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IEEE Computer Society Nigeria Chapter

Proceedings of the 36th iSTEAMS Accra Bespoke Multidisciplinary Innovations Conference

Flipped Classroom Instructional Package Efficacy on Undergraduate Students' Problem-Solving Skills in Integrated Science in Federal University of Kashere, Gombe State, Nigeria

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ABSTRACT

This study determined the efficacy of flipped classroom instructional package on undergraduate student's problem solving skills in integrated science in Federal University of Kashere, Gombe State. Simple random sampling technique was used to select 100 integrated science students in the Department of Science Education, Federal University of Kashere, Gombe State, Nigeria for the study. Participants were randomly assigned to lecture method and flipped classroom instructional strategies. The duration of treatment lasted for 12 weeks. Two main validated instruments were used in the study thus: (1) Integrated Science Problem Solving Ability Test (ISPSAT, r=0.85) and Flipped Classroom Instructional Package (FCIP). Two research questions were raised to find out the difference between pretest mean scores of students' problem solving skills in lecture and flipped classroom instructional strategies and gender as well. Two hypotheses were raised to test the significant difference between lecture and flipped classroom instructional strategies integrated science and significant difference between gender and students' problem solving skills. The two hypotheses were tested at 0.05 level of significance. Data were analysed using mean, standard deviation and t -test analysis. Finding revealed that there was significant difference in the students' problem solving skills between participants taught with lecture and flipped classroom instructional strategies. The result also showed that there was no significant difference between male and female students' problem solving skills. Integrated science lecturers should be trained and educated through workshops, seminars, conferences on the instructional benefits of the use of flipped classroom instructional package, among others.

Keywords: Flipped Classroom Instructional Strategies, Undergraduate Integrated Science Course, Students' Problem-solving Skills, Nigeria, Gombe,

Proceedings Citation Format
Ogundare, Samuel Akinola, Veronica Oluwatoyin Animasahun, Adeyanju Saudat Titilope & Manu Joseph. (2023): Flipped Classroom Instructional Package Efficacy on Undergraduate Students' Problem-Solving Skills in Integrated Science in Federal University of Kashere, Gombe State, Nigeria. Proceedings of the 36th iSTEAMS Accra Bespoke Multidisciplinary Innovations Conference. University of Ghana/Academic City University College, Accra, Ghana.
31st May – 2nd June, 2023. Pp 287-296.
https://www.isteams.net/ghanabespoke2023. dx.doi.org/10.22624/AIMS/ACCRABESPOKE2023P26

1. INTRODUCTION

Integrated Science Education is education programme aimed at producing primary, secondary school and college teachers who are knowledgeable in the subject matter/concepts and pedagogical processes of the subject. They are to have all needed and relevant skills to succeed in their duties. National University Commission (NUC, 2012) stated clearly that integrated science is an approach to teaching and learning of science in which concepts and principles are presented so as to express the fundamental unity of scientific thought and deviate from undue stress of differences among various scientific fields. Therefore, the importance of integrated science education cannot be overemphasized.

The objectives of integrated science education programmes are stated in NUC (2012) and National Commission for Colleges of Education (NCCE, 2012) thus:

1. Enable student to acquire the various concepts, principles, theories, laws and concept schemes, among others of integrated science
2. Enable students to acquire necessary teaching and practical skills and aspects of teaching methodology of integrated science
3. Help students to become effective classroom integrated science teachers
4. Expose students to industrial application of integrated science
5. Acquire the ethics of teaching as a profession
6. Become professional integrated science teacher
7. Disseminate information in integrated science to society
8. Develop positive values and attitudes for efficient discharge of their duties and relevant in the technological advancement as integrated science teachers.

Integrated Science Education Programme stands to be one of the most challenging programmes in different levels of education and institutions in Nigeria (Ogundare & Musa, 2021). The challenges are evidence of the fact that good number of undergraduate students studying integrated science at higher institutions in Nigeria perform poorly in the programme, many carry over courses and some either seek for change of course or withdraw from the programme (Federal University of Kashere, 2020). Integrated undergraduate students have to take courses in faculty of science in biology, chemistry, physics and mathematics so as to be grounded and rooted well in the pure basic sciences and this seems to be a great challenge for most of them. The nature of integrated science and other basic science course include processing, attitude and products which the students need to understand and acquire. The stated basic three nature of integrated science can best be achieved when students are exposed to, acquire and develop problem solving skills which is required in integrated science.

Researchers have observed that undergraduate students majorly depend on lecture notes, textbooks and lecture deliver in the class especially in the science class (Ogundare & Musa, 2021; Hsu & Lin 2016). Beside, teachers and lecturers concentrate more efforts in delivering their lecture in the class from their lecture notes they have prepared. Lecture method of teaching can only be effective when teaching essay related courses but nature of integrated science and other significant aspects in integrated science such as nature of science and problem solving skills demand intervention and innovation instructional techniques (Almassru & Zaharydin, 2023; Davies et al., 2013). Good instructional approach that may enhance and motivate students to acquire all the nature of integrated science and problem solving skills is embedded in blended instructional strategies. Constructivism theory supports and very relevant to blended instructions. The theory of constructivist of education states that students should be able to create or construct their understanding and knowledge through their personal experience.

Constructivist instruction affords the learners the opportunities to active learning techniques to construct their knowledge and create real daily world problems solving skills through discussion, collaborations, among others (social constructivists). Instructional approach such as technology based which includes blended learning, puzzle based pedagogies, game based, among others are all constructivist approach. Savery (2015) define problem solving as a cognitive processing directed at achieving a goal when no solution method is obvious to the problem solver. Poor students' problem solving skills is another factor that is closely associated with poor students' achievement in mathematics and basic science. Problem solving skills is centred on hands-on, active and collaborative learning. Students proficient in problem solving will enhance the learners to construct research and learn by solving real world and open-ended problems. Students with problem solving skills will easily acquire 21st century skills which includes self-direction, collaboration, intervention, creativity and innovation, among others (Muntean et al, 2018; Larmer, 2014).

Flipped classroom is a blended learning platform whereby learners watch teacher's lecture video at their deferent homes at their convenient time and where teachers guide and interact with other learners instead of a traditional conventional classroom (Atwa et al, 2022; Al-Zoubi, 2021). According to Atwa et al (2022 flipped classroom comprises of two parts which are direct computer-based individual instruction taking place outside the classroom (individual homes) and within the classroom setting, group (entire students) interactive learning activities. Besides, Charles-Ogan and Willaims (2015) refer to flipped classroom as an approach of teaching where home works or assignments are done in the school or classroom and school works at home.

Based on the views of scholars on the concepts of flipped classroom, the students are required to come to the class after they might have viewed the lecture video prepared by the teacher/lecturer in their different comfort homes and have meaningful interactive activities with their peers and teachers on the viewed teacher's instructional contents in the classroom. The students are expected to have completed the assignments given by the teacher, prepare for discussion and explanation of the contents and concepts they have studied for the preparation for the next lecture/lesson. In other word, what the learners have done at home is now becoming what they do in the school. In fact the conventional class works and assigned activities at home are flipped. Flipped classroom pedagogical practices is an intervention and novel in Nigerian schools which emphasizes active learning and students-centredness rather than teacher centredness teaching-learning processes.

The advantage of flipped classroom teaching has been identified by Turan and Goktas (2018) as providing and fully maximizing the support given to students learning. This is done by helping the teacher to shift the teacher/lecturer role from teaching to training students on solving problems through freeing up class time active class activities. Other benefits of flipped classroom include it enhances students' engagement (Carles-Ogan & Willaims, 2015), affords students' personal guidance and makes learning environment flexible for the students to meet their academic needs (Alvarez, 2012). Flipped classroom instructional package helps students to achieve their learning objectives by working on real-world problem through collaboration to solve problems and the use of hands-on active learning (El Mawa & Muntean, 2018).

Bradford et al. (2014) observed in a study of applying flipped classroom to teach a first year course on the introduction to mathematics for computing and remarked that students exposed to flipped class were better in problem solving skills and continuous assessments than those not exposed to flipped classroom. Besides, Love et al. (2014) conducted a flipped classroom to teach a linear algebra mathematics course and found out that the flipped group had a higher grades for the second examination in problem solving skills in relation to their first and third examination.

However, Jensen et al. (2015) conducted a flipped classroom to study biology course and noted that flipped classroom does not have significant benefits over non-flipped classroom in higher reasoning skills and problem solving skills as long as both follow an active learning approach. McLaughlin et al. (2014) applied flipped classroom for teaching basic pharmaceutics and observed that the flipped classroom group were better in performance in critical thinking, problem solving skills and their ability to apply knowledge to solve problems in the future. Similarly, Touchton (2015) applied flipped classroom teaching method to teach an advanced statistic course and discovered that the flipped classroom group were better in problem solving skills in difficult topics than the traditional group, however, the difference in the overall result was small.

Gender is another factor that may affect the use of technology in teaching, learning and acquisition of problem skills. Gender is constructed phenomenon that is brought about a society ascribes different role, duties, behavior and mannerism to the two sexes (Aderele & Abidoye, 2022). This implies that gender relates to cultural attributes of both males and females. Tienxhi (2017) in his study shows that there are no longer distinguishing differences in cognitive, affective and psychomotor skills achievement of learners in respect of gender because girls are being encouraged and sensitized into developing positive learning and acquisition of skills to solve daily problems. Study of Kurt (2017) affirmed that there was a significant impact of gender on students' academic self-concept in favour of the female students than their male counterparts in biology. However, Ajala (2013) observed in his study that male students showed a remarkable post mean score in biology than their female counterparts exposed to cooperative computer-assisted instructional technics. Therefore, gender neutrality, critical thinking and problem solving skills in under graduate students in integrated science is worth investigating especially with flipped classroom teaching and learning techniques.

1.2 Statement of the Problem

Teacher centred pedagogical approached has dominated instructional practices from time immemorial particularly the science subjects that supposed to be practical based in Nigeria. This practice seems not to enhance students' critical thinking and problem solving skills. Literature abound that suggest pedagogical innovation for instructions, such as discovery, project, inquiry, technology based, flipped classroom, among other. Several attempts have been made in teaching science with flipped classroom instruction and learning with different outcomes reported regarding its effectiveness, as researchers claimed positive learning impacts, while others reported otherwise. Despite affirming the positive contribution of flipped classrooms in teaching science subjects, roust studies on using flipped classroom in teaching integrated science to enhance students' critical thinking and problem solving skills are limited. Therefore, the aim of this study was to investigate the effectiveness of flipped classroom instructional package on undergraduate students' problem solving skills in integrated science in Federal University of Kashere, Gombe State, Nigeria.

Specifically, the main objectives are: to examine the effects of flipped classroom instructional strategy on student's problem solving skills in integrated science, determine the effect of lecture method on student's problem solving in integrated science and investigate the difference between male and female learners' problem skills when they participated in flipped classroom instructional strategies

1.3 Research Questions

1. What are the pretest problem solving mean scores of students taught using flipped classroom instructional strategy and those taught with lecture method?
2. What are the pretest problem solving mean scores of male and female students exposed to flipped classroom instructional strategy and those taught with lecture method?

1.4 Research Hypotheses

HO_1: There is no significant difference between problem solving skills of students exposed to flipped classroom and conventional lecture instructional strategies.

HO_2: There is no significant difference between male and female students' problem solving skills exposed to flipped classroom instructional strategy in integrated science.

2. METHODOLOGY

2.1 Design and participants

The numerical strength of the population of this study comprises all the one hundred and six (106) 300 and 400 levels undergraduate integrated students in the Department of Science Education, Federal University of Kashere, Gombe State, Nigeria. Intact class of all the 106, 300 and 400 undergraduate integrated science education levels that registered for SED 3219: Industrial Processes and Application were purposively selected for the study because of easy accessibility, using pretest-posttest quasi-experimental design, but only one hundred students participated in the study because six of them were indisposed. Twenty six (26) and twenty five (25) students were randomly selected from 300 and 400 levels respectively, making a total of fifty one (51) to form group one. Twenty four students (24) and twenty six (26) students were also randomly selected from both 300 and 400 levels respectively making up of fifty (50) participants to form group two.

Each group was randomly assigned to treatment. Group 1 was exposed to conventional lecture method that made of 49 students and group 2 was exposed to flipped classroom instructional strategy comprises of 51 students as well. Two main instruments were used in the study thus: (1) Integrated Science Problem Solving Ability Test (ISPSAT) and Flipped Classroom Instructional Package (FCIP). ISPSAT was to test logical and critical thinking of students through their selection of correct matching reasons to correctly solve problems. It is made of 20 multiple-choice centred on problem solving ability of the students in integrated science course titled: Industrial Processes and Application questions related to application of integrated science concepts to solve life problems with special application to industrial processes (operations and application); the scientific processes involved in the synthesis/manufacture of important items used in industry and everyday life, such as paints, textile, brewing, petroleum, ore smelting, fertilizers and food processing and preservation.

Each item was in question mode with five possible distracters to assess students' matching reasons. Each correct answer earned the participant 1 mark and wrong answer earned the participant zero (0) mark. Besides, it showed the participants who merely guessed answers from those with correct reasoning modes for solving conceptual and related problems in integrated science course. Most of the questions were understanding, critical thinking, analyzing, synthesis and application levels because problem solving skills require higher order mental processes. In other word, it involves students understanding of the concepts before reasoning and thinking out of the solution using the correct reasoning modes.

The validity of the instrument were ensured by two experts in the Department of Science Education, Federal University of Kashere, Gombe State, Nigeria. The reliability instrument was established by subjected it to Kuder-Richardson 20 measure of internal consistency of the multiple choice items and matching reasons yielding an alpha value of 0.85. FCIP is a stimulus instrument that comprised the video clips of integrated science course contents of industrial processes (operations and applications) developed by the researchers. It was validated by two ICT experts and two lecturers in Educational Technology both in the Science Education Department, Federal University of Kashere, Gombe State, Nigeria. Their observation were used to improve the instrument.

Data collection comprised three stages: pretest lasted for a duration of one week, experimental stage lasted for a period of ten weeks and posttest lasted for a period of one week. The researchers exposed the participants in both experimental and control group for the treatment for ten weeks in which the experimental group was taught using FCIP for 10 weeks and the control group was taught using conventional lecture method for 10 weeks, teaching the same concepts in integrated science course (scientific processes involved in the synthesis/manufacture of important items used in industry and everyday life, such as paints, textile, brewing, petroleum, ore smelting, fertilizers and food processing and preservation). After which the test was conducted for another one week using the same instrument as for posttest (ISPSAT). The researchers carried out the teaching in both experimental and control groups for ten weeks. One week was used for test using the same instrument ISPSAT.

Data collected were analyzed with the use of descriptive statistics such as mean and standard deviation and inferential statistics such as t -test analysis.

3. RESULTS

1. What are the pretest problem solving mean scores of students taught using flipped classroom instructional strategy and those taught with lecture method?

Table 1: Pretest Mean Score of Students' Problem Solving Exposed to Lecture Method and Flipped Classroom Instructional Strategy

		N	Mean	SD	SE
Pretest	Lecture	49	24.47	10.29	1.469
	Flipped Classroom	51	25.12	10.47	1.466

Table 1 shows the pretest mean score of students' problem solving ability taught using lecture and flipped classroom instructional strategies. The participants in lecture method group scored 24.47 while those in flipped classroom scored 25.12. The difference in their pretest mean score of problem ability are almost the same.

2. What are the pretest problem solving mean scores of male and female students exposed to flipped classroom instructional strategy and those taught with lecture method?

Table 2: Pretest Mean Score of Students Exposed to Flipped Classroom Instructional Strategy and Lecture Method According to Gender

	Gender	N	Mean	SD	SE
Pretest	Male	52	28.17	10.91	1.143
	Female	48	31.00	11.98	1.261

Table 2 indicates the pretest mean score of students' problem solving ability taught using lecture and flipped classroom instructional strategies according to gender. The male participants scored 28.17, while the female counterparts scored 31. The difference in their pretest mean score of problem ability is marginal.

$H0_1$: There is no significant difference between mean score problem solving ability of students exposed to flipped classroom and conventional lecture instructional strategies.

Table 3: t-test analysis of Mean Scores of Integrated Science Students Problem Solving Skills Exposed to Flipped Classroom Instructional Package and Lecture method

Variable	N	Mean	SD	SE	DF	t-value	P	Remark
Lecture	49	55.80	10.56	1.47				
Flipped classroom	51	75.70	13.56	1.47	98	-5.202	.000 (2-tailed)	Sig.

*Significant at $P \leq 0.05$

Table 3 presents t-test analysis of mean scores of integrated science students' science problem solving skills exposed to flipped classroom and regular conventional lecture methods. It showed that students taught with flipped classroom instructional strategy (mean = 75.7) performed better than the lecture method participants (mean = 55.8) in problem solving skills when exposed to flipped classroom and lecture method respectively. The two groups have difference of mean 19.9 and the 95% interval for the estimated population mean difference is between -3.51 and -1.36. The effect size was large (d = 1.64). The independent t-test showed that the difference between the flipped classroom and lecture instructional strategies was significant (t = -5.202, df = 98, p = .000, two tailed). Hence, hypothesis 1 is rejected.

$H0_2$: There is no significant difference between male and female students' problem solving skills exposed to flipped classroom instructional strategy in integrated science.

Table 4: t-test analysis of Mean Scores of Male and Female Students Problem Solving Skills Exposed to Flipped Classroom Instructional Package and Lecture method

Variable	N	Mean	SD	SE	DF	t-value	P	Remark
Male	52	66.58	15.30	2.13				
Female	48	65.35	16.35	2.345	98	-3.36	.386 (2-tailed)	Not Sig.

*Significant at $P \leq 0.05$

Table 4 shows t-test analysis of mean scores of male female students' problem solving ability exposed to flipped classroom and conventional lecture methods. It revealed that male and female participants' problem solving abilities had little or no difference (mean of = 66.58 and 65.35) respectively. The difference between the mean of the two groups was 1.23 at the 95% interval for the estimated population mean difference is between -.59 and 1.38. The effect size was not large (d = 0.075). The independent t-test indicated that the difference between the male and female students' problem solving abilities was not significant (t = .633, df = 115, p = .528, two tailed). Hypothesis 2 is therefore upheld.

4. DISCUSSION

The result revealed that the students taught with flipped classroom instructional package performed better in problem solving abilities industrial processes and application in integrated science course as compared with those taught with method. The result obtained however showed higher mean score between the two groups 75.7 flipped classroom) and (55.8 lecture method) respectively. This might be as a result of students were able to study at their different homes with ease and comfort to develop better understanding, critical thinking and problem solving skills of industrial processes and application concepts. The result of the study is in agreement with the findings of McLaughlin et al. (2014) and who applied flipped classroom for teaching basic pharmaceutics and observed that the flipped classroom group were better in performance in critical thinking, problem solving skills.

The result of the study aligned with the findings of Touchton (2015) who applied flipped classroom teaching method to teach an advanced statistic course and discovered that the flipped classroom group were better in problem solving skills, difficult topics than the traditional group. However, the finding of the study negates the study of Jensen et al. (2015) that conducted a flipped classroom to study biology course and noted that flipped classroom does not have significant benefits over non-flipped classroom in higher reasoning skills and problem solving skills provided both follow an active learning approach.

The result of the study also showed that the problem solving of male and female participants had no significant difference. This might be that the participants were subjected to the same pedagogical practice conditions. In addition, both sexes were given equal opportunity in the learning processes and activities to perform skills, such as listening and watching videos, performing the same tasks doing the same assignments, among others to develop better problem solving abilities in the course concepts.

This result corroborates with result of Tienxhi (2017) that there are no longer distinguishing differences in cognitive, affective and psychomotor skills achievement in of learners in respect of gender. Nevertheless, the finding negates the result of Kurt (2017) which affirmed that there was a significant impact of gender on students' academic self-concept in favour of the female students in flipped instructional techniques. The finding was in variance with the result of Ajala (2013) that male students showed a remarkable post mean score in biology than their female counterparts exposed to cooperative computer-assisted instructional technics.

5. CONCLUSION

The study established the facts that the students taught with flipped classroom instructional packages performed better than in conventional lecture methods. This was due to the facts that participants exposed to flipped classroom instructional strategies were able to learn better through listening, watching videos of lecturer's instructions, studying and doing assignments individually at homes and group interactions in the real classroom. They were very active and inquisitive and discovered that they can find out things and solve problems by themselves. Hence, they were able to perform better in problem solving skills. Besides, study established that both sexes performed almost the same because they were given the same teaching opportunities and learning conditions.

6. RECOMMENDATIONS

Based on the findings of this study, the following recommendations are made.
Lecturers particularly integrated science lecturers should be trained, retrained and educated through workshops, seminars, conferences on the pedagogical benefits of the use of flipped classroom instructional package. Lecturers should be motivated and encouraged to maximize the benefits of flipped classroom instructional package curriculum delivery Government and educational institutions should make sure that adequate technological facilities are in supply that would facilitate the integration of flipped classroom instructional strategies in universities and higher institutions of learning,

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