped classroom and e-learning strategies.

Research Questions

1. What difference exist in the academic performance of undergraduate science education students exposed to flip classroom teaching strategy and lecture teaching method?
2. What difference exists in the academic performance of undergraduate science education students exposed to e-learning strategy and lecture teaching method?
3. What difference exists in the academic performance of undergraduate science education students exposed to flipped classroom and e-learning strategies?

Hypotheses

1. There is no significant difference in the academic performance of pre-degree science education students exposed to flipped classroom teaching strategy and lecture teaching method.
2. There is no significant difference in the academic performance of pre-degree science education students exposed to e-learning strategy and lecture teaching method.
3. There is no significant difference in the academic performance of pre-degree science education students exposed to flipped classroom and e-learning strategies.

Significance of the study

The findings of this study will serve as guide for teachers' selection of the best teaching strategy, comparatively, which will be appropriate for assimilation of various concepts by students. Also, the findings of this study will benefit curriculum designers by providing alternative best teaching strategies out of the effective ones for recommendation to teachers. Furthermore, students stand to benefit from the comfort of assessing information at convenience offered by flipped classroom, if utilized by teachers as a choice.

Methodology

Quasi-experimental design, specifically the pretest posttest non-randomized control design was adopted in this study. The population which also served as the sample comprised 49 pre-degree science education students comprising 15 male and 34 female student participants in their third year in Ignatius Ajuru University of Education offering Research Methods and Statistics (EDU 322). Three groups were used for the study. The groups were randomly assigned experimental group 1, experimental group 2 and control. Experimental group 1 comprising 17 students were treated with flipped classroom strategy while experimental group 2 comprising 16 students were treated with e-learning and the control group with 16 students exposed to lecture method. The three groups received lecture from the same lecturer. In the flipped classroom, audio and video recorded version of the lecture content were given to students to watch at home using smart phones or personal computer before the actual classroom session. During the face -to-face lecture, teacher started with evaluating the level of students' understanding and revising what had been learnt at home. This was followed by presentation of activities, and group problem-based projects to be performed in the classroom. The instrument was Research Methods and Statistics Performance Test (RMSPT)

developed by the researcher and subjected to validation by two Senior Science Education lecturers and one Measurement and Evaluation lecturer. The reliability coefficient of the instrument was 0.89 determined by test retest method. Mean and standard deviation were used to answer research questions and the three hypotheses at 0.05 level of significance using Analysis of Covariance (ANCOVA). The instrument, Research Methods and Statistics Performance Test (RMSPT) was administered as pretest and posttest before and after treatment.

Results

Research Question1

What difference exists in the academic performance of pre-degree science education students exposed to flipped classroom teaching strategy and lecture teaching method?

Table 1: Mean and standard deviations in the academic performance of pre-degree science education students exposed to flipped classroom strategy and lecture method

		Mean			Standard Deviation	
Teaching Method	**n**	**Pretest**	**Posttest**	**Difference**	**Pretest**	**Posttest**
Flipped classroom	17	45.24	84.53	39.29	1.23	2.14
Lecture method	16	46.43	55.22	8. 570	2.21	1.67

From table 1, the post-test mean score of pre-degree science education students exposed to flip classroom strategy was higher (84.53) than those of lecture method (55.22) in the performance test. The difference between the Post-test mean scores was 39.2% for flipped classroom while that of lecture method was 8.57

Research Question2

What difference exists in the academic performance of pre-degree science education students exposed to e-learning strategy and lecture teaching method?

Table 2: Mean and standard deviations of the academic performance of pre-degree science education students exposed to e-learning and lecture method

		Mean			Standard Deviation	
Teaching Method	**n**	**Pretest**	**Posttest**	**Difference**	**Pretest**	**Posttest**
e-learning	16	43.01	62.13	18.12	1.01	0.68
Lecture	16	46.43	55.22	8. 570	1..81	1.23

From Table 2, the post-test mean score of pre-degree science education students exposed to e-learning strategy was higher than those exposed to teacher method (55.22). the difference between the Post-test mean score of the e-learning category was 18.2 while the teacher method group had 8.57.

Research Question 3

What difference exists in the academic performance of pre-degree science education students exposed to flipped classroom and e-learning strategies?

Table 3: Mean and standard deviations of the academic performance of pre-degree science education students exposed to e-learning and lecture method

		Mean			Standard Deviation	
Teaching Method	**n**	**Pretest**	**Posttest**	**Difference**	**Pretest**	**Posttest**
Flipped classroom	17	45.24	84.53	39.29	1.23	2.14
e-learning	16	43.01	62.13	18.12	1.01	.0.68

From Table 3, the Post-test mean scores of the flipped classroom category (84.53) was higher than that of the e-learning group (62.13). the difference between the post-test mean scores was 39.29 for the flipped classroom while that of the e-learning group was 18.12.

Hypothesis 1

There is no significant difference in academic performance of pre-degree science education students exposed to flip classroom teaching strategy and lecture method.

Table 4: Analysis of Covariance (ANCOVA) of the mean academic performance of pre-degree science education students exposed to flip classroom teaching strategy and lecture method

Source	**Type III Sum of Squares**	**Df**	**Mean Square**	**F**	**Sig.**
Corrected Model	18362.245[a]	2	8734.234	78.332	.000
Intercept	2345.139	1	2346.196	32.109	.000
Pretest	5421.230	1	8920.567	65.123	.000
Treatment	6354.116	1	6456.792	45.784	.000
Error	15342.654	20	127.732		
Total	512894.000	33			
Corrected Total	3128.845	32			

a. R Squared = .674 (Adjusted R Squared = .478)

From Table 4, F1, 33 = 45.784, $P<.05$, giving grounds to reject the null hypothesis. This implies that there is a significant difference in academic performance of pre-degree science education students exposed to flip classroom teaching strategy and lecture method.

Hypothesis 2

There is no significant difference in the academic performance of pre-degree science education students exposed to e-learning strategy and lecture teaching method.

Table 5: Analysis of Covariance (ANCOVA) of the academic performance of pre-degree science education students exposed to e-learning and lecture method.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	23476.132[a]	2	12564.542	191.211	.000
Intercept	10230.345	1	13256.342	192.389	.000
Pre-test	1456.543	1	1783.987	14.99	.001
Treatment	25188.897	1	22377.178	109.897	.000
Error	12567.194	29	86.546		
Total	425112.000	32			
Corrected Total	3056.783	31			

a. R Squared = .674 (Adjusted R Squared = .667)

From Table 5, F1, 32= 109. 887, P<.05 giving grounds for rejection of the null hypothesis. This implies that, there is a significant difference in the academic performance of pre-degree science education students exposed to e-learning strategy and lecture teaching method.

Hypothesis 3

There is no significant difference in the academic performance of pre-degree science education students exposed to flipped classroom and e-learning strategy.

Table 6: Analysis of Covariance (ANCOVA) of difference in the academic performance of pre-degree science education students exposed to flipped classroom and e-learning strategy.

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2731.148[a]	2	2031.564	14.122	.000
Intercept	15633.234	1	15345.241	132.436	.000
Pretest	243.114	1	632123	1.567	.087
Treatment	2246.213	1	2235.156	67.286	.000
Error	22333.342	28	89.812		
Total	456678.000	31			
Corrected Total	12387.673	30			

a. R Squared = .158 (Adjusted R Squared = .148)

From Table 6, F1, 171 = 18.888, *P*<.05, therefore, the null hypothesis is rejected. This implies that there is a significant difference in the academic performance of pre-degree science education students exposed to flipped classroom and e-learning strategy.

Discussion of Findings

Findings of the study revealed a significant difference in performance of pre-degree students subjected to flipped classroom teaching and those in lecture method in favour of flipped classroom where students performed better than those in the lecture group (Tables 1&4) This result of corroborates the findings of Sirakaya and Özdemir (2018) which revealed a significant difference in academic achievement of students offering scientific research methods treated with flipped classroom and lecture method in the Faculty of Education at Ahi Evran University and that of Khadjieva and Khadjikhanova (2019) where there was a statistically significant difference in the scores of achievement test of the students in favour of flipped classroom in Westminster University in Tashkent. The results further corroborate the results of studies by Al-Jarrah, Ayasreh, Ahmad & Othman (2021), Karadag and Keskin (2017), Enekwechi and Okeke (2021), Elian and Hamaidi (2018), Asad. Ali, Churi and Moreno-Guerror (2022). However, this result does not corroborate the findings of Dusenbury and Olson (2019) which established no significant difference in the performance of students in the flipped and lecture classrooms.

Similarly, there was a significant difference in performance of pre-degree students subjected to e-learning approach and lecture teaching method in favour of e-learning where students performed better than those in the lecture classrom (Table 2). This finding agrees with the results of Banda, Tailoka and Muma (2021) at Mukuba University which revealed that e-Learning approach improved students' academic performance. Younas et.al., (2022) which revealed higher levels of academic satisfaction and achievement among University students who utilized e-learning during the COVID-19 Pandemic in Pakistan

However, comparative study of flipped classroom and e-learning strategies revealed significant difference in the academic performance of pre-degree student subjected to flipped classroom teaching strategy and those in the lecture method classroom. Students in the flipped classroom performed with higher scores in the performance test than those in lecture classroom environments. (Table3 and 6). Although it is evident in the previous studies that both flipped classroom and e-learning are effective strategies when compared to lecture method, comparative study of the two strategies shows a significant difference in their level of effectiveness in favour of the flipped classroom teaching strategy. The implication, therefore, is that their established effectiveness notwithstanding, flipped classroom teaching strategy is more effective and has advantage over e-learning strategy.

Contributions to Knowledge

1. This study will enrich the body of existing knowledge on flipped classroom teaching approach.
2. Findings of this study will provide additional alternative for selection of appropriate teaching strategies that will produce the best level of effectiveness.
3. Findings will provide basis for drawing conclusion for other researches of the use of online-based teaching strategies in science education.

Recommendations

1. The use of flipped classroom teaching strategy should be embraced by teachers mostly lecturers in tertiary institutions of learning
2. Further studies on comparative study of effective teaching strategies should be carried out to provide the best teaching method out of the effective ones.
3. Government should ensure the provision of basic information and communication technology facilities and internet services in schools to assist lecturers and students access information for academic works.

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