

Effect of Physics-Based Puzzles on Senior Secondary School Physics Students' Achievement and Interest in Mechanics in GWER-EAST LGA of Benue State

Atsuwe Bernard Aondofa¹ and Mkali Iormbalun Francis²

¹Department of Science Education, Joseph Sarwuan Tarka University, Makurdi
atsuwe.bernard@uam.edu.ng

²Department of Science Education, Joseph Sarwuan Tarka University, Makurdi
iormbalunfrancis@gmail.com

Abstract: *The study interrogated the effect of physics based puzzles on senior secondary school physics students' interest in Mechanics in Gwer East local government area of Benue State. The specific objectives were to; determine the effect of puzzle based games on the academic achievement of secondary school students' in Gwer East Local Government Area of Benue State ; find out the interest level of students' in the learning of Physics amongst males and females; consider the effect of physics based puzzle games on male and female achievement scores in Mechanics and examine the relationship of physics based games and gender amongst secondary school students' in Gwer-East local government area of the state. A quasi experimental design was adopted for the study and 120 students' were used for experimentation (quasi-experiment). Results showed that there was an effect of puzzle based games on the academic achievement of secondary school students in Gwer East Local Government Area of Benue State, and that the interest level of the students in the learning of Physics was insignificant amongst the male and female students. Also, the effect of physics based puzzle games male and female achievement scores in Mechanics was not significantly different, while there was no significant relationship between physics based games and gender among the students. It was concluded that; Puzzle based games should be adopted in the teaching of physics in Schools so as to enhance better understanding of the topic. Gender has no effect on the interest level of Students in learning of physics based puzzles in schools in Gwer East Local Government Area, and there is no relationship between physics based games and gender in secondary schools. Recommendations made were that Physics based puzzles should be used in the teaching and learning of physics in secondary school; Gender should not be a barrier to the learning of physics and Physics based puzzles have no gender selection hence suitable for all.*

Keywords: *Physics-Based, Puzzles, Senior Secondary, School, Achievement, Interest, Mechanics, Benue State*

1. INTRODUCTION

Literacy is the knowledge of basic skills and technical discipline (Adeyemo, 2013). These skills are associated with the value of knowledge which is one of the most powerful weapon which you can use to change the world (Muba, 2011). Muba (2011) further stated that literacy is the culmination of facts, experiences, and thought that is gained over a lifetime which is the useful part of learning. According to Wikipedia definition, Education is said to be the process of facilitating learning, it is also said to be the acquisition of knowledge, skills, values, beliefs, and habits.

According to Ajayi (2015), education helps to develop critical thinking and problem-solving skills to make better choices and decisions, it increases economic growth and stability. He further added that education is an invaluable tool that liberates the minds of individuals to an elevated state of understanding and potential. Mark (2011) added that education enhances the lives of individuals and allows the society to develop, flourish and invariably gives us reasons to be hopeful. Without education, there is less to hope for in life. Nwogwu (2017) is of the opinion that the impartation of knowledge of science is dependent on the educational system. It takes good educational system to deliver the knowledge of science from generation to generation.

Science is any pattern of learning that deals with the physical world and its phenomena which gives rise to unbiased observations and systematic experimentation (Kynaston, 2019). Generally, Science involves a pursuit of learning that covers general truth or the operations of fundamental laws. Therefore, Science can be categorized into various subsidiaries based on the subject of study. However, the physical sciences study the inorganic world and comprise the fields of astronomy, Physics is the natural science that studies matter, its fundamental constituents, its motion and behavior through space and time, and the related entities of energy and force (Virk, 2014). Physics is one of the most fundamental scientific disciplines, and its main goal is to understand how the universe behaves (Kynaston, 2019). Physics is one of the oldest academic disciplines and, through its inclusion of astronomy, perhaps the oldest. According to Abiodun (2019) Advances in physics often enable advances in new technologies such that by critically understanding the topics of electromagnetism, solid-state physics, and nuclear physics led directly to the discovery of new products that have suddenly transformed modern-day society in electronics such as television, computers, domestic appliances, and nuclear weapons. Also, in the field of thermodynamics which led to the development of industrialization and in mechanics which inspired developments in calculus.

Physics, chemistry, and the Earth sciences are collectively referred to as natural sciences with Physics as that arm of science dealing with the physical phenomena (Kynaston, 2019). Physics is one of the most exciting disciplines of science but it has many puzzles

and enigmas which make it somewhat difficult to understand and comprehend at school, college and university levels (Virk, 2014). The role of sciences, and specifically physics in the growth of any Nation can never be over emphasized as posited by Nwogwu (2017). Nwogwu (2017) stated that Physics is an exciting intellectual adventure that inspires young people and expands the borderline of our knowledge about Nature. According to Abiodun (2019), Physics generates fundamental knowledge needed for the future technological advances that will continue to drive the economic engines of the world. Physics provides the much needed technological base and trained work force to take advantage of scientific approaches and discoveries. Physics improves our quality of life by providing the essential perceptives necessary for the development of new instruments and techniques for medical applications, like computer tomography, magnetic resonance imaging, positron emission tomography, ultrasonic imaging, and laser surgery (Abiodun, 2019; Yusuf, 2000). Abiodun (2019) opined that physics is believed to be a difficult subject for students due to the puzzle and rational constituent of the subject. He further likened physics to Mathematics as subject of rationality.

A puzzle can be said to be a [game](#), [problem](#), or a [toy](#) that tests the ingenuity or [knowledge of a person](#). The solver of a puzzle is expected to put pieces together in a logical way, in order to arrive at the correct pattern simply find solution of the puzzle. There are different categories of puzzles, some of which include crossword puzzles, word-search puzzles, number puzzles, relational puzzles, and logic puzzles (Inwood, 2009). Puzzles are meant to be a form of entertainment but they can also arise from serious [mathematical](#) or [logical](#) problems (Virk, 2014). According to Simanek (2019), Physics Based puzzles are special thinking types of puzzles where you have to use some physics laws to solve them and many requires moving an object from point A to point B through various means (Simanek, 2019).

Gamification has been viewed by the researcher as a formidable tool to boost students interest in physics (Mechanics). This position is from observable evidence of games being played by most students with keen interest of winning. Oleh (2020) postulated that Puzzles sharpens the spatial visual intelligence of human beings which is the intelligence of thinking and learning with images, understanding the shape of patterns and the space of an object, including thinking creatively. Following Oleh (2020) work, a study conducted by the University of Chicago, United States in 2011 shows the results that regular toddlers who play puzzles have better spatial visual skills than those who do not. This is because of the ability to recognize and understand the shapes, sizes, colors, and spaces are sharpened through playing with the puzzle.

In light of this background, the researcher wishes to investigate the effect of physics-based puzzles on senior secondary school physics student's interest in Mechanics in Gwer-East Local government area (LGA) of Benue state

1.1 Research Questions

- i. What is the effect of puzzle based games on the academic achievement of students in secondary schools in Gwer East LGA of Benue State?
- ii. What is the level of students' interest in physics based puzzle games amongst males and females in Mechanics in Gwer East LGA of Benue State?
- iii. What is the effect of physics based puzzle games on male and female achievement scores in Mechanics in Gwer East LGA of Benue State?
- iv. What is the relationship between physics based games and gender among secondary school students in Gwer-East LGA of Benue state?

1.2 Hypotheses

Ho1: there is no significant effect of puzzle based games on the academic achievement of students in secondary schools in Mechanics in Gwer East LGA

Ho2: there is no significant difference between male and female level of interest in Mechanics in Gwer-East LGA of Benue State.

Ho3: there is no significant difference between male and female achievement scores in Mechanics in Gwer-East LGA of Benue State.

Ho4: there is no significant difference between students taught with physics based games and gender among students in secondary schools in Gwer-East LGA of Benue state.

2. METHODOLOGY

2.1 Design of the Study

Quasi-experimental design was employed for the research because it has been proven by educationist to be very effective in sourcing primary data from a group of people or individuals across the globe (Egwu 2014).

2.2 Area of the Study

Gwer East is a Local Government Area in Benue State, Nigeria. Its headquarters is Aliade and It has an area of 2,294 km² and a population of 163,647 according to the 2006 census. The postal code of the area is 971. The Local Government has three districts; Yonov, Njiriv and Ngyohov. It has 17 Council wards. It shares boundary with seven other local government areas. The major source of livelihood is agriculture and trade with her teeming youth engaged in farming and schooling. This means that almost every family is represented in school especially at the secondary school level. Several factors limits the teaching and learning of science especially physics in the area which includes interest for the subject of physics, probably as a result of the perceived difficulty of the subject. Hence, the reason for this study in Gwer East Local Government area of Benue State.

2.3 Population of the Study

A population of 10,800 science students were selected from secondary schools. According to information gotten from the education board in the local government, there are about 73 approved (Government-2, Grant aided-27, Phase III approved-44) secondary schools in Gwer East LGA (Ewaoche, 2018).

2.4 Sample and Sampling Technique

Four (4) schools shall be sampled from the population by simple random sampling technique. Students from senior secondary section were selected from the sampled schools making the total of respondents from the four schools to 120 respondents. The sample consisted of 30 SS 2 students divided into 2 groups (experimental and control) each from each school

2.5 Instrument for data collection

Tests instrument was made of achievement test. Two group, A and B(experimental group and control group respectively) shall be administered with achievement test using puzzle based strategy for group A and using conventional teaching for group B. A topic in Physics (Mechanics) shall be expanded into test instrument to be used to elicit responses from the SSS2 Students. The test was administered personally during physics lectures, to the respondents with the cooperation of the physics teacher’s in each of the selected school.

2.6 Validation of Instrument

The project supervisor scrutinized the instrument for observations and necessary comments on the face and content validation before the production of final copies for administration.

2.7 Method of Data Collection

The researcher visited the selected secondary schools to seek the permission and co-operation of the schools authorities. A suitable period was fixed for the exercise. With the cooperation of other physics teachers, the researcher met with the students for about one hour during the normal period of the lesson to teach them using both the conventional method and puzzle method and these lasted for one week.

Day One:

The researcher taught the students the topic, work, energy and power using conventional method.

Day Two:

The researcher divided the class into two, to make up two groups i.e experimental and control groups. The control group was the conventional method and the experimental group was taught using the puzzle method. Then both groups were tested using puzzles in scientific concepts.

Senior Secondary School 2 (SS2) Students of Gwer-East local Government Area formed the population of the study. Male and female students were randomly selected from each stated school for the rest with the cooperation of physics teachers in each school. The topic chosen motion, force and energy are normally taught in SS2 level, 120 students formed the study’s sample.

2.8 Methods of Data Analysis

The entire puzzle were filled and returned by the respondents. The presentation of data of the respondent was first presented and analyzed using percentage while the responses from the respondent based on the research question formulated to guide the study using t-test, correlation coefficient and paired t-test.

3. RESULT AND DISCUSSION

Data was collected from four secondary schools with 30 students from each school. Results are presented in tables. The research question and corresponding hypothesis were however answered in order of presentation from research question 1 to research question 4.

Research Question 1: What is the effect of puzzle based games on the academic achievement of students in secondary schools in Gwer East Local Government Area (LGA) of Benue State?

Table 1: effect of puzzle based games on the academic achievement of secondary school students in Gwer East Local Government Area of Benue State.

		N	Mean	Mean Difference	Std. Deviation
Pair 1	experimental (pretest)	60	16.4500	4.25	5.85828
	experimental post test		20.7000		5.62169
Pair 2	control_pretest	60	13.9333	5.05	5.57496
	control_post_test		18.9833		7.14853

The data presented in table1 above shows the pretest scores for the experimental group had a mean score of 16.45 and the post test score for the experimental group had 20.70. in contrast, the control group (pretest) had a score of 13.93 and the control post test has 18.98. the mean score difference for the pretest and post test of the experimental group is 4.25 while the mean score difference for the pre test and post test of the control group is 5.05.

3.1 Research hypothesis 1

H01: There is no significant effect of puzzle based games on the academic achievement of students in secondary schools in Mechanics.

Table 2: correlational coefficient of the effect of puzzle on the academic performance of students in Mechanics

variable	Mean	SD	DF	t-cal	t-tab	Remark
Experimental	62.0571	12.79027	118	0.387	0.678	not significant
Control	61.0400	22.56687				

From the above table, it is clear that the value of t-cal (0.387) is lower than the value of t-tab (0.678) which means, there is no significant difference between the male and female students. We therefore accept the null hypothesis that there is no significant effect of puzzle based games on the academic achievement of secondary school students in Mechanics.

3.2 Research Question 2: What is the level of students' interest in physics based puzzle games between male and female students in Mechanics in Gwer East Local Government Area of Benue State?

Table 3:Level of students' Interest in physics based puzzle games between male and female students in Mechanics in Gwer East Local Government Area of Benue State.

		N	Mean	Mean Difference	Std. Deviation
Male	control	60	17.25	4.48	5.658
	experimental post test		21.73		5.321
Female	control pretest		12.39		5.965
	experimental_post_test	60	16.89	4.50	3.853

Table 3 shows the responses on the level of students' interest in physics based puzzle games amongst male and female students in Mechanics in Gwer East LGA. The male (control) had a mean score of 17.25 and the experimental (post test) have mean score of 21.73. The difference within the male performance is 4.48 above the experimental group score. The female (control) have a mean score of 12.39 and 16.89 for the experimental group mean score. The differences with the female mean performances is 4.50 above the experimental group.

3.3 Research Hypothesis 2

H02:there is no significant difference between male and female interest in Mechanics.

Table 4: Male and Female interest in Mechanics (t-test)

variable	Mean	SD	DF	t-cal	t-tab	Remark
Male	62.0571	12.79027	118	0.387	0.678	not significant
Female	61.0400	22.56687				

From the above table, the value of t-cal (0.387) is more than the value of t-tab (0.678) which means that there is no significant difference between the male and female students interest in Physics. We therefore accept the null hypothesis that, there is no significant difference between male and female interest in Mechanics.

3.4 Research Question 3: What is the effect of physics based puzzle games on male and female achievement scores in Mechanics in Gwer East LGA of Benue State?

Table 5: Effect of physics based puzzle games on male and female achievement scores in Mechanics in Gwer East LGA of Benue State

		Mean	Mean Difference	Standard deviation
Male	Control	16.35	4.58	5.66830
	experimental	20.93		5.69230
Female	Control	13.78	5.58	5.29820
	Experimental	19.36		6.61013

Table 5 shows result on the effect of physics based puzzle games on the male and female achievement scores in mechanics in Gwer East LGA of Benue State. The male (control) mean scores is 16.35 while the experimental (male) mean score is 20.93. The female (control) mean score is 13.78 while the experimental (female) mean score is 19.36. The differences in the mean score between genders are 4.58 and 5.58 for male and female respectively.

3.5 Research hypothesis 3:

Ho3: there is no significant difference between the male and female achievement scores in Mechanics

Table 6: differences between male and female achievement scores in Mechanic

variable	Mean	SD	DF	r-cal	r-tab	remark
Male	79.2500	14.08043	118	0.213	0.678	not
Female	45.9500	10.92567				significant

From the table above, the calculated value of r is more than the table value. In view of this, the null hypothesis which is ‘there is no significant relationship between the performance of students taught with puzzle and those taught using the conventional method is not significant’. Therefore, there are no significant relationships between the students taught with puzzle and those taught using the conventional method

3.6 Research Question 4: What is the relationship between physics based games and gender among students in secondary schools in Gwer-East LGA of Benue state?

Table 7: Relationship between physics based games and gender among students in secondary schools in Gwer-East LGA of Benue state

Paired Samples Correlations

		N	Correlation	Sig.
Male	Experimental & Control	60	-.066	.615
Female	Experimental & Control	60	.151	.248

Table 7 above shows that there is negative relationship between the male experimental and control groups while the female experimental and control group have positive correlation. The male $p=0.615>0.05$ while female also have $p=0.248>0.05$. **Research 3.7 hypothesis 4:**

H04: There is no significant relationship between physics based games and gender among students in secondary schools in Gwer-East LGA of Benue state

Variable	Mean	SD	DF	r-cal	r-tab	remark
Male	79.2500	14.08043	118	0.213	0.678	not significant
Female	45.9500	10.92567				

From the table above, the calculated value of r is more than the table value. Therefore, we accept the null hypothesis that there is a relationship between physics based games and gender among students in secondary schools in Gwer-East LGA of Benue state

4. Discussion of Findings

The result presented in tables 1 to 7 and from the testing of hypothesis 1 to 4, shows correlation between the experimental group and control group for the hypothesis 1 (r-cal) is 0.213 and the degree of freedom is 118, it also shows that there are no significant relationships between the academic achievement of students taught with puzzle and those taught using the conventional method meaning that the methods are independent of each other then used in teaching the physics students and deduced from the hypothesis that these students performed better when the puzzle method were used. This was supported by Hmielski (2003), he opined that students learning styles through puzzle method affects their performance, and that students learn effectively. Due to these individual differences their performance will be based on what they have learnt in one way or the other, as affirmed by Geary (1995). If you want somebody to know something and retain it for along period if time, then you have them practice it. Moreover it may well be seen that a series of physics concepts, skills and attitude can be taught using this strategies of puzzles as the backbone of the physics curricula throughout all classes of senior secondary school education.

Gender play insignificant role in the performance of students in mechanics. In line with this, if students are taught physics using puzzle methods, it enhances students' comprehension in the study of physics however it is irrespective of the gender.

Also, the interaction between physics based games and gender among students' in secondary schools in Gwer east LGA of Benue State. These was supported by Tyler (2018), who observed that the falling standard in secondary school physics students' performance was due to the insufficient teaching strategies or principles employed by the physics teacher in teaching the students which resulted in their low performances and performance can be boosted using game based method to ease the tension in students. Gardener (1986), also supports this notion noted that the achievement of students in all the three domains that is cognitive affective, psychomotor domain of learning, is dependent on the use of the puzzle method and the conventional method, therefore this in teaching physics helps the students to develop more confidence and had greater freedom in discussion of physics concepts. This freedom in discussion can be achieved with the use of puzzles in teaching physics in senior secondary schools because it will serve as a mediator of the teacher –student relationship and a medium of communication, which was lacking among students' taught physics using the conventional method.

Interest of students in learning physics were not significant based on gender classification however, there is a general boost of performances when puzzles were used as shown in tables 1 to 7

5. Conclusion

The following conclusions were made;

1. Puzzle based games should be adopted for teaching of physics in Gwer East LGA of Benue State.
2. Gender have no effect in Students' interest of learning of physics based puzzles in secondary schools in Gwer East LGA.
3. There was no relationship between physics based games and gender in secondary schools in Gwer East LGA of Benue State.

6. Recommendation

- a. Physics based puzzles should be used for the teaching and learning of physics in secondary schools.
- b. Gender should not be a barrier to the learning of physics. Physics based puzzles have no gender selection hence suitable for all.

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