EFFECTS OF CIRCLE-THE-SAGE COOPERATIVE LEARNING STRATEGY ON SECONDARY SCHOOL STUDENTS' ACHIEVEMENT AND RETENTION IN WAVES AND MEASUREMENTS OF HEAT ENERGY CONCEPTS

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Abstract

This study examined the effects of circle-the-sage cooperative learning strategy (CSCLS) on secondary school students' achievement and retention in waves and measurements of heat energy in Jos South, Nigeria. The unsatisfactory and fluctuating achievement of students in Physics was the premise that led to the study. The study adopted the non-equivalent control group quasi-experimental research design. A total of 65 senior secondary two (SS2) students (33 males and 32 females) offering Physics from two co-educational secondary schools (two intact classes) in Jos South, Nigeria was used as sample. The Waves and Measurement of Heat Energy Achievement Test (WMHEAT), which consisted of 40 multiple-choice items, was used to collect data for the study. The reliability coefficient of WMHEAT, using the Kuder-Richardson formula 20 on SPSS version 25, was determined as 0.85. Three research questions were answered and six formulated hypotheses were tested in this study. The mean was used to answer the research questions and the Analysis of Variance (ANOVA) was used to test the hypotheses. Findings from the study revealed that students taught using CSCLS achieved higher in waves and measurements of heat energy than those taught using conventional lecture method of instruction (CLM). It was also revealed that students taught using CSCLS retained better than those taught using CLM. Further findings showed that the CSCLS is not gender-biased. It was recommended, amongst others, that the use of CSCLS should be encouraged in secondary schools as a method of teaching and learning of Physics, as it promotes students' achievement and retention and is not gender-biased.

Keywords: Learning, Strategy, Students' Achievement, Retention, Physics, Waves, Measurements of Heat Energy, Students' Gender

Introduction

Education in general can be viewed as development of life process and universal practice of human learning resulting from man's interaction with his social and natural environment. It is the process of facilitating the learning or acquisition of knowledge, skills, values, beliefs and habits. This process can be achieved both inside and outside the classroom through the many methods of teaching which include lecture, storytelling, discussion, demonstration, play way and cooperative. Any experience that has a formative effect on the way a learner thinks, feels or acts, may be considered educational. For the purpose of studies in secondary schools, most senior secondary schools in Nigeria have categorized education into arts, commercial and science. Science education prepares students towards providing scientific and technological development for the enhancement of the living standard of people. Scientific and technological development is the most effective factor in enabling less-developing countries into the main stream contemporary technology and commerce.

An analysis by Akpan (2018) indicated that

countries that lead economically also lead technologically. In other words, countries that lead technologically are the ones that lead economically. This situation is like the 'chicken and egg' dilemma, whereby one may be inclined to ask "Is it the technological advancement of a country that results to its economic growth or is it the reverse?" At the senior secondary school level of education in Nigeria, the core science subjects that students learn are biology, chemistry and physics. Physics plays a critical role in the scientific and technological development of the society. Physics propels resourcefulness, develops process skills and correct attitude which are needed in solving problems in other to attain the socio-economic, scientific and technology development of a nation. Summarily, no nation can experience national growth without the acquisition of physics concepts by citizens. Josiah and Okonkwo (2020) opined that the development of any nation is expected to begin from the secondary school classroom, where the fundamentals of the core sciences are taught. This simply implies that the fundamental acquisition of science skills, which can serve as a platform for economic growth of any nation, commences from the secondary school classroom. Agommuoh and Nzewi, (2013) viewed Physics as a subject highly needed for technology breakthrough. Lending credence, Josiah and Okonkwo (2020) opined that Physics plays a vital role in all human endeavours and serves as a pre-requisite for Physics-related courses such as Pharmacy, Geology, Mining and Aeronautical engineering. The study of Physics is, therefore, crucial for any nation that desires to place itself in the map of developed nations. However, the technological potentials of any nation could be more accurately gauged by the quality of its scientific exploits, especially in Physics education; for without Physics, the technology of its citizens may not be firmly established.

Many teaching methods have been in use for teaching physics in secondary schools. In Nigeria, and in other places as attested to by Kalhotra (2015), these pedagogies are mostly expository in nature. Expository methods of teaching consists of presentation of facts, concepts and principles by the teachers while the learners are only asked to listen, answer questions and take some notes. Josiah and Okonkwo (2020), Josiah and Shedow (2020) opined that most physics teachers in Nigeria use lecture method in the classroom. Lecture method is a teaching method where a teacher is the central focus of information transfer. Typically, the teacher stands before the class and presents information for the students to learn by listening and taking notes. This method does not promote or foster critical thinking and students' participation. Studies reveal the Nigerian teachers' persistently use expository methods which do not lead to high achievement in students (Josiah & Larina, 2015; Josiah, Mallo & Inyang, 2019). There are teaching methods, such as cooperative learning, that foster active participation of students in the teaching-learning process. Lending credence, Johnson, Johnson and Smith as cited in Ogunleye and Oladehin (2012) wrote that cooperative learning improves knowledge acquisition, retention of knowledge learnt, higher-level thinking skills, interpersonal skills, communication skills and self-confidence. In cooperative learning, learners positively depend on each other in learning, interact physically with each other as they learn, develop appropriate collaborative and interpersonal skills to teach and encourage each other to learn and reflect on concepts, and assess their effectiveness as a group for future learning. Circle-the-sage cooperative learning is a strategy used in cooperative learning method.

Circle-the-sage cooperative learning strategy is a teaching strategy where the teacher polls the class to see students who have special knowledge or experience on a concept to be learnt that would benefit other students. Those identified students, referred to as sages, are made to stand and spread out in the class. The remaining students are then placed in groups of 3-5, with each member of a group going to a different sage for the purpose of learning. No two members of the same group

go to the same sage. Students in a sage group surround the sage, who shares his/her knowledge or experience with them. According to Ogunleye and Oladehin (2012), the students in the sage group listen as the sage shares the knowledge, ask questions for clarity and write down notes. After a specified period of time, the students are asked to return to their initial groups, where they take turns to share their learnt knowledge. The different groups thereafter compare notes; if there is a disagreement with a group, such a disagreement is discussed in the class.

Studies abound on the effect of cooperative learning strategy on students' achievement. A study conducted by Ogunleye and Oladehin (2012) on improving students' achievement and attitude to basic science through "circle-the-sage" mode of cooperative learning, indicated that students who were exposed to the strategy achieved significantly high. Findings from studies on various cooperative learning also show that students exposed to such methods achieve significantly higher than their counterparts exposed to expository method of teaching (Awoniyi & Kamanga, 2014; Fasanya & Mankilik, 2020; Josiah, 2019; Josiah & Emmanuel, 2020; Josiah & Shedow, 2020; Mankilik & Mallo, 2020; Nnorom, 2015; Tran, 2014; Umaru & Mankilik, 2020). In contrast, a study by Ajaja and Eravwoke (2010) on the effects of cooperative learning strategy on students' achievement in integrated science revealed no significant difference between the achievement of students exposed to cooperative learning and those exposed to lecture method.

This research was anchored on the social constructivist theory of learning propounded by Lev Vygotsky in 1978. The theory states that knowledge is co-constructed and that individual learners learn from one another. In the learning process, each learner must be engaged. Learning in an individual takes place with the help of other learners, thereby contributing the social aspect of Vygotsky's theory. One essential characteristic of the theory is the Zone of Proximal Development (ZDP), which is a situation in which the learner is in a position of understanding a concept or task, but cannot achieve it without external assistance. Another characteristic of Vygotsky's theory is scaffolding; that is, facilitating the learning of concepts for the learner at the right time. A learner is closer to mastering a concept or task when he/she is assisted to perform the task. This theory is relevant to healthy adolescent development because when students work in groups, as in circle-the-sage cooperative learning strategy, they are interacting with one another and therefore can learn different concepts or tasks from one another; they can assist one another and co-construct knowledge. In circle-the-sage cooperative learning strategy, students are grouped such that students who do not understand the concept to be learnt fall into the same group with students who understand (the sages). Students who do not understand specific heat capacity, for example, are placed in the same group with a student who understands that concept; for the purpose of learning.

Gender issues are topical all over the world. Gender issues are classroom policies or practices which distinguishes teaching and learning experiences in ways that limit opportunities for male and female teachers and students in the classroom. Driessen and van Langen (2013) were of the opinion that a lot of the discussions on gender gap is now projected on whether female students achieve higher in education, in all educational stages and school subjects, than their male counterparts. Slavin (2009) opined that group rewards and accountability based on individuals in a cooperative learning group, such as the groups in CSCLS, are essential elements for facilitating basic skills achievement. This implies that group members must not only work together, but must take each member's achievement seriously. Any form of gender discrimination could be eliminated since rewards to groups are based on the learning progress of each member of the group, and group achievement depends on individual learning by way of in-

dividual accountability. This indicates that the activities in CSCLS favour both male and female learners.

Findings from studies of Alao and Abubakar (2010), Josiah (2019), Josiah and Okonkwo (2020), Josiah and Shedow (2020) revealed no significant disparity in the academic achievement of male and female students. However, other studies exist which revealed significant difference in in the achievement of students: Trisma and Josiah (2008), Mankilik and Mallo (2020), Samuel and Peter (2013) found out that female students achieved significantly higher in Physics than male students.

Most assessments of what students learn in school measure their performance on a short-term basis (during teaching or at the end of a term), Rather than measure long-term performance of students. However, what is important in the teaching-learning process is not what students know during teaching or the day of a □nal examination, but the concepts they have retained, which they can apply much later in life. Bjork as cited in Deslauriers and Wieman (2011) opined that many standard educational practices that encourage rote learning could promote short-term performance in students rather than long-term retention. Findings from the studies of Tran (2014) showed that students exposed to cooperative learning had significant higher retention of information than their counterparts exposed to lecture method. A study on effects of computer simulation puzzle-game strategy on students' achievement and retention in mechanics by Umaru and Mankilik (2020) indicated no significant difference between male and female retention of concepts in mechanics, an aspect of Physics. Ajai and Imoko (2015), Eze, Ezenwafor and Obidile (2016) also had earlier found no significant difference between male and female retention of information.

Statement of the Problem

In Nigeria, many factors might have contributed to the unsatisfactory and fluctuating achievement of students in Physics. Some of the factors identified by Agommuoh and Nzewi (2013), Josiah and Larina (2015), Josiah and Okonkwo (2020), Sule and Mankilik (2015) are lack of well-equipped physics laboratory, lack of curriculum content coverage, teacher's quality, negative attitudes of students towards physics, lack of frequent practice by students, poor background in mathematics, poor classroom management, and teaching methods used in physics. Although there have been improvement in the recent past years, the achievements of the students in physics have been fluctuating. This is vividly seen in the statistical reports obtained from the West Africa Examinations Council (WAEC) and National Examinations Council (Josiah, 2019; Josiah & Gana, 2019; Josiah & Mankilik, 2018).

Ahmed and Abimbola (2011) and Umar (2011) opined that the persistent use of the lecture method makes students passive rather than active learners and it does not promote insightful learning and long-term retention of concepts. Many research studies have been undertaken on the effect of cooperative learning methods on students' achievement. However, it is apparent that little emphasis on researches concerning the influence of circle-the-sage cooperative learning strategy on students' achievement in waves and measurements of heat energy in Jos North, Nigeria has been made. For the purpose of this study, Jos South Local Government Area was operationally defined as Jos South. It is a Local Government Area in Plateau state in the North-central part of Nigeria.

This study was, therefore, undertaken so as to determine the effects of circle-the-sage cooperative learning strategy on secondary school students' achievement and retention in waves and measurements of heat energy in Jos South, Nigeria. Moreover, due to the role Physics plays in national development, this study further investigated the impact of the strategy on students' retention and whether it

affects their achievement and retention gender-wise.

Research Questions

The following research questions were answered in the study:

1. What are the pre-test and post-test mean achievement scores of senior secondary two (SS2) students in waves and measurement of heat energy?
2. What are the post-test mean achievement scores of SS2 male and female students in waves and measurement of heat energy that were exposed to circle-the-sage cooperative learning strategy (CSCLS)?
3. To what extent does the mean retention score of SS2 students exposed to waves and measurement of heat energy using CSCLS differ from that of students exposed to the same concepts in Physics using conventional lecture method (CLM)?

Hypotheses

The following hypotheses were tested at 0.05 level of significance:

1. There is no significant difference between pre-test achievements of SS2 students taught waves and measurement of heat energy using CSCLS and those taught using CLM.
2. There is no significant difference between pre-test and post-test achievements of SS2 students taught waves and measurement of heat energy using CSCLS.
3. There is no significant difference between post-test achievements of SS2 male and female students who were taught waves and measurement of heat energy using CSCLS.
4. There is no significant difference between post-test achievement and retention of SS2 students who were taught waves and measurement of heat energy using CLM.
5. There is no significant difference between post-test achievement and retention of SS2 students who were taught waves and measurement of heat energy using CSCLS.
6. There is no significant difference between retention of SS2 male and female students exposed to waves and measurement of heat energy using CSCLS.

Research Method

The research adopted the non-equivalent control group quasi-experimental design, because intact classes were used for the study. Moreover, the principals of the sampled schools could not allow random sampling of their students into the experimental and control groups as doing so would have disrupted their academic programmes. Judgmental sampling technique was employed to obtain the two schools used for the study. The criteria used were based on qualified physics teacher (a minimum of a B.Sc (Ed) in physics or a B.Sc in Physics with an additional Postgraduate Diploma in Education (PGDE) certificate, and a well-equipped physics laboratory. Thereafter, simple random sampling technique was employed to place the students in the two intact classes (one from each of the two schools) into experimental group and control group. A total of 65 SS2 Physics students from two co-educational secondary schools in Jos South, Nigeria were used as sample. This sample consisted of 15 males and 20 females for experimental group while the control group consisted of 18 males and 12 females. Hence, there were 35 and 30 students in the experimental and control groups respectively.

The research instrument used for data collection was the Waves and Measurement of Heat Energy Achievement Test (WMHEAT). It consists of 40 multiple-choice items, with each item having four options labeled a, b, d and d. The WMHEAT was developed by the researchers using test blueprint based on Bloom's taxonomy of educational objectives in the cognitive domain, past WASSCE and SSCE question papers of WAEC and NECO. It sought to elicit information on students' achievement in waves and measurements of

heat energy, and to determine the students' ability to retain the concepts taught when circle-the-sage cooperative learning strategy was used. The content validity of WMHEAT was done by three experts, one each from the Department of Educational Foundations, Department of Science and Technology Education and Department of Physics, University of Jos. The reliability of WMHEAT was determined using Kuder-Richardson formula 20 and its coefficient was obtained as 0.85.

The WMHEAT was administered as pre-test to both the experimental and control groups a week before the commencement of the treatment of teaching using circle-the-sage cooperative learning strategy. Treatment was then given to the experimental group for a period of six weeks. The control group was taught the same content of waves and measurement of heat energy as the experimental group for the same six weeks, but using the conventional lecture method. After the six weeks of treatment, the WMHEAT was administered on the two groups as post-test. Four weeks after the post-test administration, WMHEAT was administered to the two groups as retention test. The pre-test was used to determine the equivalence of the two groups with respect to their achievement in the concepts of waves and measurement of heat energy; and the results of the pre-test were used as covariate measures. The mean, a descriptive statistics, was employed to answer all the research questions, while the Analysis of Variance (ANOVA) was used to test all the hypotheses; using Statistical Package for Social Sciences (SPSS), Version 25.

Results

Research question one

What are the pre-test and post-test mean achievement scores of senior secondary two (SS2) students in waves and measurement of heat energy?

To answer this research question, the results are presented in Table 1.

Table 1: Mean Rating of Pre-test and Post-test Achievement Scores of SS2 Students in Waves and Measurement of Heat Energy

Group	N	Pre-Test		Post-Test	
		$\bar{X}$	SD	$\bar{X}$	SD
Experimental	35	33.87	5.95	53.02	9.42
Control	30	35.34	6.89	48.69	10.44

The results of analysis in Table 1 revealed pre-test and post-test mean achievement scores of 33.87 and 53.02 for students in the experimental group, while their counterparts in the control group had a mean achievement score of 35.34 and 48.69 in the pre-test and post-test respectively. These results imply that no much difference was observed in the pre-test mean achievement scores of students in the two groups before exposure to the treatment of teaching concepts of using CSCLS. However, their post-test depicts that those in the experimental group had a higher mean achievement score (with a difference of 4.13), signifying that the strategy should be used in teaching SS2 students concepts of waves and measurement of heat energy in Jos South, Nigeria.

Research question two

What are the post-test mean achievement scores of SS2 male and female students in waves and measurement of heat energy that were exposed to circle-the-sage cooperative learning strategy (CSCLS)?

To answer this research questions results are presented in Table 2.

Table 2: Mean Rating of Post-test Mean Achievement Scores of SS2 Male and Female Students exposed to Waves and Measurement of Heat Energy Using CSCLS

Gender	N	$\bar{x}$	SD
Male	15	53.30	9.37
Female	20	52.73	10.78

The findings from Table 2 indicates that male students in the experimental group exposed to the treatment using CSCLS had a mean achievement score of 53.30 in waves and measurement of heat energy, while their female counterparts in the same group had a mean achievement score of 52.73. This implies that male students achieved slightly higher than female students when exposed to waves and measurement of heat energy using CSCLS, with a difference of 0.57 in favour of the male students.

Research question three

To what extent does the mean retention score of SS2 students exposed to waves and measurement of heat energy using CSCLS differ from that of students exposed to the same concepts in Physics using conventional lecture method (CLM)?

To answer this research question, the results are presented in Table 3.

Table 3: Extent of Difference between Mean Retention Scores of SS2 Students in Waves and Measurement of Heat Energy Exposed to CSCLS and CLM

Group	N	$\bar{x}$	SD
Experimental	35	49.26	4.63
Control	30	34.63	5.95

Table 3 shows that SS2 students in the experimental group exposed to waves and measurement of heat energy using CSCLS had a mean retention score of 49.26, while those in the control group who were taught the same concepts using CLM had a mean retention score of 34.63. This implies that the retention score of students in the experimental group was marginally higher than that of those in the control group, with a mean difference of 14.63 in favour of students in the experimental group.

Hypothesis one

There is no significant difference between pre-test achievements of SS2 students taught waves and measurement of heat energy using CSCLS and those taught using CLM.

The results of the test on this hypothesis are presented in Table 4.

Table 4: ANOVA Results of Pre-test Achievements of Experimental and control Groups

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.	Decision
Between Groups	35.201	1	35.201	1.176	.282	Accept H_o
Within Groups	1885.352	63	29.926			
Total	1920.554	64				

$p>0.05$

The ANOVA results in Table 4 reveal that F(1,63=1.176,p=.282),which implies that p>0.05. Based on this, the null hypothesis was not rejected. In other words, the study failed to reject the Ho and the conclusion drawn was that there is no significant difference between the pre-test achievements of SS2 students taught waves and measurement of heat energy using CSCLS and those taught the same concepts using CLM in Jos North, Nigeria.

Hypothesis two

There is no significant difference between pre-test and post-test achievements of SS2 students taught waves and measurement of heat energy using CSCLS.

The results of the test on hypothesis two are presented in Table 5.

Table 5: ANOVA Results of Difference between Pre-test and Post-test Achievements of Experimental Group

Sources of Variation	Sum of Squares	Df	Mean Square	F	Sig.	Decision
Between Groups	195.201	1	195.201	1.618	.008	Reject H_o
Within Groups	7601.352	63	120.656			
Total	7796.554	64				

p<0.05

The results in Table 5 shows F(1,63=1.618,p=.008),which means p<0.05. The null hypothesis was, therefore, rejected and the conclusion drawn was that there is a significant difference between the pre-test and post-test achievements of SS2 students taught waves and measurement of heat energy using CSCLS. In order words, a significant difference was observed between the pre-test and post-test achievements of students in the experimental group.

Hypothesis three

There is no significant difference between post-test achievements of SS2 male and female students who were taught waves and measurement of heat energy using CSCLS.

The results of the test on this hypothesis are presented in Table 6.

Table 6: ANOVA Results of Difference between Post-test Achievements of SS2 Male and Female Students Exposed to Waves and Measurement of Heat Energy using CSCLS

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.	Decision
Between Groups	1146.752	1	1146.752	11.484	.102	Accept H_o
Within Groups	3295.133	33	99.853			
Total	4441.886	34				

p>0.05

The findings from the ANOVA results in Table 6 reveal that F(1,33=11.484,p=.102). This implies that p>0.05; hence, the null hypothesis failed to be rejected. The study, therefore, concluded that there is no significant difference between the post-test achievements of SS2 male and female students who were taught waves and measurement of heat energy using CSCLS. These results may not be unconnected to the fact that both male and female students were exposed to the same treatment of teaching using CSCLS.

Hypothesis four

There is no significant difference between post-test achievement and retention of SS2 students who were taught waves and measurement of heat energy using CLM.

The results of the test on this hypothesis are presented in Table 7.

Table 7: ANOVA Results of Difference between Post-test Achievement and Retention of SS2 Students Exposed to Waves and Measurement of Heat Energy Using CLM

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.	Decision
Between Groups	2030.017	1	2030.017	7.351	.000	Reject H_o
Within Groups	1562.567	58	26.941			
Total	3592.583	59				

$p<0.05$

Table 7 showed that $F(1,58=7.351, p=.000)$, which implies that the null hypothesis was rejected and the conclusion was that there is a significant difference between the post-test achievement and retention of SS2 students who were taught waves and measurement of heat energy using CLM. The mean rating however, revealed that students taught physics using CLM did not retain much of the concepts taught compared to their post-test achievement mean scores. The result further implies that students taught waves and measurement of heat energy using the CLM hardly retain concepts taught.

Hypothesis five

There is no significant difference between post-test achievement and retention of SS2 students who were taught waves and measurement of heat energy using CSCLS.

The results of the test on hypothesis five are presented in Table 8.

Table 8: ANOVA Results of Differences between Post-test Achievement and Retention of SS2 Students Exposed to Waves and Measurement of Heat Energy Using CSCLS

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.	Decision
Between Groups	145.729	1	145.729	2.939	.091	Accept H_o
Within Groups	3371.543	68	49.582			
Total	3517.271	69				

$p>0.05$

The findings in Table 8 indicate that $F(1,68=2.939, p=.091)$, meaning that $p>0.05$. Based on this, the null hypothesis was not rejected and the conclusion drawn that there is no significant difference between the post-test achievement and retention of SS2 students who were taught waves and measurement of heat energy using CSCLS. In other words, students taught waves and measurement of heat energy using CSCLS retained much concepts after the treatment.

Hypothesis six

There is no significant difference between retention of SS2 male and female students exposed to waves and measurement of heat energy using CSCLS.

The results of the test on hypothesis six are presented in Table 9.

Table 9: ANOVA Results of Difference between Retention of SS2 Male and Female Students Exposed to Waves and Measurement of Heat Energy Using CSCLS

Sources of Variation	Sum of Squares	df	Mean Square	F	Sig.	Decision
Between Groups	78.867	1	78.867	4.329	.145	Accept HO
Within Groups	601.133	33	18.216			
Total	680.000	34				

$p>0.05$

The findings from the results in Table 9 indicate that F(1,33=4.329,p=.145), which implies that p>0.05. Therefore, the null hypothesis failed to be rejected and inference was drawn that there is no significant difference between the retention of SS2 male and female students taught waves and measurement of heat energy using CSCLS.

Discussion

The findings from the results of analysis of the achievements of students in waves and measurement of heat energy (Table 1) revealed that prior to treatment of teaching using circle-the-sage cooperative learning strategy (CSCLS), no much difference was observed in the mean achievement scores of the students in the experimental and control groups. Further findings, however, showed that students exposed to teaching using CSCLS achieved higher than those exposed to teaching using conventional lecture method (CLM). This signifies that the much improvement in the achievement of the students in the experimental group could be due to their exposure to the CSCLS. The findings from Table 4 showed that there was no significant differences between the pre-test achievements mean scores of students in the two groups. Table 5 further revealed a significant difference between the pre-test and post-test achievements of students who were taught waves and measurement of heat energy using CSCLS. This revelation could be attributed to the fact that students who learn using CSCLS interact with one another and therefore can learn varying concepts from one another; they can assist one another by co-constructing knowledge which enhances their understanding of concepts. This finding is in conformity with the findings of Ogunleye and Oladehin (2012) who found out that the strategy significantly affects students' achievement.

The findings from Table 2 showed that male students achieved slightly higher than female students when exposed to waves and measurement of heat energy using CSCLS. The findings from Table 6, however, revealed no significant difference between the achievements of male and female students who were taught waves and measurement of heat energy using CSCLS. The insignificant difference in their post-test achievement scores can be attributed to the fact that both students were exposed to CSCLS, which eliminates any form of gender discrimination in its activities. This finding is in discordance with the findings of Trisma and Josiah (2008), Mankilik and Mallo (2020), Samuel and Peter (3013) that female students achieve significantly higher than male students.

The findings from Table 3 showed that students exposed to waves and measurement of heat energy using CSCLS had a higher mean retention score than their counterparts who were taught using the CLM. This means that the retention of students exposed to CSCLS was much higher than that of those exposed to CLM. Although findings from Table 7 indicated a significant difference between the post-test achievement and retention of students exposed to waves and measurement of heat energy using CLM, analysis from Table 3 had earlier shown that the students' mean retention score (34.63) was much lower than their post-test mean achievement score (48.69) from Table 1. The implication of this finding is that students taught waves and measurement of heat energy using the CLM hardly retain the concepts taught. This concurs with the opinion of Ahmed and Abimbola (2011) and Umar (2011) that the persistent use of the lecture method does not promote long-term retention of concepts learnt.

The findings from Table 8 did not indicate a significant difference between the post-test achievement and retention scores of students who were taught waves and measurement of heat energy using the CSCLS. That is to say, students who were taught waves and measurement of heat energy using CSCLS retained most of what was taught. This can be attested to by the mean achievement score (53.02) from Table 1 and the mean retention score (49.26) from Table 3 of the students, the difference of which is 3.76 compared to 14.06

for the students exposed to CLM. This finding conforms to that of Tran (2014) that students exposed to cooperative learning had significant higher retention of information than their counterparts exposed to lecture method. The findings from Table 9 revealed that there was no significant difference between the retention of male and female students who were taught waves and measurement of heat energy using CSCLS. This is in line with the findings of Ajai and Imoko (2015), Eze, Ezenwafor and Obidile (2016), Umaru and Mankilik (2020) that there was no significant difference between the retention of information by male and female students. However, it can be infer that the insignificant difference in their mean retention scores may be linked to the fact that both students were exposed to the same treatment.

Conclusion

The circle-the-sage cooperative learning strategy (CSCLS) could be suitable for teaching Physics in secondary schools in Nigeria. This is because the strategy has been found to have a positive effect on secondary school students' achievement and retention in the concepts of waves and measurement of heat energy. The strategy has also been found to enhance students' achievement and retention irrespective of gender difference.

Recommendations

The following recommendations were made based on the findings of the study:

1. The use of circle-the-sage cooperative learning strategy should be encouraged in secondary schools as a method of teaching and learning of Physics, as it promotes students' achievement and retention and is not gender-biased.
2. Government and stakeholders should encourage the teaching and learning of Physics by providing enabling environment in schools which will stimulate students' achievement and retention by the use of circle-the-sage cooperative learning strategy.
3. Since circle-the-sage cooperative learning strategy relies on students with background knowledge of the content/topic to be taught in the classroom, parents should always provide and encourage their children to study their books so as to have prior knowledge of the topic to be taught in school.

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