Journal of Digital Educational Technology
2023, 3(2), ep2303
e-ISSN: 2752-5503
https://www.jdet.net/

Research Article

OPEN ACCESS

Improving students' geography achievement using computer simulation and animation packages in flipped classroom settings

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Citation: Falode, O. C., & Mohammed, I. A. (2023). Improving students' geography achievement using computer simulation and animation packages in flipped classroom settings. *Journal of Digital Educational Technology, 3*(2), ep2303. https://doi.org/10.30935/jdet/13106

ARTICLE INFO

Received: 19 Dec. 2022

Accepted: 20 Mar. 2023

ABSTRACT

The deployment of innovative and learner-centered approaches into teaching and learning has strong potential of improving students' learning outcomes. The study compared the effectiveness of computer simulation and animation instructional packages in flipped classroom settings on secondary school students' achievement and retention in geography. The study adopted a pre-/post-test, non-equivalent, non-randomized quasi-experimental control group design. A sample of 126 senior secondary school class two (SS2) geography students was purposively drawn from two intact classes in Minna Metropolis, Niger State, Nigeria as participants for the study. The two intact classes were randomly assigned to experimental group I (computer simulation package, n=67) and experimental group II (computer animation package, n=59) in flipped classroom settings. A 50-item geography achievement test (GAT) was used for data collection, while computer simulation and computer animation instructional packages were administered to students as treatment in flipped classroom settings. The face and content validity of GAT was carried out using experts in the field of geography, educational technology and computer science from Federal University of Technology, Minna. GAT was further subjected to pilot testing, and a reliability coefficient of 0.85 was obtained using test re-test method and PPMC formula. Descriptive statistics of mean and standard deviation were used to answer the research questions, while inferential statistics of t-test was used to test the null hypotheses at 0.05 level of significance. Findings revealed that computer simulation (mean gain=41.70) and computer animation (mean gain=38.32) instructional packages in flipped classroom settings improved students' achievement and retention of geography concepts. Also, no significant difference was found in the mean achievement (t=.05, df=124, p=0.63) and retention (t=2.04, df=124, p=0.82) scores of the two groups. It was therefore recommended that teachers should incorporate technology-based flipped classroom instructional strategies into teaching and learning of geography in order to improve students' learning outcomes in the subject.

Keywords: achievement, animation, simulation, flipped classroom, geography, retention

INTRODUCTION

Technology has brought to limelight some new innovations and skills to teaching and learning in all aspects of education. In this regard, increasing growth in educational technology and its application in numerous learning forms expedite some novel learning ecosystems that offer students different approaches to learning opportunities and resources other than the traditional approach (Campillo-Ferrer & Miralles-Martínez, 2021).

Expansion in technology has also increased the necessity for interactive learning process, which therefore guarantees the inclusion of different technological learner-centered atmospheres in education practices (Ozyurt, 2022). These technological interventions are vital and relevant to teaching and learning of geography.

Geography is one of the essential subjects being taught in senior secondary schools and tertiary institutions in Nigeria. It entails the study of natural topographies and occurrences on the earth surface and in the atmosphere. The subject also emphasizes on location, space association and changes of physical occurrences on the surface of the earth; it focuses on the interrelationship among occurrences on the earth surface and those in the atmosphere based on stated objectives (Mogbo et al., 2021). The main emphasis of geography is the physical and human or cultural phenomena on earth. It lays emphasis on people, places, and occurrences as they occur in particular forms and as they change in a process in any surrounding. Moreover, the knowledge of geography has been meaningfully linked to national integration and

infrastructural development of every developed nation It has been discovered in repeated studies that geography education has a direct effect on the national integration and infrastructural development of a nation (Olaniyi & Oladokun, 2021). However, over the years, students' performance in the subject in Nigeria has not been encouraging, and this menace is not unconnected to insufficient number of geography teachers in schools and the old-fashioned lecture method of teaching, which is unexciting, unappealing and teacher-centered (Eze, 2021; Falode et al., 2016a). In order to ameliorate this problem, the call for the integration of learner-centered, new and interactive styles into teaching and learning of geography becomes imperative. One of such styles is the flipped classroom settings.

Flipped classroom is an innovative teaching approach in a personalized learning environment that leverages on technology in order to transform the organization and performance of school happenings before, during and after the face-to-face periods (Cabero-Almenara et al., 2021; Ruslan et al., 2022). Ozyurt (2022) noted that during flipped classroom settings, the activities carried out in the classroom environs in orthodox learning is usually relocated to the home environment, and the happenings executed at home environment is moved to the classroom setting. Flipped classroom enables teachers to bring new modernizations into school activities by combining information and communication technologies (ICTs) into teaching before, during and after the face-to-face sessions (Salas-Rueda, 2022). With the support of learning technologies, students study pre-assigned class resources in the form of recorded videos, readings materials and simple tasks so that the teachers will be able to conduct activities that build students' critical thinking skills in the face-to-face instructions. This is primarily done by necessitating learners to view videos outside of their class so that during face-to-face classes, students will be able to interface more with their students and instructors, instead of mere talks (Dong et al., 2019). Furthermore, Lee and Martin (2020) observed that the flipped classroom method is based on the conversion of classroom and home roles in traditional learning. Flipped classroom enables students to study materials gently and learn at their own pace thus bridging the individual differences gap in the classroom. On this note, when students learn at their own pace in order to discuss what they have learnt in the class, they better construct their knowledge, build and plan their own understanding of ideas with the eventual objective of improving learning. Without a doubt, numerous studies were conducted to increase students' achievement and retention in flipped classroom. Salas-Rueda (2022) explored the usefulness of flipped classroom in teaching and learning of descriptive statistics and revealed that students' achievement improved after being imparted using the model. Also, Oladimeji et al. (2021) examined the effectiveness of flipped classroom approaches on students' learning outcomes in electrical installation and maintenance work in technical colleges in Niger state, Nigeria, and established substantial variation in the achievement and retention of those imparted using flipped classroom video instructional strategy and those taught using audio and text in flipped classroom settings. In addition, Gambari et al. (2016) tested the usefulness of flipped classroom instructional model and revealed that flipped classroom upgraded students' achievement and retention. Adonu et al. (2021) also conducted a study on students' achievement and retention in biology using flipped classroom and PowerPoint instructional package and discovered that students exposed to flipped classroom performed better in their achievement and retention. Afzali and Izadpanah (2021) in another study determined the effect of flipped classroom model on Iranian English foreign language learners' engagement and motivation in English language and revealed a significant enhancement in the mean achievement score of students exposed to flipped classroom style. With the established efficiency of the flipped classroom model as shown in these foregoing studies, it is still not clear if the same model will be effective when computer simulation and computer animation resources are used along with it.

Computer simulation is a program that produces a natural occurrence through the picturing of the progression of its state. It is also seen as the use of computer to model real-life occurrences in order to help students gain understanding into the behaviour of difficult systems. Inyang (2021) considered computer simulation as the depiction of the behaviour or appearances of a system through the use of another channel especially a computer program intended for the purpose. With computer simulation, students are provided with an opportunity to view things that cannot be readily seen or imagined. The simulation therefore shapes their intellectual thinking to comprehend theoretical ideas they hitherto do not understand. As a technique for instruction, simulation allows students to deal in a realistic way with matters of vital concern. Several studies conducted on computer simulation revealed its usefulness in teaching and learning setting. For instance, Asogwa et al. (2016) found that computer simulation package increases achievement and retention in genetic concepts. A similar study led by Gimba et al. (2015) discovered that students' retention improved meaningfully when taught arithmetic progression using computer simulation. In addition, Jega et al. (2018) studied the effect of computer simulation on students' achievement and retention of knowledge in mathematics and found that students exposed to simulation experienced enhancements in their achievement and retention.

Computer animation on the other hand is a video demonstration that comprises of motion graphics, audio-virtual, content translation into words to ensure effective and meaningful learning. Animation teaching approach provides additional information and gives external support for intellectual simulations, thus allowing learners to perform a higher amount of cognitive processing (Falode et al., 2016b). Thus, classroom best practices in various concepts should be subjected to visualization of subject matter, which is better processed in cognitive structure (Olatunde-Aiyedun, 2021). The use of animation helps in smooth teaching and learning, it improves retention of concepts because it is only when the concepts learned are stored and recalled in the long run that performance can improve (Faruk et al., 2022). Moreover, the use of computer animation in the classroom will stir the interest of the students, motivate them to learn and increase independent and personal responsibility for education, higher thinking skills and creativity in problem solving skills. In view of this, Ahmed and Inti (2021) added that a well-designed

computer animation may help students learn quicker and stress-free. It is also an outstanding aid to teachers when it comes to elucidating tough subjects. With animation, learning becomes fascinating, attractive, which promotes understanding and also improves student-student teamwork by interacting with the computer package to make meaning out of the content studied. Numerous studies have shown the significance of computer animation in improving students' achievement and retention. While investigating the effect of animation instructional strategy on secondary school students' learning outcome in climate change concepts, Olatunde-Aiyedun (2021) reported a significant difference in the performance of those exposed to animation and conventional teaching method. Likewise, in their research to check the effects of animation and concept map visualization elements on achievement, retention and interest in geography among secondary school students in Abuja, Nigeria, Mogbo et al. (2021) found a substantial difference in the achievement and retention of students exposed to animation and concept map visualization. In another study, Ahmed and Inti (2021) revealed a substantial difference in the achievement of students exposed to animation and lecture method. Faruk et al. (2022) also found a significant difference in the achievement and retention of students exposed to animation and orthodox method of teaching. In another study, Gambari et al. (2014) informed a significant difference in the mean achievement and retention of students taught using animation and geometrical model. Accordingly, if appropriately designed and executed in an appropriate learning setting such as flipped classroom, computer simulation and animation packages can be effective in bringing about improvement in students' achievement and retention in geography.

Achievement and retention in any academic pursuit are vital learning outcomes that show the degree to which learning has occurred. Academic achievement refers to quantifiable changes in students' behaviour in a learning task as a result of contact to a given treatment. It represents performance outcomes that indicate the extent to which a person has accomplished specific goals that were the focus of activities in instructional environments, specifically in school, college, and university (Ahmed & Inti, 2021). Retention is the ability to store what has been learned by an individual and be able to recall what has been stored thereafter.

In the face of the importance attached to geography as one of the central subjects in Nigerian secondary school curriculum, the achievement of students has remained disappointing. This menace has unfailingly been linked to the old-fashioned approaches habitually used by teachers, which are unexciting and make learners inactive during teaching and learning process. To solve this problem, several innovative methods have been recommended and used, yet the problem continues. While a number of prior studies only examined the independent effectiveness of computer simulation and computer animation in teaching and learning process, the potential of these resources when used in a learner-based setting such as flipped classroom surroundings has however not been explored. Therefore, this study was carried out to compare the effectiveness of computer simulation and animation instructional packages in flipped classroom settings on academic achievement and retention of senior secondary school students in geography.

Purpose of the Study

The general purpose of the study was to compare the effects of computer simulation and animation instructional packages in flipped classroom settings on academic achievement and retention of senior secondary school students in geography. Specifically, the study:

(1) examined the effect of using computer simulation and animation packages in flipped classroom settings on academic achievement of secondary school students in geography and

(2) determined the effect of using computer simulation and animation packages in flipped classroom settings on retention of secondary school students in geography.

Research Questions

The following research questions were answered in the study:

1. **RQ1.** What are the effects of computer simulation and animation instructional packages in flipped classroom settings on academic achievement of secondary school students in geography?
2. **RQ2.** What are the effects of computer simulation and animation instructional packages in flipped classroom settings on the retention of secondary school students in geography?

Research Hypotheses

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

1. **HO1.** There is no significant difference in the mean achievement scores of students taught geography using computer simulation and animation instructional packages in flipped classroom settings.
2. **HO2.** There is no significant difference in the mean retention scores of students taught geography using computer simulation and animation instructional packages in flipped classroom settings.

METHODOLOGY

The study adopted a pre-test, post-test, non-equivalent and non-randomized quasi-experimental design.

Participants

A sample of 126 (67 in experiment 1 group, & 59 in experiment 2 group) senior secondary school two (SS2) geography students in Minna Metropolis of Niger State drawn from two separate intact classes during the 2019/2020 academic session were purposively selected as participants for the study. The two schools were purposively selected because they are boarding schools with well-equipped computer laboratories that are accessible to students at the end of school hours since the study requires flipped classroom settings. The selection of SS2 class was based on the fact that the perceived

Table 1. Research design layout

Group	Pre-test	Treatment	Post-test	Retention
Experimental group I	O_1	X_1	O_2	O_3
Experimental group II	O_1	X_2	O_2	O_3

Note. O_1: Pre-test for experimental group I & II; X_1 & X_2: Treatment for experimental group I & II; O_2: Post-test for experimental group I & II; & O_3: Retention for experimental group I & II

Table 2. Pre- & post-test achievement scores of students taught geography using computer simulation & animation instructional packages in flipped classroom settings

Group	n	Pre-test		Post-test		Mean gain
		Mean	Standard deviation	Mean	Standard deviation	
Computer simulation	67	27.46	5.76	69.16	11.65	41.70
Computer animation	59	24.33	7.02	62.65	15.67	38.32

difficult geography concepts selected for learning are drawn from the syllabus of SS2. Intact classes were used because the researchers could not randomize without disrupting the school's activities. The two sampled groups were then assigned into experimental group I and experimental group II using a simple random sampling technique. **Table 1** shows research design layout.

Instrument

Three instruments were used for the study: computer simulation instructional package (CSIP), computer animation instructional package (CAIP), and geography achievement test (GAT). CSIP was developed using Adobe Flash CS6, Action Script 3.0, and Box2D professional software. The menu of the package has Log in interface, lesson objectives, practical interface, and simulation tools. CAIP on the other hand was developed using DigiCel's Flip Book animation software. The menu of the package has introductory page, lesson objectives, animated videos, text and narration. Both packages contain lessons on map reading, longitude, and latitude concepts, which secondary school students offering geography always find difficult to comprehend (Falode et al., 2016a).

The GAT, a 50-item multiple-choice objective test was validated by three geography lecturers from Federal University of Technology, Minna. These experts checked the face and content validity of the instrument whereby all observations and suggestions pointed out for improvement were corrected in the final draft of the instrument. Computer simulation and computer animation instructional packages were validated by two experts in the department of computer science and one expert in the field of educational technology all from Federal University of Technology, Minna. GAT was subjected to a pilot study using a test-retest method of reliability, and a co-efficient value of 0.85 was obtained using Pearson product moment correlation coefficient (PPMC) formula.

Data Collection and Analysis

At the commencement of the experiment, the achievement test was administered as pre-test to students in each of the two groups. The same test was later administered as post-test at the end of the experiment. After an interval of two weeks, pre-/post-test was also administered using the same test to measure the retention ability of the students. The instructional packages were administered for a period of four weeks between pre- and post-testing. The packages were installed on standalone computers available in the computer laboratories of the participating schools. Relevant orientations were also conducted for students based on their experimental group on how to use the instructional packages in their respective computer laboratories before coming to class. Also, the geography teachers in the two schools were given orientation of the working principles of flipped classroom environment, and they were also intimated of their tasks in classroom after students' interaction with the instructional packages before coming to class. The data collected were analyzed using the descriptive statistics of mean and standard deviation in order to provide answers to the research questions, while inferential statistics of t-test was used to test the null hypotheses at 0.05 level of significance.

RESULTS

Research Question One

Research question one is, as follows: What are the effects of computer simulation and animation instructional packages in flipped classroom settings on academic achievement of secondary school students in geography?

Table 2 shows the pre- and post-test scores of students taught geography using computer simulation and computer animation instructional packages in flipped classroom settings. From **Table 2**, the students exposed to computer simulation in flipped classroom setting had a mean score of 27.46 with standard deviation of 5.76 in the pre-test, and a mean score of 69.16 with standard deviation of 11.65 in the post-test. The mean gain was 41.70, which implies computer simulation package in flipped classroom setting improved students' achievement in geography greatly. Also, from **Table 2**, the students exposed to computer animation package in flipped classroom setting had a mean score of 24.33 with standard deviation of 7.02 in the pre-test, and a mean score of 62.65 with standard deviation of 15.67 in the post-test. The mean gain was 38.32. This implies that computer animation package in flipped classroom setting improved students' achievement in geography greatly.

Research Question Two

Second research question is, as follows: What are the effects of computer simulation and computer animation instructional packages in flipped classroom settings on the retention of secondary school students in geography?

Table 3. Post-test & retention scores of students taught geography using computer simulation & computer animation instructional packages in flipped classroom settings

Group	n	Pre-test		Post-test		Mean gain
		Mean	Standard deviation	Mean	Standard deviation	
Computer simulation	67	69.16	11.65	67.48	9.88	1.68
Computer animation	59	62.65	15.67	59.07	11.38	3.58

Table 4. Independent sample t-test result of mean achievement scores of students exposed to computer simulation & animation instructional packages in flipped classroom settings

Group	n	Mean	Standard deviation	df	t-value	p-value	Decision
Computer simulation	67	67.48	9.88	124	2.04	.82^{NS}	Accepted
Computer animation	59	59.07	11.38				

Note. NS: Not significant, p>0.05

Table 5. Independent sample t-test result of mean retention scores of students taught geography using computer simulation & computer animation instructional packages in flipped classroom settings

Group	n	Mean	Standard deviation	df	t-value	p-value	Decision
Computer simulation	67	69.16	11.65	124	1.05	.63^{NS}	Accepted
Computer animation	59	62.65	15.67				

Note. NS: Not significant, p>0.05

Table 3 shows the post-test and retention scores of students taught geography using computer simulation and computer animation packages in flipped classroom settings. From **Table 3**, the students exposed to computer simulation in flipped classroom setting had a mean score of 69.16 with standard deviation of 11.65 in the post-test, and a mean score of 67.48 with standard deviation of 9.88 in the retention test. The mean difference was 1.68, which implies the students greatly retained the contents taught using computer simulation in flipped classroom setting. Also, from **Table 3**, students exposed to computer animation package in flipped classroom setting had a mean score of 62.65 with standard deviation of 15.67 in the post-test, and a mean score of 59.07 with standard deviation of 11.38 in the retention test. The mean gain was 3.58, which implies students greatly retained the concept learnt when exposed to computer animation package.

Testing of Null Hypotheses

Hypothesis one

First hypothesis is, as follows: There is no significant difference in the mean achievement scores of students taught geography using computer simulation and computer animation instructional packages in flipped classroom settings.

Table 4 shows the independent sample t-test result of the mean achievement scores of students exposed to computer simulation and computer animation instructional packages in flipped classroom settings. From **Table 4**, t=1.05 and p-value=0.63. Since p>0.05, the null hypothesis is accepted. This implies that there is no significant difference in the mean achievement scores of students exposed to computer simulation and computer animation instructional packages in flipped classroom settings.

Hypothesis two

Second hypothesis is, as follows: There is no significant difference in the mean retention scores of students taught geography using computer simulation and computer animation instructional packages in flipped classroom settings.

Table 5 shows the independent sample t-test result of the mean retention scores of students taught geography using computer simulation and computer animation instructional packages in flipped classroom settings. From **Table 5**, t=2.04 and p-value=0.81. Since p>0.05, the null hypothesis is accepted. This implies that there is no significant difference in the mean retention scores of students exposed to computer simulation and computer animation instructional packages in flipped classroom settings.

DISCUSSION

The outcome of hypothesis one discloses that while the two groups accomplished well in the post-test after the treatment, there is no significant difference in the mean achievement scores of students taught using computer simulation and computer animation instructional packages in flipped classroom settings. This outcome differs from Adonu et al. (2021), Afzali and Izadpanah (2021, Gambari et al. (2016), Oladimeji et al. (2021), and Salas-Rueda (2022) whose study found a significant difference in the achievement scores of students exposed to flipped classroom instructional approach. It is also not in tandem with Ahmed and Inti (2021) whose study showed a significant difference in the achievement of students exposed to animation instructional method. Nonetheless, the reason for the lack of significance difference in the achievement of the two groups even though there was a huge difference in the post-test after the treatment is due to the fact that while other studies independently compared computer animation, computer simulation and flipped class with conventional approach, this specific study compared the two computer packages in flipped classroom backgrounds in an inter-research in order to compare their effectiveness whether computer simulation in flipped classroom situations can be superior than computer animation in flipped classroom

settings and vice versa. In the end, it was revealed that the two packages used in flipped classroom settings do not vary in their effectiveness as far as students' achievement is concerned as realized in the result. Consequently, it means that both of them are very effective and can be used to increase students' attainment efficiently and proficiently in flipped classroom settings.

The result of hypothesis two reveals that while the two groups retained the contents well as shown in the post-test, there is no significant difference in the mean retention scores of students taught using computer animation and computer simulation instructional package in flipped classroom settings. This finding is not in consonance with Adonu et al. (2021), Gambari et al. (2016), and Oladimeji et al. (2021) whose study revealed a significant difference in the mean retention of students exposed to flipped classroom instructional approach. It also goes contrary to Faruk et al. (2022) and Mogbo et al. (2021) whose study on computer animation discovered a significant difference in the retention scores of students. The reason for this discovery is due to the fact that the computer simulation and animation package used in flipped classroom situation in this study incorporated videos, texts and voice mechanisms, which, for that reason, has what it takes to arouse both auditory and visual senses of learners and, in this manner, supporting them to retain the content. While the two groups revealed no significant difference in terms of retention, this means the two packages are effective and can be used excellently and competently to augment students' retention.

CONCLUSION

The deployment of computer simulation and computer animation instructional packages in flipped classroom settings make students active participants during teaching and learning of geography, and invariably improved the achievement and students in the subject. There is no doubt that the menace of unsatisfactory performance of students in geography will be resolved if the strategies are regularly adopted in teaching and learning of the subject and other related ones.

Recommendations

Based on the findings that emanated from the study, the following recommendations are made:

1. The use of simulation and animation-based instructional packages in flipped classroom settings should be integrated into teaching and learning of secondary school geography in order to boost students' achievement and retention of the subject.
2. Development of computer simulation and animation instructional packages should be integrated into teachers' training programs in order to prepare them for future integration into education.
3. Innovative approaches strategies such as flipped classroom settings should be incorporated into teaching and learning of secondary school subjects in order to make learners active participants.

Author contributions: The two authors are fully involved in all stages of this study while preparing the final version. They all agree with the results and conclusions.

Funding: No external funding is received for this article.

Ethics declaration: The authors declare that the consent of participating schools and students was sought and granted, and that confidentiality of all sensitive information obtained was fully ensured.

Declaration of interest: The authors declare that they have no competing interests.

Ethics approval and consent to participate: Not applicable.

Availability of data and materials: All data generated or analyzed during this study are available for sharing when appropriate request is directed to corresponding author.

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