INTERACTIVE EFFECTS OF FLIPPED LEARNING MODEL ON NCE II STUDENTS' CRITICAL THINKING SKILLS AND CONFIDENCE LEVEL IN SCIENCE EDUCATION IN NIGERIA

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Abstract

The crave to achieve the 21st Century skills may not be realised if learning outcomes like critical thinking skills and confidence are not developed among the learners through effective teaching and learning. This study therefore investigated the interactive effects of flipped learning model on students' critical thinking skills and confidence level in Science Education. The study utilised a non-randomised pretest-posttest quasi-experimental design. A sample of 103 NCE II students studying Physics and Integrated Science was drawn from a population of 456 using stratified sampling technique. The instruments for data collection, SECTS and SCLT which gave reliability coefficients of 0.81 and 0.87 were obtained using Kuder-Richardson (KR_{20}) and Cronbach Alpha. Two research questions were raised and answered, using mean and standard deviation while the two null hypotheses were tested using ANCOVA at 0.05 level of significance. Findings revealed that there was a significant difference between critical thinking skills scores ($P = 0.00 < 0.05$); and confidence level scores ($P = 0.00 > 0.05$) of the experimental and control groups. It was recommended that school proprietors and governments should support the use of flipped model innovation while teachers are also encouraged to key into this instructional model since it is a factor in students' learning outcomes, particularly critical thinking skills and learning confidence.

Key words: Flipped learning, Critical thinking skills, Confidence level, integrated science, physics, science education.

Background to the Study

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The education as a veritable tool for transmission of societal values and skills is not only the *sine qua non* but the nucleus of other spheres of life where the crisis of low academic outcomes is mostly debated. In the quest for what could result in low students' academic outcomes, the outcry for paradigm shift in how we teach and what we teach, have become evident. One prominent approach being identified is the need to shift teaching from knowledge to skills-centered. This necessitated the proposition of flipped learning model where critical thinking skills such as analysis, evaluation, synthesis, observation, communication among others can be instilled into learners. These skills can only be developed through effective knowledge of science education which can be achieved through adaptation to innovative pedagogies that can enculture these and other 21st Century skills in the students.

Science Education as a discipline concerns with sharing of science contents, process skills, attitudes, theories, and other accumulated body of knowledge with learners. It is therefore, necessary that they are groomed with critical thinking skills that can help them succeed in the challenging world with untold poverty and high unemployment rate. This could be why the 21st Century training requires a holistic and quality education that can mold students to become a comprehensive and global citizen with lifelong thinking and self-sufficiency skills. In this regards, it is pertinent to empower learners with learning and innovation skills; Information and Communication Technology (ICT) skills; life-skills, especially critical thinking in order to live well in the globalised world (Morgan, 2014; Nichols, 2010; Stone, 2012).

To achieve these lofty dreams of global education, adaptation to innovative teaching and learning models should be considered as priority to be pursued with vigour. Instead of caging students under the control of authority figure for hours listening to a one-way form of communication through traditional teaching, it should be rather advantageous to teach them how to expend time on interactive activities in the classroom using technology-driven models like flipped learning (Pustaka, Bergman & Sams, 2012). These activities bring more values to learners. For this reason, teachers

should try to explore and apply information technology, though the flexible use of this active teaching method in classrooms is still a puzzle game in the face of many teachers who are ICT-phobic, particularly in Nigerian schools. The nagging challenge is that, many teachers find it hard to use modern and active learning methods in the classroom seemingly because they are accustomed to traditional teaching. This problem could be addressed by the adoption of models like flipped learning that can enhance the development of critical thinking skills and confidence among learners.

In an effort to overcome the challenge of ineffective teaching method, the concept of the flipped model was proposed in 2000 to meet different learning needs of learners. By way of definition, flipped learning model is a technology-driven approach to teaching and learning in form of video packages in which the conventional notion of classroom-based learning is inverted, so that students are introduced to the learning material before class, with classroom time being used to deepen understanding through discussion with peers and problem-solving activities facilitated by teachers (Sayah, Haryni & Wijayati, 2016). In flipped teaching, teachers assign lessons in advance to students through pre-designed lectures provided in software or online, then in classroom, teachers support individuals or groups of 5, 7, 9, 11, 13, 15 and so to solve problems.

Means, Toyama, Murphy, Bakia, and Jones (2010) report a significant difference in learning outcomes. The researchers buttressed that flipped classroom has created a deep learning environment as well as the development of learning skills. This model helps to create an environment that promotes learning autonomy, giving learners ample opportunities to learn at their own pace to become responsible for knowledge-building rather than passive learning (Morgan, 2014; Nichols, 2010; Stone, 2012).

Critical thinking as the major variable in this study is the process of reviewing every aspect of the problem and coming to a conclusion to solve it. It is thinking about learning materials, concepts, theories, and principles including reviewing, verifying

their accuracy and evaluating them to accept or reject them. Critical thinking is fostered in science classrooms by opportunities to engage students in critique, argumentation, discussion, and questioning (Osborne, 2014; Azza & Shimaa, 2018). Critical thinking skills include but not limited to analysis, synthesis, evaluation, observation, communication and interpretation. These skills do not only help to build students' understanding of science, but also play a key role in developing their ability to reason scientifically.

Confidence level is another vital variable in this study. It is a motivational construct that has a main role in the development of critical thinking skills. In a theoretical framework, learners' confidence and interests are important factors in critical thinking. From one hand, students' confidence in learning results in their motivation and in the other hand, non-confidence is an obstacle to critical thinking. Wanga and Yi Wub (2008) found that self-confidence is a good predictor of using high level learning strategies, such as critical thinking. Confidence results in the improvement of critical thinking skills. This can be achieved through the use of flipped model which gives learners opportunity to learn at their own pace. This is because learning at one's own convenience gives courage and confidence as learners can repeat learning process as many times as possible even if they fail at first attempt (Das, Das & Kashyap, 2016; Martino & Zan, 2010). Thus, there are many chances to make trials until mastering of concepts occur. This study compared the interactive effects of flipped learning model on NCE II students' critical thinking skills and confidence level.

Statement of the Problem

Despite unrelenting efforts by science educators in developing improved methods of instruction as well as nagging worries about the continued usage of archaic strategies for science teaching in Nigeria, it is however, observed that teachers are recalcitrant taught science subjects in theory and abstraction with teacher-centric traditional methods like lecture and expository methods characterised by chalk-and-talk and rote learning mainly for the purpose of examination and certification. The effects of this are

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disgraceful learning outcomes, particularly lack of critical thinking skills and confidence among male and female students.

Flipped learning model would hopefully fill this gap; since the model is hypothesised to enhance students' learning outcomes through individualised and collaborative instruction. One may ask: Are students' critical thinking skills dependent on instructional model? Or Do students' confidence level dependent on teaching model? This study sought to answer these questions. The problem of this study therefore, was to explore whether flipped learning model has the power to enhance or inhibit students' critical thinking skills and confidence level in science education in Nigeria.

Research Questions

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

i. What is the difference between the mean critical thinking skills scores of the students taught dynamics using flipped learning model and those taught with expository method?
ii. What is the difference in the mean confidence level scores of the students taught dynamics using flipped learning model and those taught with expository method?

Hypotheses

The following null hypotheses were formulated and tested at 0.5 level significance:

Ho1. There is no significant difference between the mean critical thinking skills scores of the students taught dynamics using flipped learning model and those taught with expository method.

Ho2. There is no significant difference between the mean confidence level scores of the students taught dynamics using flipped learning model and those taught with expository method.

Methodology

The study adopted a non-randomised pretest-posttest quasi-experimental design. Both the experimental and control groups received the same treatment and assessment's contents on dynamics. The selected contents for the treatment were speed and acceleration, momentum, work, energy and power and motion in a circle. Two research questions were stated and analysed using mean and standard deviation; and Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

A sample of 103 comprising of 49 Integrated Science students (28 males and 21 females) and 54 physics students (32 males and 22 females) drawn from a population of 456 were selected using stratified sampling technique. Integrated science students were assigned to experimental group who were taught with flipped learning model while physics students were assigned to control group who were taught with expository method.

A validated 2-in-1 instrument, Science Education Critical Thinking Skills Test (SECTS) and Students' Confidence Level Test (SCLT) developed by the researcher having reliability coefficients of 0.81 and 0.87 were used for data collection. The SECTS consisted of 30 items multiple choice questions with allocation of 30 marks; and 10 alternative to practical essay questions with allocation of 70 marks. The SCLT was an additional instrument placed under the SECTS that measured the students' confidence level. The test which lasted for 60 minutes has a total of 100 marks. The control group took their test in paper and pencil mode while the experimental group took theirs on the internet programmed on Google docs.

Using test-retest, the two groups were pretested to determine the entry knowledge of the students as well as to obtain the reliability coefficients of the instruments. After six weeks of treatment, a posttest was administered at its end and the scores recorded again. These scores were then used for reliability analyses of the instruments using Kuder Richardson (KR_{20}) and Cronbach Alpha. The entire study lasted for six weeks. To collect the data efficiently using SECTS and SCLT, four research assistants were recruited and trained for two days who in turn assisted the researcher in teaching the

content, administered the pretest and posttest and collected the data for further analysis.

Data Analysis and Results

Under this section, the data collected and collated for the study were analysed and interpreted as follows:

Research Question 1

What is the difference between the mean critical thinking skills scores of the students taught dynamics using flipped model and those taught with expository method?

Table 1: Mean and Standard Deviation of Students' Critical Thinking Scores in Flipped Model and Expository Method

Critical Thinking Skills	Experimental Group (N = 49)				Control Group (N = 54)			
	Pretest		Posttest		Pretest		Posttest	
	Mean	S.D	Mean	S.D	Mean	S.D	Mean	S.D
Evaluation	9.50	0.98	11.60	0.70	8.61	0.72	10.23	1.31
Problem-Solving	8.90	0.70	9.72	1.99	9.22	1.91	9.23	1.04
Observation	9.90	0.80	9.99	0.94	8.99	0.95	9.20	0.90
Analysis	8.77	1.33	8.72	1.56	6.78	1.56	7.99	1.33
Inference	7.30	1.70	9.33	0.67	8.42	0.67	9.09	1.70
Communication	10.00	1.80	12.67	0.93	10.46	0.93	11.05	1.80
Creativity	8.96	0.72	10.54	0.76	9.93	0.95	9.77	0.72
Mean Summary	**63.28**	**8.03**	**72.49**	**7.35**	**62.41**	**7.69**	**66.56**	**8.80**

Table 1 reveals that, in pretest, the mean summary of students' scores in the experimental group was 63.29 with a standard deviation of 8.03 while that of control group was 62.40 with a standard deviation of 7.69. The mean difference between the two groups was 0.89; meaning that the students were of close cognitive levels before the treatment because the mean difference was considered small

In posttest, the mean critical thinking scores of 72.49 with a standard deviation of 7.35 in experimental group compared with the mean of 66. 56 with a standard deviation of 8.80 in control group showed that the mean difference is 5.93. This showed that experimental group had higher critical thinking scores than their control group counterparts.

Hypothesis 1

There is no significant difference between the mean critical thinking skills scores of the students taught dynamics using flipped model and those taught with expository method.

Table2: ANCOVA Test of Students' Critical Thinking Scores in Flipped Model and Expository Method

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3753.566[a]	2	1876.783	48.739	.000
Intercept	1133.118	1	1133.118	29.427	.000
Pretest Critical Thinking Scores	2848.911	1	2848.911	73.985	.000
Groups	**730.266**	**1**	**730.266**	**18.965**	**.000**
Error	3850.667	100	38.507		
Total	503384.000	103			
Corrected Total	7604.233	102			

a. R Squared = .494 (Adjusted R Squared = .483)

The result in Table 2 shows one-way ANCOVA test of students' critical thinking skills scores in the experimental and control groups. Students' pretest scores were used as covariate to control the initial difference in the two groups. This result reveals that $F_{1, 102} = 18.965$, $P = .000 < .05$ for the main treatment. The significant value P-value (.00) was less than the set significant value of the study ($P < .05$). Therefore, the null hypothesis which stated that, there is no significant difference in the mean critical thinking skills scores of the students taught using flipped learning model and those taught by conventional strategy was rejected.

Research Question 2

What is the difference in the mean confidence level scores of the students taught dynamics using flipped learning model and those taught using expository method?

Table 3: Mean and Standard Deviation of students' Confidence level in Flipped Model and Expository Method

Confidence Level	Experimental Group (N = 49)						Control Group (N = 54)					
	Pretest			Posttest			Pretest			Posttest		
	n	Mean	S.D	n	Mean	S.D	n	Mean	S.D	n	Mean	S.D
Not Confident At All	2	2.00	-	0	0.00	-	1	1.00	-	-	0.00	-
Slightly Confident	7	7.00	-	2	2.00	-	13	13.00	-	30	11.00	-
Moderately Confident	25	25.00	-	15	15.00	-	26	26. 00	-	25	13.00	-
Completely Confident	15	15.00	-	32	32.00	-	15	15.00	-	10	40.00	-
Total	49	49.00	-	49	49	-	54	54.00	-	54	54.00	-

Table 3 shows the distribution of mean and standard deviation of confidence level scores in both experimental and control groups. However, in each case, the standard deviation is zero. In pretest, two students in the experimental group with a mean score of 2.00 representing 4.08% rated that they were not confident at all while the mean of the control group was 1.00 (1.85%) rated the same. Also, students' mean ratings in experimental group on the measurement scales: slightly confident, moderately confident and completely confident were 7.00 (14.00%), 25.00 (51.02%), and 15.00 (30.61%); while their peers in the control group were 13.00 (24.07%), 26.00 (48.15%), and 15.00 (27.78%). This implies that, before the treatment, only 15.00 (30.61%) of the students in the experimental group were completely sure of the answers they gave while the rest guessed answers. On the other hand, only 15.00 (27.78%) in the control group sure of the answers they gave.

In post test, students' mean confidence level ratings in the experimental group of not confident at all, slightly confident, moderately confident and completely confident were 0.00 (0.00%), 2.00 (4.08%), 15.00 (30.61%), 32.00 (65.31%) while their control group were 0.00 (0.00%), 40.00 (74.74%) and 11.00 (20.37%). From the analysis, it was deduced that,

after the treatment, the students' confidence level scores in the experimental group were positively boost up. This could because the use of flipped model encouraged them to learn. While in the control group, only 11.00 (20.37%) were confident of the answers they gave.

Hypothesis 2:

There is no significant difference between the mean confident level scores of students taught dynamics using flipped model and those taught with expository method.

Table 4: ANCOVA Test of Students' Confidence level scores in Flipped Model and expository Methods

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2658.590[a]	2	1329.295	28.694	.000
Intercept	2221.134	1	2221.134	47.945	.000
pre	1687.597	1	1687.597	36.428	.000
Methods	829.295	1	829.295	17.901	.000
Error	4632.678	100	46.327		
Total	517616.797	103			
Corrected Total	7291.268	102			

a. R Squared = .365 (Adjusted R Squared = .352)

The result in Table 4 shows one-way ANCOVA test of students' mean confidence level scores in flipped learning and expository method. This result reveals that $F\ 1,_{102} = 17.901$ $P = .00 < .05$ for the main treatment. The significant value P-value (.00) was less than the set significant value of the study ($P < .05$). Therefore, the null hypothesis which stated that, there is no significant difference in the mean confidence level scores of the students taught using flipped model and those taught by expository strategy was rejected.

Discussion of Findings

The purpose of this study was to determine the interactive effects of flipped learning model on students' critical thinking skills and confidence level in science education. Based on the result of the data analysis, there was a significant statistical difference

between the students taught the concept of dynamics using flipped learning model and their peers taught the same content using expository method. Thus, the experimental group acquired more critical thinking skills scores than their control counterparts taught the same content. This finding was supported by the study by Means, Toyama, Murphy, Bakia and Jones (2010) who established that there was significant difference in the learning outcomes of learners when taught with flipped technology. This is buttressed that flipped classroom has created a deep learning environment as well as the development of learning skills (Morgan, 2014; Nichols, 2010; Stone, 2012)

The implication of this is that, the flipped model enabled students to be familiar with science concepts outside the classroom by watching educational videos and PowerPoint presentations prepared by teachers. Inside the classroom, teachers took advantage of class time to discuss the appeared ideas. This enhanced thinking, collaborative learning and provided different student-centered activities. Thus, the method promoted skills of analysis, evaluation, problem-solving, observation, communication, inference and creativity better than the expository method.

The second finding of the study indicated that there was a significant difference in the mean confidence level scores of the students taught the concept of dynamics using flipped learning model and those taught with expository method. This finding is in line with the conclusion drawn by Azza and Shimaa (2018) as well as Wanga and Yi Wub (2008) that the utilisation of the flipped learning model improved students' confidence and satisfaction level of the students. This implies that students' confidence is an important element in the teaching and learning process. Furthermore, successful learning is basically a product of self-confidence and satisfaction the learners garnered about the learning materials.

This is in consonance with the finding of Das, Das and Kashyap (2016); and Martino and Zan (2010) who found that the model is important because it supported students' participation in deep learning. This is because learning at one's own convenience gives

courage and confidence as students repeat learning process as many times as possible even if they fail at first attempt. The use of technology-driven strategy enabled the students to really understand the concept and thus, rote learning is discouraged.

Conclusion and Recommendations

The major thrust of this study was the development of flipped learning model that can fill the wide performance gaps in terms of lack of critical thinking skills and confidence level among students due to the continued usage of ineffective instruction. From the result of the analysis, the students taught using the flipped model acquired more critical thinking skills and confidence than their counterparts who were taught with conventional method.

Based on these findings, it was recommended that:

1. School proprietors, governments and non-governmental organization (NGOs) should provide adequate and dependable flipped tools such as educational apps, websites, projectors, Wifi, tablets, high speed internet connection, flipped boards, routers and other digital facilities to enable teachers integrate flipped learning model into everyday teaching and learning, since it is a factor in students' learning.
2. While science teachers are encouraged to embrace and adapt to modern trends in scientific and technological advancement, schools should integrate flipped learning effectively into their systems because the world is becoming more technologically inclined.

Contributions to Knowledge

Based on the findings of this study, the following contributions to knowledge banks were made:

1. The study established that flipped learning model has positive effects on students' critical thinking skills and confidence level.

2. This study has provided useful information on the needs to encourage science teachers and students to adapt to innovations and trends in science and technology education.

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