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Flipped Learning with Gamification and Secondary School Students' Interest in Physics in Nigeria

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Abstract

This study investigated the effect of flipped learning with gamification on the interest of students in senior secondary schools in Ondo State, Nigeria. It also examined the moderating effect of gender on interest. The study was a two-group pretest-post-test quasi-experimental design of a 2x2 factorial matrix in which data was collected with the aid of a Questionnaire on Students' Interest in Physics (QSIP) which was found reliable at Cronbach's alpha coefficient r = 0.91, and administered on 64 participants. The data collected were analysed with inferential statistics of t-test and ANCOVA at 0.05 level of significance. The results show that there was a significant difference in the interest of students in treatment groups, $t = 5.49$, $p < 0.05$; and that there was no significant interaction effect of students' gender on their interest in Physics, $F(1,62) = 1.40$; $p > 0.05$. It was concluded that flipped learning with gamification significantly enhanced students' interest in learning Physics, and that gender does not affect interest. Hence, gender should not be used to divide a Physics class. It was advised that teachers should teach Physics with a flipped learning strategy and curriculum planners should recommend the strategy for teachers.

Keywords: Flipped Learning Approach, Gamification Approach, Flipped Learning with Gamification strategy, Scaffolding, Interest in Physics, Gender

1.0. Introduction

The level of development of every nation is determined to a very great extent by the quality of education given to citizens and, to be relevant amongst nations, a nation must give education a high priority to its educational system while constantly improving on it.

Science Education is a very important discipline that is pivotal to the technological development of an economy and for the understanding and management of the technologies deployed for use in such an economy. And for an economy to be technologically-self-reliant, Science Education must be prioritised, as no nation can be self-reliant in technology without paying attention to Science Education.

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The objectives of Physics, according to the National Educational Research and Development Council (NERDC, 2009) include providing basic literacy in Physics for functional living in society; acquiring basic concepts and principles of Physics preparatory for further studies; acquiring essential scientific skills and attitudes preparatory for technological application of Physics; stimulating and enhancing creativity; and providing a course – which is complete for students not proceeding to higher education,while it is concurrently a reasonable adequate foundation for a post-secondary Physics course – all point to the reason proper attention must be paid by Physics teachers in secondary schools through the adoption of strategies that are effective and that suit the style of learning of learners, to ensure that learners have a proper basic understanding of the subject which Erinosho (2013) opined to be a difficult one, and essentially, to achieve the objectives of the curriculum.

However, this subject has witnessed low enrolment over the years, due to the negative attitude students have about the concepts related to it at the junior level, making them less interested in offering the subject at the senior secondary school level, because of the abstract and Mathematically-inclined nature of the subject (Bello et al. 2018; Djudin 2018; Hirschfeld 2012). This has also led to a decrease in the number of students who apply for Physics-related subjects at the tertiary education level (Ayodele & Aina 2018). However, Ogunleye and Babajide (2011) and Mbamara and Eya (2015) have noted that methods of instruction have contributed to the low enrolment of students in Physics. Other causes of poor enrolment, as affirmed by Mbamara and Eya (2015), are students' misconception about the subject (Telima 2019); inadequate exposure and motivation (Aina & Adedo, 2013); students' negative interest in Physics (Halim et al. 2018) and insufficient Physics teachers (Okeke 2019).

According to Saha et al, (2021), students pay attention to the subjects they are interested in. Further research has shown that the interest students show in a particular subject will determine if they will enroll in the subject or related subjects at a higher education level (Erinosho, 2013). To be able to address the issue of low enrolment, strategies that engage the interest of the learners should be adopted. The methods used by teachers in teaching Physics are observed as not motivating the interest of learners towards the subject, hence, it is important to consider the teaching methods and strategies (Kristiyani & Budiningsih, 2019). Owen et al. (2008) opined that passive methods of teaching are the causes of lack of interest by students in Physics. Passive methods of teaching are those in which students receive information from the teacher and memorise them (Shreyasi, 2017); one of its variants is the traditional lecture method. Different methods have been used to teach Physics; some of these methods are Gamification and Game-based learning methods (Jalal et al. 2017; Tolentino & Roleda, 2017); Flipped learning (Cleveland 2017; Prasetyo et al., 2018); Brain-based teaching method (Saleh & Subramaniam, 2018). These methods are found to significantly affect students' interests and academic performance.

This study is, therefore, different from other studies that have been carried out, in that it focuses on combining two active methods of instruction which are Flipped learning and Gamification as one strategy and their effectiveness in improving interest in Physics. The flipped learning method is the method in which the content of instruction is given to learners to study before class such that they

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can solve problems concerning the concept in class, with the readily available assistance of the teacher (Bishop & Verleger, 2013) while the Gamification method is the teaching method that can increase students' motivation, engagement, and attitude towards learning (Anekwe 2018). Since Physics involves solving problems and explaining physical concepts using mathematical methods, the use of the flipped learning method will afford learners the opportunity to get some information about concepts before class time, while the gamification method involves the use of gaming elements to increase engagement and motivation that affords the learners the opportunity of getting points or stars, badges for participating in the class activities, and be able to monitor their progress (that is the points they have accrued and the badges they have acquired and so on) on a ranking board.

Among the factors that could interfere with the interest and the performance of students in Physics is gender. Gender is a factor whose influence has attached a stereotype to Physics as a subject studied by male students rather than by female students (Francis et al. 2016; Kalender et Al. 2019). This has caused a lower enrolment of the female gender compared to the enrolment of the male gender in Physics (Stout et al. 2013). Female students see Physics as a difficult subject and, as a result, have developed less interest in Physics (Jugovic 2017); however, the use of interactive and engaging methods could bridge this observed interest gap between both genders.

1.1. Statement of the Problem

The need for nations to develop and become relevant in the technologically-advancing world has made it very important for their citizens to be well-prepared, by paying enough attention to Physics at the secondary education level. By increasing the interest of students in Physics at the secondary education level, the rate of enrolment into Physics-related subjects at higher levels of education will increase. There has nonetheless been a decrease in the number of students interested in taking Physics lessons, a result of which is the reduction witnessed in the number of students who enroll for Physics and its related subjects at tertiary education levels. Indeed, it has especially had lower enrolment of the female gender than the male gender.

However, to solve the problems, researchers have recommended the use of active learning and interactive strategies that would ensure the involvement of students in class, as well as increase their interest in lessons. This study, therefore, investigated the effect of flipped learning with gamification on the interest of students and it also examined the moderating effect of gender on interest.

1.3. Hypotheses

The following hypotheses were tested;

1. There is no significant difference in the interest of students in the treatment groups
2. There is no significant interaction effect of students' gender on their interest in Physics.

2.0. Literature Review

This study was based on behaviourist learning theory.

The behaviourist learning theory asserts that there should be changes that serve as evidence that learning is taking place and that these changes should be observable. In education, this theory becomes important as it advocates that learning should be by doing and, so, learners should be allowed to participate in classroom activities through the use of active teaching methods. The behaviours observed through participation should be rewarded if desirable for learning to take place or punished if not desirable, to prevent such learning from

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taking place. According to Watson (1878-1958), one of the proponents of behaviourism, human behaviours are the responses they give to the stimuli they receive, and human development takes place as a result of observable behaviours. However, Skinner, another proponent of the theory, proposed that, when the outcome of an action is favorable, such action is repeated but, when the outcome of an action is unfavourable, such an action is not repeated (Shaffer, 2000). The theory implies that when students begin to seek re-engagement in a particular activity, concept, or lesson, they have begun to develop an interest in that activity, concept, or lesson.

Interest is also seen as incorporating a state of motivation and a mood to re-engage with an activity or content (Hidi et al. 2004). Interest can be determined after an instruction has taken place where instruction represents the interaction that takes place between a learner and the teacher in the learning environment. A learner is said to have developed an interest in a particular activity content or subject when they want to re-engage with it after the previous interaction. Interest, therefore, is an important factor to be considered in learning and, if a subject like Physics which has been tagged difficult by students (Erinosho 2013), is going to be learned effectively, the difficulty level of the subject should not be ignored; rather, interest level has been raised.

In order to increase the interest of students in Physics, this study focused on the use of flipped learning with gamification strategy which is a combination of two active methods for teaching science subject. Flipped learning is a method based on a blended learning model which combines physical classroom discussions and group work with pre-class interaction with teacher-generated content. Al-Derbashi (2017) and Eyitayo (2017) noted that flipped learning method improved the understanding and attitude of learners. Gamification, however, is based on the principles and elements of game design. Gamification helps students construct their own knowledge in a playful manner (Simoes et al. 2013) and makes it easier for students to learn contents of subject matter (Dominguez et al. 2013). It has, as well, increased the involvement and interest of students in learning (Brewer et al. 2013; Perez-Manzano et al. 2018; Wang et al. 2015). Flipped learning with a gamification strategy together has improved motivation (Chyr et al. 2017), teamwork and attitude (Kwon & Woo, 2017; Lee et al., 2018), and commitment (Huang et al. 2018). This research hence studied the effect of flipped learning with gamification on the interest of learners.

3.0. Methodology

3.1. Instructional Design

The ADDIE model was adopted as an instructional design model for the design of flipped learning with gamification instruction. The ADDIE instructional design model is divided into five steps which are Analysis, Design, Development, Implementation, and Evaluation. The application of each step to the design of the instruction is detailed below.

3.1.1. Analysis

This is the process of identifying what is to be learned and the context in which it is to be learned. This includes the selection of topics, determining how the contents will be organised, and determining how the topics will be taught. This step was divided into three which include Need Analysis, Instructional Goals, and Learner Analysis.

a. **Need Analysis:** Physics as a subject is required for the technological

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development of nations. But it has been discovered that students are hardly interested in it; thus causing a reduction in the number of learners who enroll for its related courses in higher institutions. This is a result of reduced interest in the subject which is important to address.

b. **Instructional Goal:** To increase learners' interest in Physics.

c. **Learner Analysis**: The category of learners includes students offering Physics in senior secondary school (SSS) 2 class, between the ages of 12 - 18 years, with heterogeneous learning styles and no learning difficulty.

d. **Constraints**: These include time, class size, and mixed ability.

3.1.2. Design

This is the process of specifying how the content would be learned; that is, the flow of instruction. It involves stating instructional objectives and the method of assessment.

a. **Instructional Objectives:** By the end of the Flipped learning with gamification instruction, students should be able to show increased interest in learning Physics

b. **Method of Assessment:** A questionnaire which was adapted from Snow's (2011) Math Interest Inventory was administered to assess the student's level of interest. This was administered to assess their level of interest before the treatment was administered as the pre-test. After the treatment had been administered, the questionnaire on interest was administered the second time, as the post-test.

3.1.3. Development

This stage involves authoring or producing materials for the instruction. The instruction was developed in two phases; phase one was done before the class while phase two was done in the class.

a. **Phase one:** This phase contained individual activities that required that the learners study given materials and practice given exercises in their respective homes, and these individual activities were to enable learners to have a level of information about the lesson before the class.

b. **Phase two:** This phase consists of both individual activities and group activities which were done in the class. In this phase of the instruction, point cards, badges, and scoreboards were used as instructional resources.

Each activity in this phase was timed and each activity attracted points. Points were acquired for attempting an activity as well as for getting it correctly; badges were awarded to groups that completed more activities than others while points were awarded to all members of the groups for attempting. The total points accrued by each of the students were recorded on a scoreboard.

If no group got an activity right before the time was up, the teacher provided necessary support for all the students and then allowed them to try again, in a reduced time.

3.1.4. Implementation

This involves the use of the developed material for the strategies in the class for teaching during the treatment period. This is the stage at which the actual instruction occurs, it involves training the trainers, preparing the learners, and preparing the environment.

The researcher visited the selected secondary schools to teach the Physics teachers, with the assistance of the trained research assistant(s).

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The subject teachers performed the instruction with the aid of the instructional guide and lesson plans provided by the researcher. This step lasted for four weeks, and at the end of each instruction, the teacher corrected misconceptions, and distributed material for the next lesson.

3.1.5. Evaluation

This is the process of determining the accuracy of the instructional strategy or material in achieving the identified learning outcomes.
Students were assessed on the topics they were taught during the treatment administration; these topics are Linear momentum, Speed, Velocity and Acceleration, and Equation of Uniformly Accelerated Motion. The feedback data collected from students on their level of interest through the "Questionnaire on Students' Interest in Physics" were analysed to provide feedback on the instructional process.

Click on the link below to view the lesson plans that were developed for the experimental and control treatments. Also, view the flipped material for each week through the link.
https://drive.google.com/drive/folders/1QDNgHbQKEBrXEf9i3jHdbEmbXOjG8ogN?usp=sharing

Table 1.0: Teacher's and Students' Guide on Flipped Learning with Gamification
The teacher reads this guide and also reads it to the students before the first lesson

	Teacher's Activities	Learners' Activities
Step 1: Introduction	The teacher welcomed the learners to class and then gave a detailed explanation of flipped learning with a gamification strategy. The teacher explained that the strategy or method is two-in-one. Flipped Learning is a method of instruction in which classroom activities are done at home, while the home activities, such as assignments are done at school. Gamification on the other hand is the use of the elements used in a game environment in a learning environment. This means we shall be making use of those elements that make you want to play more to make you want to learn more. In this lesson, we shall be engaging in activities that will attract the use of points, badges, and scoreboards. At the end of each activity, points will be given to every student who attempts the activities, and additional points will be given to those who get them right. At the end of each lesson, badges will be awarded to learners who performed best by scoring the highest point; also groups will be awarded badges based on their performance in group activities.	Learners listened to the teacher as explanations were being made on the modality of the instruction, and they asked questions on areas where they needed clarity.
Step 2: Setting the Rules and Giving the modality for the use of Point cards and badges.	The teacher gave a set of rules that guided the class: All students must be seated by the time the class starts. There will not be side talks once the class starts. Students will only be allowed to discuss on permission or during group activities. Students should signify by raising their hands, to attempt questions asked generally. The teacher-guided in grouping the students and selecting a secretary for each group. There were not more than five groups. The teacher guided the students in the selection of a Scorekeeper, the scorekeeper recorded the points acquired by each student. The teacher displayed the points cards, badges, as shown in Figure 1, and scoreboard for students to see, and gave details on their functions. **Points Cards**	Learners listened as the instructions were being given. Learners participated in the selection of group secretaries and scorekeepers Learners paid attention as the points and badges were being displayed and explained.

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	1 Point card – for every student who attempted individual and group activities. 2 Points card – was given when all the students had to try the second time before getting an activity right 3 Points card – was given to students who got activities right at once. **Badges** Most organised (4 stars) – was given to the most organised group. Highest Points Scorer (5 stars) – was given to the students with the highest score at the end of each lesson Humble (3 stars) – was awarded to groups that scored an average cumulative point by the end of the lesson Member (2 stars) – was given at the end of the treatment to students who did not get any badge during the lessons but were present in all.	
Step 3 Conclusion – giving materials to students	The teacher distributed materials containing notes and practice exercises to all the learners for them to interact with before the first lesson in the next class.	Learners collected the materials being distributed by the teacher, to prepare ahead of the first lesson, in the next class.

3.2. Research Design

This study adopted a pretest-post-test quasi-experimental design. A simple random sampling technique was used to select two public senior secondary schools in the Ile-Oluji/Oke-Igbo Local Government Area of Ondo State. This selection was based on the discovery by Shikalepo (2020) that poor learning can be attributed to the rural nature of a community.

The experiment took place for six weeks, the first week being for introducing the students in the treatment groups to the methods. A pretest was also administered in the first week. Treatments were administered from the second to the fifth week following the guides produced.

Finally, in the sixth week, awards were given and the post-test was administered.

3.3. Sample Size

The participants of this study consisted of students who were in senior secondary school 2 (SS2) who were not preparing for any terminal examination and they were deemed mature enough to work cooperatively. Two intact classes that consisted of 64 participants were used for the study.

3.4. Method of Data Collection and Analysis

Both stimulus and response instruments were used to collect data for this research; the stimulus instruments included Point Cards, Badges, and Leader board which were used to elicit responses during an instructional process. These responses were evaluated with the use of a response instrument called a questionnaire on students' interest in Physics (QSIP). Data gathered were analysed using T-Test and Analysis of Covariance (ANCOVA). T-test was used to determine the difference between the interests of treatment groups, while ANCOVA was used to find the effect of gender on interest at 0.05 level of significance.

4.0. Results and Discussion

The results of the experiment are interpreted and then discussed respectively.

H01: There is no significant difference in the interest of students in the treatment groups

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Table 1: T-Test of Students' Interest Scores

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	T	Df	Sig. (2-tailed)	Mean Diff.	Std. Error Diff.	Lower	Upper
posttest interest	Equal variances assumed	5.493	.022	1.100	62	.275	.08333	.07573	-.06805	.23471
	Equal variances not assumed			1.237	61.966	.221	.08333	.06738	-.05137	.21803

Table 1 shows that there is a difference between the interest of students in treatment groups where $t = 5.49$, $p < 0.05$; the null hypothesis is rejected, hence, it is restated that there is a significant difference in the interest of students in treatment groups.

This research found that there is a significant difference in the interest of students in the treatment groups. Students exposed to flipped learning with the gamification method proved to have developed more interest in learning Physics than the students treated with the lecture method by the end of the treatment process. This result is supported by the research of Ekici (2021) which discovered that adding gamification to a flipped learning strategy improves students' participation, which may have been the cause of greater interest. Similarly, Jo et al. (2018) observed a resurgence in interest when game elements were introduced into an online flipped classroom, and this was manifested in the participation rate of students which increased after the application. Also, the findings of Pozo et al. (2020) that introducing gamification to a face-to-face flipped classroom improves motivation, interaction with their teacher, and interaction of students complement the findings of this present research. These findings are evidence of Skinner's proposition that, when the outcomes of an action are favourable, such action is repeated but when the outcomes of an action are unfavourable, the action is not repeated (Shaffer 2000).

Students in the experimental group appeared to show more interest in learning Physics, the teaching strategy appealed to their emotions, they placed a higher value on learning Physics, and they were ready to do what it takes to acquire more knowledge in the process of learning Physics, they were well-engaged in the learning process, by participating in the different tasks outlined for them, hence, these students wanted more of the active learning experience they had during the experiment.

H_o2: There is no significant interaction effect of students' gender on their interest in Physics

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Table 2: ANCOVA of interaction effect of students' gender on their interest

Tests of Between-Subjects Effects						
Dependent Variable: post-test interest						
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.120[a]	1	.120	1.400	.241	.022
Intercept	.000	0	.	.	.	.000
pretest-interest	.000	0	.	.	.	.000
Gender	.120	1	.120	1.400	.241	.022
Error	5.317	62	.086			
Total	238.000	64				
Corrected Total	5.437	63				
a. R Squared = .022 (Adjusted R Squared = .006)						

Table 2 above shows that there is no significant effect of gender on interest, where $F(1,62) = 1.40$; $p > 0.05$; the null hypothesis is therefore accepted, hence there is no significant interaction effect of students' gender on their interest in Physics.

The result of this study that shows that gender does not affect students' interest in Physics is corroborated by Fatoba and Aladejana (2014) who discovered that gender has no effect on the attitude, which could be used to measure students' interest in physics. It is, however, not consistent with the findings of Godpower-Echie and Ihenko (2017) and Temitope (2011) who argued that gender has a significant effect on how interested students are in learning science subjects. The lack of consistency of the results of Godpower-Echie (2017) and Temitope (2011) with the findings of this research could have been because of the presumption that Physics possesses a strong association with the male gender. This gender stereotype could have made the girls prefer Physics less; hence, focusing more on other less-male-stereotyped subjects.

This study, however, has shown that Physics could be studied by both genders. According to behaviourists, to repeat an action is a function of the previous outcome of the action, and not a function of the gender of the actor (Shaffer 2000). This confirms the result of the analysis of covariance which pointed out that interest in Physics does not depend on students' gender.

5.0 Conclusion

This study shows that the strategy used by the teacher to deliver instruction will determine how interested students will be in the subject. Hence, it can be generalized that actively involving students in lessons will help them develop an interest in Physics. Flipped learning with gamification strategy is an effective strategy that can be used to involve students actively in all physics lessons. The study also showed that gender does not affect students' interest in Physics. This means that no gender has more tendency to like Physics than the other, and both the male and female genders can have high interest in Physics. Finally, this study showed that flipped learning with gamification strategy could be used to increase students' interest in Physics because it involves participation and reward for participation, and can be used to gain the equal participation of both the male and the female genders in the classroom.

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