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Relative Effectiveness of Guided Inquiry and Collaborative Learning Instructional Strategies on Students' Performance and Retention Ability of Physics Students' in Akoko Southwest Local Government Area, Ondo State, Nigeria

Ojo Ezekiel Oluwaseyi [1*]

[1] Department of Science Education, Faculty of Education, AdekunleAjasin University, Akungba-Akoko, Ondo State, NIGERIA
***Corresponding Author:** ojoeasy@gmail.com

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ABSTRACT

Poor teaching methods have been single handily adduced for students' poor performance in physics at secondary school level. In lieu of this, this study investigates the relative and comparative effectiveness of the guided inquiry, collaborative learning conventional teaching methods on students' academic achievement and retention in physics. This study hypothesized that there is no significant difference in the academic performance and retention ability in physics by the students' taught with these methods. Pre-test, post-test control group quasi experimental design consisting of two experimental and one control groups was the research design used. The studied population consisted of all students who are offering physics in senior secondary class two in Akoko Southwest Local Government Area of Ondo State. Three secondary schools among the seventeen senior secondary schools in the study area were randomly selected and their 113 students were purposively selected schools were randomly selected and randomly assigned to two treatment and one control groups. The physics achievement test, an instructional package on physics were administered on the sampled students. The data collected were analyzed using ANCOVA. It was revealed that students taught using the collaborative learning method academically performed better to those taught using guided enquiry and conventional teaching methods. Similarly, collaborative method (CM) group retained best the contents taught followed by the guided inquiry group and lastly the conventional teacher expository method group. This study concludes that CM method is the best method of improving learning outcomes (performance and retention ability) in physics in the study area. This study therefore recommends that physics teacher in secondary schools in the study area should be synthetized via workshops, symposia, lectures, etc. on the procedures, techniques, and applications of collaborative teaching method in physics classrooms. Similarly, active participation of students in physics classroom should be encouraged by teachers.

Keywords: inquiry, collaboration, conventional method, retention, learning outcome

INTRODUCTION

Physics, the study of matter, energy, and their interaction, is the bedrock of development in the modern world. Physics was recommended in the 6-3-3-4 educational system (National Policy of Education [NPE], 2014). The word "development" as it is being used today emphasized advancement in physics-based technology.

This manifests in all areas such as economy, agriculture, medicine, computer, telecommunication, and warfare. No wonder, United States of America, Britain, Japan, China, Russia, and most European countries are denoted as developed countries and most African countries are denoted as either underdeveloped or developing nations. Therefore, any nation that pays lip service to the development of physics education will surely lag behind among comity of nations.

The foregoing facts spurred many science educators in Nigeria to designed and developed curricula that can aid the development of scientific skills in physics and also explored different effective teaching and learning methods to aid high levels of honesty and objectivity among learners in physics (Olatunbosun et al., 2017). Inspite of all these scholars' efforts, the students have fair performance in physics at the secondary school level in Nigeria (West African Examination Council [WAEC], 2018) but there is still need more improvement on the

Table 1. The distribution of students that made up the sample for the study and the three groups assigned

Control group		Treatment group	
Teaching method	**Number of students**	**Teaching method**	**Number of students**
Conventional teaching method (control)	38	Guided inquiry	36
		Collaborative learning	39
Total	38	Total	75

Note. Source: Fieldwork, 2022

performance of the students, especially in the areas of practical skills and creativity in physics.

The summary of the academic performance of students at senior secondary school certificate examination (SSCE) between 2014 and 2018 in which the percentage of students that passed at credit and above (A1-C6) had consistently ranged within 50.14%-58.95%. While a considerable percentage above 40% to 48% of students still failed physics at non- credit level D7-F9 WAEC report 2018. It was also noticed that those students who scored less than 50% in each year under consideration will not be qualified to pursue any physics related courses in higher school of learning.

This implies that the national curriculum for physics has not yielded the expected outcome. Duyilemi and Olusola (2016) had earlier reported that the performance of Ondo State physics students keeps on decreasing from year to year that is between (2005 to 2014).

Statement of the Problem

The under achievement of physics students in SSCE has been linked to poor teaching methods, abstract nature of physics concepts and topics, lack of qualified teachers, poor infrastructure and inadequate laboratory facilities, teacher-centered instruction, non-availability and non-utilization of instructional materials, teachers' strategies as curriculum users are obstacles to achieving expected goals in science. Thus, in an attempt to make the learning of physics to be more meaningful, effective, and efficient in the promotion and maximization of physics learning outcomes, continual search for the ways to improve valid learning experiences and more effective physics teaching techniques were developed such strategies include cooperative learning, computer-assisted instruction, concept mapping, field trip and demonstration method among others.

Inspite of the proofed efficiency of these strategies they failed to improve the teaching and learning of physics thus, their overall effects of these methods is declining performance of physics students in higher secondary school physics examinations. In lieu of the foregoing, this study investigates the relative effectiveness of the guided inquiry and collaborative learning instructional strategies on students' academic performance and retention ability in physics in Akoko Southwest Local Government Area Ondo State, Nigeria.

Objective of the Study

The study investigated the relative effectiveness of guided inquiry and collaborative learning instructional strategies on students' performance and retention ability of physics students. Specifically, the study aimed to:

1. Investigate the relative effectiveness of guided inquiry and collaborative learning instructional strategies on students' academic performance.
2. Examine the comparative effectiveness of the guider inquiry and collaborative learning instructional strategies on students' retention ability.

In liu of the foregoing, this study succinctly hypothesized that:

1. There is no significant difference in the academic performance of students taught with guided inquiry, collaborative, and conventional teaching methods.
2. There is no significant difference in the retention ability of students taught with guided inquiry, collaborative, and conventional teaching methods.

METHODOLOGY

This study used the pre-test, post-test control group quasi experimental design consisting of two experimental and one control groups. The independent variables used are the variables relating to guided inquiry, collaborative learning, and conventional teaching methods. The dependent variables used are related to variables that determine students' achievement and retention ability in physics.

The studied population consisted of all students who are offering physics in senior secondary class two (SSC II) in Akoko Southwest Local Government Area of Ondo State. Simple random sampling technique was used to sample three secondary schools from 17 senior secondary schools in the study area. Thereafter, one intact science class was purposefully selected in each of the three sampled schools while all 113 students that are offering physics in these schools were purposively selected for this study. Finally, the students selected were randomly assigned to treatment groups and the control group I (**Table 1**).

The two instruments used are physics achievement test (PAT) and an instructional package (IP). The PAT consisted of 25-item multiple choice questions extracted from WAEC senior certificate examinations and National Examination Council (NECO) senior school certificate examinations. Each of the selected questions have each with live options labeled "a" to "e". The IP was lesson on two topics that involved numerical problems on motion and friction.

The PAT was validated using Bloom's (1956) taxonomy. The complete test items were given to two experienced physics teachers and seasoned examiners of WAEC and NECO for comments on the validity and correctness of the questions and options. Based on the comments of the assessors a few questions were modified. The instrument was then field-tested on a random sample of 50 students selected from SSC II in each of the sampled schools.

The result of the field test was used to calculate the difficulty indices (P) of the test items. Only the items with P

Table 2. ANCOVA of the effect of guided inquiry, collaborative, and conventional teacher expository methods on students' academic performance in physics-1

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Corrected model	536.625[a]	3	178.875	31.899	.000	.482
Intercept	1,098.361	1	1,098.361	195.871	.000	.655
Pretest scores	4.739	1	4.739	.845	.360	.008
Treatment groups	506.079	2	253.039	45.125	.000	.467
Error	577.580	103	5.608			
Total	15,647.000	107				
Corrected total	1,114.206	106				

Note. Dependent variable: Post-test academic performance scores; [a]R^2=.482 (adjusted R^2=0.467); & Source: Fieldwork, 2022

Table 3. ANCOVA of the effect of guided inquiry, collaborative, and conventional teacher expository methods on students' academic performance in physics-2

Variables	R	r^2	$r^2 \times 100$
Guided inquiry, collaborative, and conventional teacher expository methods	0.6833	0.467	46.70%

Note. Source: Fieldwork, 2022

Table 4. Scheffe pair-wise comparisons of differences in the academic performance of students taught physics using guided inquiry, collaborative, and conventional teacher expository methods

Treatment	Mean	Standard error	95% confidence interval	
			Lower bound	Upper bound
Guided inquiry method	11.661[a]	.472	10.725	12.597
Collaborative method	14.341[a]	.401	13.547	15.136
Conventional teacher expository method	9.033[a]	.419	8.203	9.863

Note. Dependent variable: Post-test academic performance; [a]Covariates appearing in the model are evaluated at the following values: Pre-test scores of students in all groups=5.45; Source: Fieldework, 2022

value between 0.32 and 0.72 were selected. Based on this, fifteen test items were dropped from an initial forty items and twenty-five items were retained, for the study. The final set of twenty live questions made up the PAT. The reliability of the instrument was also determined using Kuder-Richardson 20 formula (K-R-20) and the reliability coefficient was found to be 0.86.

Data Collection and Analysis

With the assistance of physics teachers in the sampled schools, the students were given the pre-test to ascertain uniformity of their entry level during the first week of the experiment. Thereafter, treatment (teaching) that lasted for six weeks of two periods per week commenced the following week after the administration of pre-test. The first and second experimental groups were taught using the guided inquiry and collaboration methods respectively while the third group (control group) was taught using the conventional Teaching method. After the treatments, the students were post-tested. Two weeks after the post test, a retention test was administered.

The data collected were analyzed using ANCOVA. Where significance difference occurs in the result, of the ANCOVA the Scheffe test was used to determine the direction of the significance.

RESULTS OF HYPOTHESES TESTING

Hypothesis One

There is no significant difference in the academic performance of students taught using guided inquiry, collaborative method (CM) and those taught with conventional method. The result of the analysis carried out using ANCOVA is as presented in **Table 2**.

Results from **Table 2** showed that there was significant difference among the performance of students in the three groups (F=45.125, p<0.05, η^2=0.467). The null hypothesis which stated that there was no significant difference in the academic performance of students taught using the three methods was therefore rejected.

From **Table 3** , it was found out that the three methods of teaching have joint moderate positive correlation (Okoko, 2000) of about 0.6833 and a coefficient of variation of about 0.467 to signify that the three teaching methods (guided inquiry, collaborative, and conventional teacher expository methods) jointly have about 46.70% variation on relative effectiveness on learning instructional strategies in improving learning outcomes of Ondo State senior secondary school students in physics while other learning instructional strategies such as play, lecture and project methods among other methods to improve learning outcomes of Ondo State senior secondary school students in physics account for the remaining 53.30%.

Further results are depicted by Scheffe pair-wise comparisons in **Table 4**.

Table 5 depicted that there was significant positive mean difference (2.628) between the academic performance of those taught using guided inquiry method (GIM) and conventional teacher expository method (CTM) in favor of those taught using GIM. It was also found that there was significant positive mean difference (2.680) between the academic performances of those taught using CM and GIM in favor of CM; and there was significant positive mean difference (5.308) in the

Table 5. Pair-wise comparisons of dependent variable (post-test academic performance)

(I) Treatment	(J) Treatment	Mean difference (I-J)	Standard error	Sig.[b]	95% confidence interval for difference[b]	
					Lower bound	Upper bound
GIM	CM	-2.680*	.645	.000	-3.960	-1.400
	CTM	2.628*	.687	.000	1.266	3.990
CM	GIM	2.680*	.645	.000	1.400	3.960
	CTM	5.308*	.561	.000	4.196	6.420
CTM	GIM	-2.628*	.687	.000	-3.990	-1.266
	CM	-5.308*	.561	.000	-6.420	-4.196

Note. Results are based on estimated marginal means; *The mean difference is significant at the .05 level; [b]Adjustment for multiple comparisons: Least significant difference (equivalent to no adjustments); & Source: Fieldwork, 2022

Table 6. ANCOVA of the effect of guided inquiry, collaborative, and conventional teacher expository methods on students' attitude towards physics-1

Source	Type III sum of squares	df	Mean square	F	Sig.	Partial eta squared
Corrected model	1,466.997[a]	3	488.999	6.691	.000	.164
Intercept	3,703.283	1	3,703.283	50.671	.000	.332
Pretest scores	955.280	1	955.280	13.071	.000	.114
Treatment groups	551.007	2	275.504	3.770	.026	.069
Error	7,454.663	102	73.085			
Total	20,4400.000	106				
Corrected total	8,921.660	105				

Note. Dependent variable: Post-test towards physics; [a]R^2=.164 (adjusted R^2=0.140); & Source: Fieldwork, 2022

Table 7. ANCOVA of the effect of guided inquiry, collaborative, and conventional teacher expository methods on students' attitude towards physics-2

Variables	R	r^2	$r^2 \times 100$
Guided inquiry, collaborative, and conventional teacher expository methods	0.2626	0.069	6.9%

Note. Source: Fieldwork, 2022

Table 8. Scheffe pair-wise comparisons of differences in the attitude towards physics of students taught physics using guided inquiry, collaborative, and conventional teacher expository methods

Treatment	Mean	Standard error	95% confidence interval	
			Lower bound	Upper bound
Guided inquiry method	39.929[a]	1.466	37.021	42.838
Collaborative method	43.208[a]	1.425	40.382	46.034
Conventional teacher expository method	45.526[a]	1.425	42.699	48.352

Note. Dependent variable: Post-test attitude; [a]Covariates appearing in the model are evaluated at the following values: Pre-test attitude=41.74; Source: Fieldework, 2022

performance of those taught using CM and CTM in favor of the CM. Adjusted mean performance showed that of the three methods, those taught using CM performed best, followed by those taught using GI and lastly those taught using CTM.

Hypothesis Two

There is no significant difference in the attitude towards physics of the students taught using guided inquiry, CM, and CTM. In order to test this hypothesis, ANCOVA, which partials out the effect of the pretest attitude of the students towards physics was used to determine if there be significant difference in the post-test attitude of the students taught using guided inquiry, collaborative, and conventional teacher expository methods. The results obtained are as presented in **Table 6**.

Results from **Table 6** showed that there was significant difference between the post-test attitude towards physics of students in the three groups (F=3.77, p<0.05, η^2=0.069). The null hypothesis which stated that there was no significant difference in the attitude towards physics of students taught using the three methods was therefore rejected. The effect size of the treatments on the academic performance of the students is small.

Correlation analysis (**Table 7**) carried out shows that the three methods of teaching have joint low positive correlation of about 0.2626 and a coefficient of variation of about 0.069 to signify that the three teaching methods (guided inquiry, collaborative and conventional teacher expository methods) jointly have about 6.90% variation on the effect of guided inquiry, collaborative and conventional teacher expository methods on students' attitude towards effectiveness of on learning instructional strategies in improving learning outcomes of Ondo State senior secondary school students in physics.

Further results are depicted by Scheffe pair-wise comparisons in **Table 8**.

Table 9 depicted that there was significant positive mean difference (3.279) between the attitude towards physics of those taught using CM and GIM in favor of those taught using CM. It was also found that there was significant positive mean difference (5.596) between the attitudes of those taught using

Table 9. Pair-wise comparisons of dependent variable (post-test attitude)

(I) Treatment	(J) Treatment	Mean difference (I-J)	Standard error	Sig.[b]	95% confidence interval for difference[b]	
					Lower bound	Upper bound
GIM	CM	-3.279	2.045	.112	-7.334	.777
	CTM	-5.596*	2.045	.007	-9.653	-1.540
CM	GIM	3.279	2.045	.112	-.777	7.334
	CTM	-2.318	2.015	.253	-6.315	1.680
CTM	GIM	5.596*	2.045	.007	1.540	9.653
	CM	2.318	2.015	.253	-1.680	6.315

Note. Results are based on estimated marginal means; *The mean difference is significant at the .05 level; [b]Adjustment for multiple comparisons: Least significant difference (equivalent to no adjustments); & Source: Fieldwork, 2022

CTM and GIM in favor of CTM group; and there was significant positive mean difference (2.318) between the attitude of those taught using CTM and CM in favor of the CTM group. Adjusted mean performance showed that of the three methods, those taught using CTM.

DISCUSSION

The results of this study showed that there was a significant difference in the academic performance of students taught using guided inquiry, collaborative learning strategies and conventional teaching, where those taught using the collaborative learning strategy group performed better than those in the other two groups. This finding agrees with several other studies where it has been concluded that regardless of the subject matter, students working in small groups tend to learn more of what is taught and retain it longer than when the same content is presented in other instructional formats. Specifically, Herrera-Pavo (2021) reported that those taught using collaborative learning performed significantly better on the critical thinking test than students who studied individually. The results of this study further showed that there was a significant difference in the retention ability of the students taught using guided inquiry, collaborative learning strategies and CTM (Atandi et al., 2019). Those in the collaborative teaching group retained best the contents taught followed by the guided inquiry group and lastly the CTM group. The finding of this study is corroborated with the report of Hernandez and Munoz (2019). Collaborative learning promotes situations where knowledge is built and sustained.

CONCLUSION AND RECOMMENDATIONS

Based on the findings of this study, it is concluded that collaborative teaching method is the best method of improving learning outcomes (performance, attitude, and retention ability) in physics in the study area. This study therefore recommends that physics teacher in secondary schools in the study area should be synthetized via workshops, symposia, lectures, etc. on the procedures, techniques, and applications of collaborative teaching method in physics classrooms. Similarly, active participation of students in physics classroom should be encouraged by teachers.

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REFERENCES

Atandi, B. C., Gisore, B., & Ntabo, A. J. (2019). Influence of teaching methods on students' academic performance in kiswahili subject in public and private secondary schools in Langata Sub-Country. *African Research Journal of Education and Social Sciences, 6*(2), 2-19.

Duyilemi, A. N., & Olusola O. L. (2016). Gender and performance in science subject in secondary schools in Ondo State, Nigeria. *Journal of Science and Technology, 1*(2), 1- 2.

Hernandez, S., & Munoz, C. (2019). Computer supported collaborative learning: An analysis of the relationship between interaction, emotional support and online collaborative tools. *Computers & Education, 138*, 1-12. https://doi.org/10.1016/j.compedu.2019.04.012

Herrera-Pavo, M. A. (2021). Collaborative learning for virtual higher education. *Learning, Culture and Social Interaction, 128*, 100437. https://doi.org/10.1016/j.lcsi.2020.100437

NPE. (2014). National policy on education. *National Policy on Education Research and Development Council*. https://education.gov.ng/wp-content/uploads/2020/06/NATIONAL-POLICY-ON-EDUCATION.pdf

Olatunbosun, S., Daramola, O., & Babarinde, F. (2017). Assessment of implementation of physics curriculum in public secondary schools in Ekiti State. *Journal of Scientific and Engineering Research, 4*(8), 45-49.

WAEC. (2018). Chief examiner's report in physics. Akure, Ondo State, Nigeria. *West African Examination Council*.