
Assessing the efficacy of two modes of digital learning object package on students' achievement and interest in rocket and satellite in post covid'19 era

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Abstract: This paper examines the efficacy of two modes of digital learning object package on students' achievement and interest in rocket and satellite in post covid'19 Era. The study adopted Quasi-Experimental research design. A sample of 132 SS3 physics students selected using purposive sampling technique. The instruments used for data collection were Rocket and Satellite Achievement Test (RSAT) and Students Interest Questionnaire (SIQ) developed by the researchers. The reliability coefficient indices of 0.88 and 0.83 for RSAT and SIQ were obtained using Kuder-Richardson 20 (KR-20) formula and Cronbach Alpha. The data obtained were analyzed using mean and standard deviation to answer the research questions and analysis of covariance (ANCOVA) to test the Null hypotheses. Findings revealed that DLO with tutor-led instructional model significantly promotes students' achievement and interest in rocket and satellite compared to DLO self-paced instructional model. Gender had some influence on physics students' achievement and interest in Rocket and Satellite but not statistically significant. Based on the findings it was recommended amongst others that: Physics teachers should adopt the use of DLO with Online teaching packages (especially using, tutor-led instructional model) to enhance students' achievement and interest in the Rocket and Satellite.

Keywords: achievement; digital learning object; post-covid'19 era; rocket and satellite

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Introduction

Physics has remained a significant subject in the realm of sciences. It is a branch of science and a bedrock for technological advancement. Its' relevance to technology has spur Nigeria government to make "physics in technology" a theme in the new physics curriculum for secondary schools (FRN, 2009) which is already in use since 2011. Topics under this thematic area include: Battery (Battery-primary cells and accumulators); Electroplating; Application of electromagnetic field; Transmission systems; Users of machines, repairs and maintenance of machines; Galvanometer electric motor, generators; Transformer (step-down and step-up transformers); Dams and energy production (location of dams for producing electricity in Nigeria and principle of production of electricity from dam); and Rockets and Satellites.

The contents of Rockets and Satellites as enshrined in the current Nigeria physics curriculum include: component parts of rockets and satellites, functions of rockets and satellites, uses of rockets and satellites, operation and uses of Niger-SAT1 and its features, operation and uses of NICOM-SAT1 and its features (FRN, 2009). The relevance of these contents to the further learning of secondary school students in sciences and, more importantly, to space physics cannot be underrated. It is useful

in communications, photography, mapping, weather forecast, defense, geographical information system (GIS), and geographical position system (GPS) (Anyakoha, 2011); in the spacecraft design: for guidance and control systems (Tipaldi, et al., 2022) and in new types of scientific applications (Silvestini & Lavagna, 2022). Hence, the teaching and learning of Rockets and Satellites to secondary school students becomes very imperative in the preparation for technological advances of the modern world.

In the outcome of school instruction, students' interest and achievement are two key interdependent concepts, which benefit mutually from each other. Students' interest describes the inclination of individual students towards and liking of a particular topic or solution of problems, whether affective or cognitive processes (Hidi, et al., 2004). Students' interest in STEM topics can be improved by making science lessons interesting through relating STEM topics with its social significance (Badri, et al., 2016). Teaching modern physics concepts using didactic strategies (i.e. applying diverse elements for teaching such as PowerPoint presentations, videos, questionnaires, and activities, following an activity-based learning strategy) contributes to the development of students' interest (Vakarou, et al., 2024). One of the importance of students' interest to physics education is that interest enhances persistence and achievement (de Barba et al., 2016; Nuutila et al., 2020). While, students' achievement remains the major outcome of students' learning (National Research Council [NRC], 2012). Meanwhile, the chief examiners report for West African Examination Council (WAEC) (2016) has noticed that questions regarding Rockets and Satellites were the least attempted by candidates, and candidates that attempted the questions performed poorly. The report showed further that the academic achievement score of these students were low because they have vague knowledge of the subject matter.

Generally, there has been a great concern and conscious attempts to integrate fully e-learning (i.e. online learning, computer-based learning, virtual classrooms and digital collaboration) into the Nigeria educational system across all levels for more than a decade. However, the unprecedented situation of COVID-19 pandemic is bringing about the rapidly switching in-person education to online education (Irele, n.d) and imperative for countries to advance in E-learning. Thus, the attempt to use technology to replace in-class time courses and learning materials with online to maintain educational continuity in tertiary institutions became necessary during the pandemic (Andreas, 2020). To this end, there was a clarion call for Nigeria policies on education to be re-directed as to make way for digital technology.

Nigeria, then, joined other developed countries to adopt online learning in order to respond to the education need during lockdown. Okocha (2020) revealed that private universities take the lead in online learning. Adeyeye, et al., (2022) observed that, even though a number of Nigerian universities used online teaching to delivered lectures but unable to use digital technologies to assign assignments to students. Some private schools in Nigeria especially in Lagos, were able to use digital technologies (mostly Microsoft Team) to assign assignments and access their students at both primary and secondary levels. The implication is that, teachers at all educational level in Nigeria needs digital skills especially teachers in public schools, be outfitted with digital technologies to be able to meet the demands of e-learning in post Covid-19 era.

E-learning is taking us to a digital world, which provides many opportunities for the younger generation to develop the capacity for action, skills, and knowledge (Papadakis, et al., 2021). Online education platforms and digital learning object (DLO) were to provide continuous education around the world (Zhou et al., 2020; Viner et al., 2020). Therefore, classroom teaching in a digital world could be presented in form of Digital Learning Object (DLO). DLO is a piece of content structured to support learning through possible inclusion of educational objectives, content, resource, activities, and assessments (Norman and Porter, 2007). DLO is designed to support learning, make teaching/learning content flexible which helps ensure a successful learning process (Jutaite, et al., 2021).

DLO has several benefits in school learning. Some of these benefits include: provision of connection, collaboration and lifelong learning in post covid-19 era (Otamas, et al., 2021); introduces innovative teaching methods and promotes collaborative learning in school (Redfors, et al., 2014); promote students' motivation and engagement in lessons; and forms positive bond with increasing students' achievement, effective classroom work and development of different thinking skills (Jutaite,

et. al., 2021). Besides, researchers have suggested that DLOs should be combined with multimedia (text, sound, graphics, animation, video recordings and simulations in the digital form) or other varieties (virtual learning environment, online storage, mobile devices) for effectiveness and better improvement in learning (Basaran, 2016; Marcus-Quinn & McGarr, 2015). In the development of the DLO and implementation, teacher takes a critical role. Singhavi and Basargekar (2019) argued that the quality of the DLO implementation depends on the teacher. Teacher, then, accept new roles which changes continuously during implementation (Loong & Herbert, 2018; and Zhu, 2010). Teacher may direct the instruction or allow students to learn on their pace during instructional delivery.

Findings of George (2014) revealed that e-learning can facilitate self-paced or instructor-led learning. The report from the findings of Yan, et al., (2022) as revealed that, self-paced online learning may ease learning but could bring about some underlying learning barriers. However, the study further suggests reinforcement learning-based adaptive practicing model, capable of removing the barriers encountered on self-paced learning. Also, the report from the study by Jung, et al., (2022) revealed that learners struggle to acquire in-depth knowledge and skills under fully applied self-paced online environments due to limited methods for accurate assessments of learning and absence of personal communications. However, comparing and contrasting the experiences of two university tutors on online lessons during lockdown, Mavroudi, & Papanikolaou (2022) reported that social-constructivist approaches favor tutor support dialogical forms of online pedagogy, as well as sustain high-quality instructional dialogue in an online learning setting.

It is worthy to note that, Nigeria is advancing in online learning. The COVID-19 pandemic has accelerated the use of e-learning in Nigeria, as schools were compelled to close their physical classrooms and shift to online teaching methods (Nwegbu et al., 2020). This transition brought a broader transformation in the Nigerian education system, as it embraces the integration of advanced technologies, and moving away from traditional approaches of learning towards e-learning and online education (Ugah, 2023). Nevertheless, the execution of e-learning in Nigeria has not been without challenges, including poor internet connectivity, unreliable power supply, and a lack of technical expertise; as well as pedagogical and technological knowledge which is a major determinants of physics teachers' effectiveness (Ogundeji, et al., 2021). To this end, it will be best to see if online learning promote students interest and achievement in space physics especially in rocket and satellite, and more importantly the approach that best favour students achievement and interest.

Research Questions

Four research questions were posed to guide the study:

1. What are the mean achievement scores of physics students' taught Rockets and Satellites using Digital Learning Object with tutor-led instructional model and self-paced instructional model?
2. What are the influences of gender on students' mean achievement scores in Rocket and Satellite?
3. What are the mean interest scores of physics students' taught Rockets and Satellites using Digital Learning Object with tutor-led instructional model and self-paced instructional model?
4. What are the influences of gender on students' mean achievement scores in Rocket and Satellite?

Hypotheses

Four hypotheses were formulated for the study:

Ho₁: There is no statistically significant difference in the mean achievement scores of physics students' taught Rockets and Satellites using Digital Learning Object with tutor-led instructional model and self-paced instructional model.

Ho₂: The mean achievement scores of male and female students taught Rocket and Satellite do not differ significantly.

Ho₃: There is no statistically significant difference in the mean interest scores of students' taught Rockets and Satellites using Digital Learning with tutor-led instructional model and self-paced instructional model.

Ho₄: The mean interest scores of male and female students taught Rocket and Satellite do not differ significantly.

Method

The research design adopted for this study was Quasi-Experiment. In specific, the non-equivalent control group research design was used. The population of the study comprised the entire SS 3 students in the private secondary schools in Eti-Osa Local Government Area of Lagos State. A sample of 132 SS3 physics students were used for the study. A purposive sampling technique were used to select both the schools and the sample for the study. The instruments used for data collection were Rocket and Satellite Achievement Test (RSAT) and Students Interest Questionnaire (SIQ) developed by the researchers. The test contains twenty questions with four options ranging from A-D from where the students are expected to select the answer that best answers the question. The SIQ were used to assess students' interest in Rocket and Satellite. SIQ have two Section A and B. Section A of the Questionnaire sought information from student's demographic data while, Section B contains sixteen items. The instruments developed were face validated by two experts drawn from Department of Science Education (Physics option) and one expert from the Department of Educational Foundation (Measurement and Evaluation option). The test blueprint was used to ascertain the content validity of the RSAT and construct validity to determine the final draft of SIQ by setting a minimum factor loading of 3.5 as recommended by Meredith (1969) for factorially pure items. The reliability of the instruments was established by administering 20 copies of the instruments on 20 SS 3 Physics students in Ikeja Local Government Area of Lagos State who are not part of the study but shares the same characteristics with the students under investigation. The reliability coefficient indices of 0.88 and 0.83 for RSAT and SIQ were obtained using Kuder-Richardson 20 (KR-20) formula and Cronbach Alpha respectively. The actual experiment started with the training of Physics teachers who were used for the study. The instruments for collection of relevant data were administered online through the school Learning Management System (LMS) (i.e. Microsoft Team) to Physics students in the sampled schools before the commencement of the training which serves as pretest score. After the pretest, the subjects were randomly assigned to two groups. The experimental group A taught with Digital Learning Object package but Tutor-Led instructional model. Thereafter, the recording of the class activity which was made possible using Microsoft Team sent to their platform. The experimental group B taught with Digital Learning Object but Self-Paced instructional model i.e. the recordings of the experimental group A class activity constituent their instructional model and thereafter teacher attends to their questions. After the treatment, the instruments for collection of relevant data were administered again to the groups. The data obtained for the study were analyzed using mean and standard deviation to answer the research questions and analysis of covariance (ANCOVA) was used to test the Null hypotheses at 0.05 level of significance.

Results and Discussion

Research Question One

The average achievement score of physics students taught by Rocket and Satellite using Digital Learning Objects with a tutor-led learning model and a self-paced learning model can be seen in Table 1.

Table 1. Mean achievements scores and standard deviation of physics students' taught Rocket and Satellite using Digital Learning Object with tutor-led instructional model and self-paced instructional model

Two Mode of Digital Learning Object (DLO)	N	Pretest		Posttest		Mean Gain
		\bar{x}	SD	\bar{x}	SD	
DLO (Tutor-Led Instr. Model)	65	3.25	1.44	15.15	1.92	11.90
DLO (Self-Paced Instr. Model)	67	3.31	1.45	10.72	2.09	7.41

\bar{x} : Means SD: Standard Deviation N: number of Students

Results in Table 1 shows the mean achievement scores of 3.25 and 3.31 with standard deviations of 1.44 and 1.45 recorded for both DLO with tutor-led instructional model and self-paced instructional model respectively at the pre-test. However, at the post-test, the mean achievement scores of 15.15 and 10.72 with standard deviations of 1.92 and 2.09 were recorded for both DLO with tutor-led instructional model and self-paced instructional model respectively. Moreover, the mean gain score of 11.90 and 7.41 recorded for the two groups (DLO with tutor-led instructional model and self-paced instructional model) means that DLO with tutor-led may be more effective in promoting achievement of students in rocket and satellite compared to DLO self-paced instructional model.

Hypothesis One

Statistically significant difference in the mean achievement scores of physics students' taught Rockets and Satellites using Digital Learning Object with tutor-led instructional model and self-paced instructional model can be seen in Table 2.

Table 2. Analysis of Covariance of mean achievement scores of Physics Students' in Rocket and Satellite using DLO

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	652.461	4	163.115	39.742	.000
Intercept	3625.444	1	3625.444	883.307	.000
Pretest	1.143	1	1.143	.279	.599
Instructional Model	623.164	1	623.164	151.828	.000
Gender	.559	1	.559	.136	.713
Instr. Model * Gender	1.429	1	1.429	.348	.556
Error	521.259	127	4.104		
Total	23145.000	132			
Corrected Total	1173.720	131			

R Squared = .556 (Adjusted R Squared = .542)

Table 2 shows that instructional model is a significant factor on students' achievement in rocket and satellite on $F = 151.83$, and $Prob. = 0.000$, thus, the null hypothesis was rejected. This is because the probability value of 0.000 is less than the level of significance set at 0.05 for testing hypothesis. Therefore, the inference drawn was that there is a significant difference in the mean achievement scores of physics students' taught Rockets and Satellites using Digital Learning Object (with tutor-led instructional model and self-paced instructional model) in favour of those taught with tutor-led instructional model.

Research Question Two

The influence of gender on the average student achievement score in the Rocket and Satellite subjects can be seen in Table 3.

Table 3. Mean and Standard deviation of male and female students' achievements scores in Rocket and Satellite

Gender	Post test			Mean Gain
	N	\bar{x}	SD	
Male	74	13.11	3.10	0.47
Female	58	12.64	2.85	

\bar{x} : Means SD: Standard Deviation N: number of Students

Results in Table 3 shows that the male students had a mean achievement score of 13.11 and a standard deviation of 3.10 while their female counterpart had a mean achievement score of 12.64 with a standard deviation of 2.85. Therefore, the mean gain 0.47 at the post test revealed that male students

had a higher achievement mean score than female students. Therefore, gender might have some influence on physics students' achievement in Rocket and Satellite.

Hypothesis Two

The mean achievement scores of male and female students taught Rocket and Satellite do not differ significantly.

From the results of the analysis in Table 2, it shows that gender is not a significant factor on students' achievement in rocket and satellite ($F = 0.136$, and $Prob. = 0.713$), thus, the null hypothesis was not rejected. This is because the probability value of 0.713 is greater than the level of significance set at 0.05 for testing hypothesis. Therefore, the inference drawn was that there is no significant difference in the mean achievement scores of male and female physics students' taught Rockets and Satellites. Hence, any difference observed in the score of male and female is due to chance.

Research Question Three

The mean interest scores of physics students' taught Rockets and Satellites using Digital Learning Object with tutor-led instructional model and self-paced instructional model can be seen in Table 4.

Table 4. Mean interest scores and standard deviation of physics students' taught Rocket and Satellite using Digital Learning Object with tutor-led instructional model and self-paced instructional model

Two mode of Digital Learning Object (DLO)	N	Pretest		Posttest		Mean Gain
		\bar{x}	SD	\bar{x}	SD	
DLO (Tutor-Led Instr. Model)	65	2.03	0.30	3.26	0.17	1.23
DLO (Self-Paced Instr. Model)	67	1.94	0.27	2.93	0.27	0.99

\bar{x} : Means SD: Standard Deviation N: number of Students

Results in Table 4 shows the mean interest scores of 2.03 and 1.94 with standard deviations of 0.30 and 0.27 recorded for both DLO with tutor-led instructional model and self-paced instructional model respectively at the pre-test. However, at the post-test, the mean interest scores of 3.26 and 2.93 with standard deviations of 0.17 and 0.27 were recorded for both DLO with tutor-led instructional model and self-paced instructional model respectively. Moreover, the mean gain score of 1.23 and 0.99 recorded for the two groups (DLO with tutor-led instructional model and self-paced instructional model) means that DLO with tutor-led instructional model may promote students' interest in rocket and satellite compared to DLO with self-paced instructional model.

Hypothesis Three

Statistically significant difference in the mean interest scores of students' taught Rockets and Satellites using Digital Learning with tutor-led instructional model and self-paced instructional model can be seen in Table 5.

Table 5. Analysis of Covariance of mean interest scores of Physics Students' in Rocket and Satellite using DLO.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3.825	4	.956	18.814	.000
Intercept	23.555	1	23.555	463.472	.000
Pretest	.008	1	.008	.165	.686
Interest	3.697	1	3.697	72.748	.000
Gender	.008	1	.008	.156	.694
Interest * Gender	.055	1	.055	1.077	.301
Error	6.454	127	.051		
Total	1272.298	132			

Corrected Total	10.279	131
R Squared = .372 (Adjusted R Squared = .352)		

Table 5 shows that students' interest is a significant factor in rocket and satellite on $F = 72.748$, and $Prob. = 0.000$, thus, the null hypothesis was rejected. This is because the probability value of 0.000 is less than the level of significance set at 0.05 for testing hypothesis. Therefore, the inference drawn was that there is a significant difference in the mean interest scores of physics students' taught Rockets and Satellites using Digital Learning Object (with tutor-led instructional model and self-paced instructional model) in favour of those taught with tutor-led instructional model.

Research Question Four

The influences of gender on students' mean achievement scores in Rocket and Satellite can be seen in Table 6.

Table 6. Mean and Standard deviation of male and female students' interest scores in Rocket and Satellite.

Gender	Post test			Mean Gain
	N	\bar{x}	SD	
Male	74	3.11	0.26	0.05
Female	58	3.06	0.30	

\bar{x} : Means SD: Standard Deviation N: number of Students

Results in Table 6 shows that the male physics students had a mean interest score of 3.11 and a standard deviation of 0.26, while their female counterpart had a mean interest score of 3.06 and a standard deviation of 0.30. Therefore, the mean gain 0.05 at the post test revealed that male physics students had a higher interest mean score than female students in Rocket and Satellite. Therefore, gender might have some influence on physics students' interest in Rocket and Satellite.

Hypothesis Four

The mean interest scores of male and female students taught Rocket and Satellite do not differ significantly.

From the results of the analysis in Table 5, it shows that gender is not a significant factor on students' interest in Rocket and Satellite ($F = 0.156$, and $Prob. = 0.694$), thus, the null hypothesis was not rejected. This is because the probability value of 0.694 is greater than the level of significance set at 0.05 for testing hypothesis. Therefore, the inference drawn was that there is no significant difference in the mean interest scores of male and female physics students' taught Rockets and Satellites. Hence, any difference observed in the score of male and female physics students is due to chance.

Discussion

Findings revealed that DLO with tutor-led instructional model was more effective in promoting achievement of physics students in rocket and satellite compared with physics students under DLO self-paced instructional model. Inference drawn was that, there was a significant difference in the mean achievement scores of physics students' taught Rockets and Satellites using Digital Learning Object (with tutor-led instructional model and self-paced instructional model) in favour of those taught with tutor-led instructional model. Gender had some influence on physics students' achievement in Rocket and Satellite. The inference drawn was that, there was no significant difference in the mean achievement scores of male and female physics students' taught Rockets and Satellites. Hence, any difference observed in the score of male and female is due to chance. Furthermore, DLO with tutor-led instructional model promote students' interest in Rocket and Satellite compared to DLO with self-paced instructional model. The inference drawn was that, a significant difference exists in the mean interest scores of physics students' taught Rockets and Satellites using Digital Learning Object (with tutor-led instructional model and self-paced instructional model) in favour of those taught with tutor-led

instructional model. Gender had some influence on physics students' interest in Rocket and Satellite. The inference drawn was that, there was no significant difference in the mean interest scores of male and female physics students' taught Rockets and Satellites. Hence, any difference observed in the score of male and female physics students is due to chance. These findings are in agreement with the findings of the recent studies of Juitaite, et al., (2021); Otamas, et. al., (2021); Redfors et al., (2014); Basaran, (2016); Marcus-Quinn and Mcgarr, (2015); Vakarou, et al., (2024); George (2014) and Yan, et al., (2022). Findings of Juitaite et. al., (2021) showed that DLOs would promote students' motivation (i.e. interest towards subject taught) as well as achievement. Also, the findings of Otamas, et al., (2021) and Redfors et al., (2014) have further strengthens the findings of the present study that DLOs are collaborative, innovative and lifelong learning Pedagogy in this Post- Covid'19 Era. Findings of Basaran, (2016); and Marcus-Quinn and Mcgarr, (2015) corroborate with the findings of the present study since they both found that DLO's would enhance students learning. The present study revealed that such teaching approach will promote students' interest and achievement, while Basaran (2016) and Marcus-Quinn and Mcgarr, (2015) showed that DLO would bring about teachers' effectiveness and better improvement in learning; and that it should be combined with multimedia and others varieties like online storage, mobile devices, videos, object, pictures etc. Also, findings of Vakarou, et al., (2024) buttressed the findings of the present study on the use of powerpoint in teaching and learning to improve students' interest. While Vakarou, et al., applied various didactic strategies for teaching using diverse elements such as powerpoint presentations, videos, questionnaires, and activities for the development of students' interest; the present study uses digital learning object presented with powerpoint. Findings of George (2014) strengthens the findings of the present study because they both emphasized that online learning can facilitate both self-paced and instructor-led learning. Findings of Yan, et al., (2022) buttresses that while self-paced online learning may ease learning, it could bring about some underlying learning barriers such as those mentioned in Jung, et al., (2022) limitation in methods for accurate assessments of learning and absence of personal communications. This might be the reason why tutor-led instructional model favoured students' achievement and interest in the present study compared to self-paced instructional model of DLO. Literature is scarce on the gender influence of digital learning object especially in space physics thus this is the gap the present study will be adding to literature.

Conclusion

Digital learning object promote students' achievement and interest in space physics especially in rocket and satellite. Tutor-led instructional model of DLO favoured significantly students' achievement and interest in rocket and satellite more compared with physics students under self-paced instructional model of DLO. Gender had some influence on physics students' achievement and interest in Rocket and Satellite but their influence was not statistically significant. The study therefore concludes that tutor-led instructional model of DLO will foster students' interest and learning of physics concepts especially physics in technology topics like rocket and satellite. The recommendations from this research are: physics teachers should adopt the use of DLO with tutor-led instructional model in their lessons in order to enhance students' achievement and interest in the subject; physics teachers should be trained on how to create a DLO with Online teaching packages; physics teachers should stimulate students' interest through a quality science education pedagogy such as the use of DLO with tutor-led instructional model; and private school owners and Government should make available digital technologies to schools.

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