EFFECTS OF JIGSAW INSTRUCTIONAL STRATEGY ON THE TEACHING SIMPLE OF HARMONIC MOTION

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Abstract

The study investigated the effect of Jigsaw Instructional Strategy (JIS) as an alternative strategy for teaching Simple Harmonic Motion (SHM). The study employed quasi-experimental research. Senior school two (SS2) students offering physics were involved in the study. Performance Test was used and the data were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA). The findings revealed that a significant difference existed between the performance of students taught SHM using JIS and those taught without, no significant interaction effect of treatments, gender and score levels on the achievement of students in SHM. The study concluded that JIS enhances students' performance in teaching physics. It was recommended that Physics teachers should use jigsaw instructional strategy in teaching and learning of simple harmonic motion.

Keyword: *Jigsaw strategy, senior school, simple harmonic motion, physics, Performance Test.*

Introduction

Physics occupies a distinctive position among other science subjects in our secondary schools in Nigeria because of the innumerable application of its concepts in improving the environment. The teaching of physics should, therefore, exhibit the processes and methods of science, which could enhance technological development. Many countries are investing in new strategies for the teaching and learning of science subjects so as to produce more and better qualified candidates for higher level scientific and technical skills (Otiende, Barchok, & Abura, 2013).

A number of factors have been identified as militating against students' attainment of the objectives of physics instruction, and the most common factor identified by researchers is the inappropriate teaching methods adopted by science teachers, (Cheema & Mirza, 2013). Physics also remains one of the most difficult subjects in the senior secondary school curriculum because Nigeria has witnessed persistent average students' performance in physics at the senior school certificate level (Ogunleye & Babajide, 2011). This has been linked to the adoption of instructional strategies which did not give enough consideration to learners' previous knowledge and how they reasoned in order for learners to construct their own knowledge. Most of the strategies used in teaching physics have been tagged

inappropriate and uninspiring (Igboegwu, 2012). Teaching strategies are those strategies the teacher uses for instruction in imparting knowledge to learners. In order to improve students' academic performance, researches into science teaching and learning strategies such as problem solving, inquiry method, demonstration method, lecture method, concept mapping, cooperative strategy, among others have been developed with the aim of making learning more meaningful and less complex. Yet, the performance of students in physics is not up to one hundred percent as expected. Therefore, there is the need to incorporate modern instructional strategies, through active learning. Active learning strategies such as jigsaw include a wide range of activities that share the common element of involving students in doing things and thinking about the things they are doing (Eison, 2010).

The jigsaw instructional strategy (JIS) is a cooperative learning strategy that promotes active learning because it encourages effective collaboration among students, and increases students' investment and motivation. JIS is an active learning exercise where students participate in group discussions, learn by themselves and teach other peers what they have learnt irrespective of their gender. Afuwape and Oludipe (2008); Kolawole (2008); Okoronka and Wada (2014), in their studies found out that differences exist in the performance of students based on gender while other researchers (Akinbobola & Ikitde, 2010; Fatoba & Aladejana, 2014; Manklik & Ofodile, 2015; Mbacho, 2013; Olorundare & Aderogba, 2009; Yusuf, Gambari & Olumorin, 2012) in their different studies reported that there are no longer differences in the performance of students based on gender. These disparities in the influence of gender on the effects of instructional strategies on students' performance need to be established. Abdulwahab, Oyelekan and Olorundare (2016) researched on the effects of cooperative instructional strategy using score levels as one of the moderating variables. They found that significant difference existed in the performance of students based on their score levels and low scorers benefit the most. In the same vein, Omiola, Enuwa, Awoyemi and Bada (2012) observed that there is a significant difference in the post test means scores of high, medium and low achievers while Obafemi and Ogunkunle (2013) found no significant difference in the performance among students with high, medium and low achievers when using instructional strategies. An efficient instructional strategy is expected to bridge the scoring gaps between high, medium and low scorers. This is why score level was chosen as one of the variables of interest in this study. Therefore, this study filled up the existing gap in the literature as it investigated the effects of jigsaw instructional strategy as an alternative strategy for teaching physics and the influence of the strategy on gender and students' score level in Ilorin, Nigeria.

Purpose of the Study

The purpose of the study was to investigate the effect of jigsaw instructional strategy as an alternative strategy for teaching simple harmonic motion in Ilorin.

Research Questions

The following research questions were raised to guide the conduct of this study;

i. What is the general performance of senior secondary school students in simple harmonic motion in Ilorin?

Research Hypotheses

The following null hypotheses were formulated and tested at 0.05 level of significance.

HO_1: There is no significant difference in the performance of students when taught simple harmonic motion using jigsaw instructional strategy and those taught without in Ilorin

HO_2: There is no significant interaction effect of gender, score level and jigsaw instructional strategy on students' performance in simple harmonic motion in Ilorin.

Method

The quasi-experimental research of the pre-test, post-test and control group was adopted. All senior secondary school students in Ilorin formed the population for the study while senior school two (SS2) students offering physics were involved in the study because it is expected that they have covered a greater part of the curriculum, and are familiar with the previous knowledge needed for the selected topic. They are also available for the study as they were not preparing for any external examination. Homogeneous purposive sampling technique was used in selecting the participating schools. This was because schools were selected based on similar characteristics they possess. The criteria for selection include; schools that have at least one professional physics teacher, are co-educational, have well equipped and functional physics laboratory and schools in which the concept of simple harmonic motion has not been taught already.

The researcher chose two comparable intact classes from two secondary schools in Ilorin. These classes consisted of 43 SS2 students. One school was assigned as the experimental group (EG) and the other school as the control group (CG). Students from both schools were classified into three score levels (high, medium, low) based on the results obtained from their senior school one third term continuous assessment in physics. Students whose scores fell between 70-100% were classified as high scorers; students whose scores fell between 50-69% were classified as medium scorers while students whose scores fell between 0-49% were classified as low scorers. This is based on West African Examinations Council (WAEC) system of grading; A1 and B2 (70-100%) as high scorers, B3, C4, C5 and C6 (50-69%) as medium scorers and D7, E8 and F9 (0-49%) as low scorers.

Instrumentation

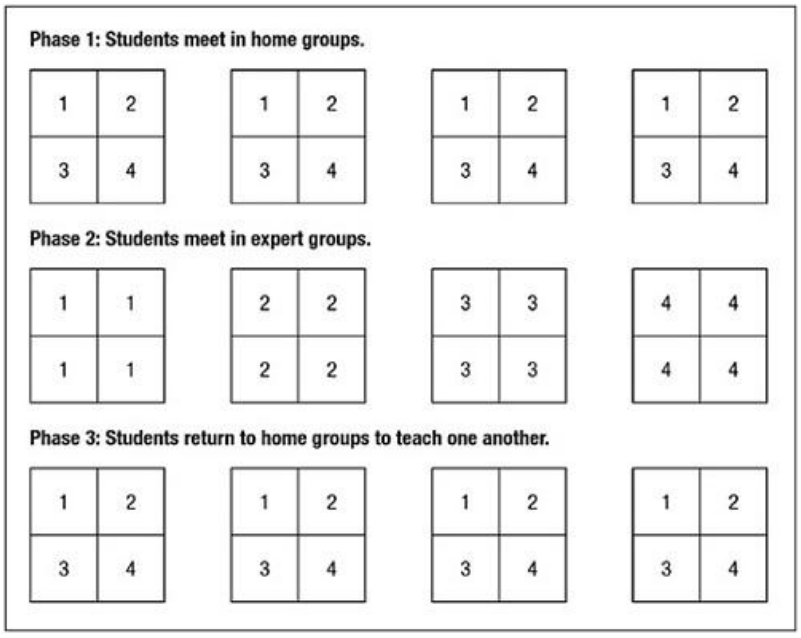
Performance Test (PT) was used as instrument for data collection which was constructed based on the researcher-designed Instructional Plans (IP) on the concept of simple harmonic motion for experimental and control groups (EG and CG). The PT consisted of 20 items validated by two (2) professional senior school Physics teachers and experts in test construction in term of appropriateness of the vocabulary used; quality of the test items and clarity of options given the level (SS2 class) of the students sampled. Each item was structure in a four-option lettered A-D with only one correct answer which attracts 5mark each. To determine the reliability of the instrument, the researcher conducted a pilot test on 20 students that were outside the participating students for this study using a Kuder-Richardson's formula and the reliability coefficient 0.86 was obtained for the instrument.

Ethical norms were taken into consideration with the approval of the schools and consent of the participating students and it was optional participation. Also, confidentiality and security of the data collected in the study

were ensured by the researcher. The experimental group was exposed to jigsaw instructional strategy while control group made use of traditional teaching method. The two groups had the same lesson, similar time of physics lesson and a teacher. A pretest was administered to the two groups to determine the students' level of knowledge of the concept of simple harmonic motion before teaching them. The researcher then trained the physics teacher in the experimental group on how the instructional package (jigsaw) was used for a week. The male and female students in the experimental group were taught simple harmonic motion through the jigsaw instructional package in the three lessons of 40 minutes duration, while the male and female students of the control group were also taught through the traditional method for only three lessons and each lasted for 40 minutes.

Experimental Group

In the experimental group, a class was divided into four sub-groups and a pre-test was conducted. The pre-test consists of 20 items multiple choice and four theory questions and the test was used in determining the performance of students in the concept of simple harmonic motion when they learn using the jigsaw instructional strategy. The researcher scored the instrument immediately after its administration. Each correct answer attracts one (1) mark with a total maximum score of 20 for the objective section and a score of 40 (10 marks each) for the theory section, to make a total of 60 marks with a maximum score of 60 and a minimum score of zero (0). Instructional plans were prepared for the selected physics topic. SHM was to be taught in three periods of 40 minutes each in senior school two according to Nigerian physics scheme of scheduled work for academic terms. The class was divided into four subgroup which is called 'home group' with the assistance of research assistance under the supervision of the researcher as shown in Figure 1.



Source Figure 1: The jigsaw technique (Roland & Martin, 2016)

The schools involved in the study had the three periods of 40 minutes each on their academic time-tables. Teaching and learning therefore lasted for two weeks consisting of three lessons of 40 minutes each. The topic was taught under simple harmonic motion which was divided into subtopics; the definition of SHM; period, frequency and amplitude of SHM; velocity and acceleration of SHM; energy of SHM; forced vibration and resonance. Each member of a group was assigned to read and become an expert on different subtopics and they teach other group member what they have learnt called 'expert group', after each person has finished teaching, they reassembled back to their original group which means that everyone in the group knows something about every subtopic. The control group also learnt the same concept under the instruction of their teacher for two weeks using traditional method of teaching. At the end of the exercise, post-test was administered to the students in both groups by reshufflling the pre-test questions and marked. The data collected were analyzed in the study: frequency was used to describe the demographic data of the participants; mean and standard deviation were used to answer the research question while hypotheses were tested using Analysis of Covariance (ANCOVA).

Results

Table 1 showed the demographic distribution of the sampled students in the study. An intact class of 20 students were taught simple harmonic motion in Physics using the jigsaw instructional strategy (Experimental Group, EG) while intact class of 23 students were taught simple harmonic motion in Physics using the traditional method (Control Group, CG). Also, out of 20 students that constituted the experimental group, 9 were male students from whom 3 students were of low score level; 4 students were of average score level and 2 students were of high score level while 11 were female students out of which 2 students were of low score level; 6 students were of average students and 3 students were of high score level. In addition, in the control group, there 3 of them were of low score level; 6 were average students and 3 were of high score level while 11 were female students out of whom 2 students were of low score level; 6 students were of average students and 3 students were of high score level.

Table 1: *Demographic Representation of Students Involved in the Study*

Groups	**N**	**Gender**	**N**	**Score Levels**	**N**
Jigsaw Instructional Strategy (EG)	20	Male	9	Low	3
				Average	4
				High	2
		Female	11	Low	2
				Average	6
				High	3
Traditional method (CG)	23	Male	12	Low	3
				Average	6
				High	3
		Female	11	Low	2
				Average	7
				High	2
Total	**43**		**43**		**43**

Source: Field Work 2019

Answering of Research Question

Question: What is the general performance of senior secondary school students in simple harmonic motion in Ilorin?

As revealed in Table 2, the performance of students (both the experimental and control groups) in the post-test were higher than their performance in the pre-test. In the post test, the performance (72.85) of students taught simple harmonic motion in Physics using Jigsaw instructional strategy was high when compared to those taught with traditional method (65.95) which was fair.

Table 2: *Descriptive Statistics of Students' Performance (before and after the Treatment*)

Groups		Mean	S.D.	Min	Max	Remark
Jigsaw Instructional Strategy	Pre-test	47.60	1.62	30.00	55.00	Low
	Post-test	72.85	1.45	60.00	95.00	High
Traditional Method	Pre-test	48.19	1.55	7.00	14.00	Low
	Post-test	65.95	1.35	10.00	15.00	Medium

Table 3 therefore shows the mean gain of the students in simple harmonic motion after the treatment. As shown in Table 3, students taught with Jigsaw instructional strategy had the mean gain score 25.25 while students that taught with conventional method had the mean gain score 17.76.

Table 3: Mean Gain Scores of the Students in Simple Harmonic Motion after the Treatment

Groups	Pre-test	Post-test	Mean Gain Scores
Experimental (*Collaborative Learning Method*)	47.60	72.85	25.25
Control (*Conventional Method*)	48.19	65.95	17.76

Hypothesis One: There is no significant difference in the performance of students when taught simple harmonic motion using jigsaw instructional strategy and those taught without in Ilorin

The result in Table 4 reveals that the *F*-value of 114.771 is obtained with a p-value of 0.000 computed at 0.05 alpha level. Since p-value (0.00) is less than alpha level (0.05), the null hypothesis one is rejected and thus, there is a statistically significant difference in the performance of students when taught simple harmonic motion using jigsaw instructional strategy and those taught without in Ilorin ($F_{(1, 39)} = 114.771$, $p<0.05$).

Table 4: *Analysis of Covariance Results of the Difference in the Performance of Students when Taught Simple Harmonic Motion Using Jigsaw Instructional Strategy and Those Taught*

Source	Type III Sum of Squares	df	Mean Square	*F*	Sig.
Corrected Model	610.518[a]	2	305.259	84.979	.000
Intercept	1095.992	1	1095.992	305.108	.000
Pretest	22.689	1	22.689	6.316	.015
treatment	581.432	1	581.432	114.771	.000
Error	197.568	39	5.066		
Total	13471.000	43			
Corrected Total	808.086	42			

a. R Squared = .756 (Adjusted R Squared = .747)

The Multiple Comparison Analysis is depicted in Table 5 to show where the difference lies (i.e. the effect of the treatment on Senior Secondary School students' performance in simple harmonic motion)

As shown in Table 5, students taught simple harmonic motion using Jigsaw instructional strategy had higher mean score of 72.85 than those in the control group that were taught with the conventional method with a mean score of 65.95. Thus, the effect of the Jigsaw instructional strategy students' performance in harmonic motion is shown by the mean score difference 6.9.

Table 5: *Pairwise Comparisons Analysis Showing the Effect of the Jigsaw Instructional Strategy on Students' Performance in Harmonic Motion*

Treatment	Mean	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
Experimental (I)	72.85[a]	6.90*	.501	.000	5.365	7.372
Control (J)	65.95[a]	-6.90*	.501	.000	-7.372	-5.365

Grand Mean = 69.40

* the mean difference is significant at 0.05 level

b. Adjustment for Multiple Comparisons: Bonferroni

Hypothesis Two: There is no significant the interaction effect of gender, score level and jigsaw instructional strategy

on students' performance in simple harmonic motion in Ilorin

Result in Table 6 reveals that the treatments was insignificant on gender (0.721>0.05) and score level (0.557>0.05). Thus, there was no statistically significant interaction effect of treatments, gender and score levels on the achievement of students in simple harmonic motion in Ilorin (0.189>0.05).

Table 6: *Analysis of Covariance Showing the Interaction Effect of Treatments, Gender and Score Levels on the Achievement of Students in Physics*

Source	Type III Sum of Squares	df	Mean Square	*F*	Sig.
Corrected Model	8.443[a]	5	1.689	.777	.574
Intercept	96.703	1	96.703	44.498	.000
Pre-test	3.185	1	3.185	1.466	.235
Gender	.281	1	.281	.130	.721
Scorelevels1	2.432	2	1.216	.559	.577
Gender*Score-level	3.925	1	3.925	1.811	.189
Error	65.196	36	2.173		
Total	7441.000	43			
Corrected Total	73.639	42			

a. R Squared = .115 (Adjusted R Squared = -.033)

P>0.05

Discussion

The findings from this study showed that the performance (72.85) of students taught harmonic motion in Physics using Jigsaw instructional strategy was higher than those taught with traditional method. This implies that JIS can be used in improving students' academic performance in physics, because it allows students to learn both independently and cooperatively, and as such reinforces their understanding since the learning was created by themselves. This is in agreement with the findings of Abdallah and Filiz (2017); Ali, Hossein and Mahin (2012); Alshammari (2015); Egbulefu, Amaela and Osaat (2015); Khan (2016); Mbacho (2013); and Odagboyi, Otuka and Uzoehi (2015) that had worked on the effect of jigsaw instructional strategy on students' academic performance in physics and other science subjects and found the strategy to be effective in improving students' academic performance.

The results indicated that there was no statistically significant interaction effect of treatments, gender and score levels on the achievement of students in simple harmonic motion in Ilorin. This means that male and female students had similar improved performance when learning simple harmonic motion using jigsaw instructional strategy. This findings were in agreement with the findings of Akinbobola (2009); Mankilik and Ofodile (2015); and Yusuf, Gambari and Olumorin (2012) who reported in their research works that there were no significant differences in the achievement of male and female

students when exposed to active and jigsaw instructional strategies in physics.

With respect to students' score levels, the treatment did not segregate among the students of low, medium and high score levels as students exposed to jigsaw instructional strategy had improved performance across the low, medium and high scoring students. Hence, the strategy is highly effective as it raised the levels of both low and medium scorers, and also, encouraged the level of high scorers. This conforms to the findings of Abdulwahab, Oyelekan and Olorundare (2016); Adeyemo (2010); Alebiosu and Michael (2011); Lamidi et al. (2015); and Obafemi and Ogunkunle (2013) who reported that low, medium and high scorers had improved academic performance after they were exposed to active instructional strategies. These results suggest that group exposed to jigsaw instructional strategy achieved better score level.

Conclusion

The study concluded that jigsaw instructional strategy is an effective strategy for learning and teaching of simple harmonic motion as it's reflected in students' performance. The study also concluded that gender did not have influence on the performance of students that learnt physics and low, medium and high scoring students benefitted when they learn simple harmonic motion using jigsaw instructional strategy as an alternative.

Recommendations

The following recommendations were made

1.) hysics teachers should use jigsaw instructional strategy in teaching and learning of simple harmonic motion.
2.) Students' of different score levels should be encouraged to use JIS for effective learning; jigsaw groups should consist of high, medium and low scoring students so that they can help each other to learn.
3.) Curriculum planners and developers should include appropriate active learning strategies such as JIS in the curriculum for the teaching and learning of physics concepts in senior secondary schools.

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