Effects of learning together on senior school students' achievement in photosynthesis and students' gender in Offa, Nigeria

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Abstract

The poor performance of students in Biology is a concern of every teacher and has evoked research interests into learning strategies that can be used to improve the performance of students in Biology curriculum and other field of sciences. One of the fundamental qualities of a curriculum is dynamism, therefore there is need to investigate the activities that could promote Biology teaching in the secondary schools. Therefore, this study aims to examine the effects of learning together strategy on students' academic achievement in photosynthesis and students' gender. The study employs quasi-experimental design with control group for the collection of data. The population for the study composed of SSI students from Offa Local Government Area of Kwara State. The sample consisted of one hundred and seven-three students (173) that were purposely selected from four secondary schools. Data was collected through Biology Achievement Test on Photosynthesis. The researcher designed lesson plan and learning modules serves as guide for both the teachers and the students. The dependent samples t-test was used to analyze the data collected. The findings of the study revealed that learning together form of cooperative learning strategy enhanced better performance of students in Biology than the students taught using conventional method of teaching. In addition, learners expressed an increased interest, motivation and self-efficacy after exposure to learning together strategy. The study concluded that learning together form of cooperative learning strategy enhanced better performance of students in Biology. One of the recommendations therefore, is that students should be taught using learning together teaching strategy.

Keywords: Effects, Learning Together, Senior School, Students' Achievement, Photosynthesis, Students' Gender.

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Introduction

Biology plays an important role in the lives of every individual and has an increasing prominence in the scientific increments in schools. The study of Biology improved all aspects of life on earth and helps us to understand ourselves and other organisms around us. Jibril, Bello and Abimbola (2015) opined that Biology is one of the popular subjects out of the three natural science disciplines at secondary schools in Nigeria; the other ones are Chemistry and Physics. Kara (2015) defined biology as the field of science that deals with the physiochemical aspects of life. Biology according to Wikipedia (2015) was defined as a science which is concerned with the study of life and living organisms including their growth, structure, functions, distribution, taxonomy and their evolutionary trends.

Biology as a natural science subject is made up of disciplines; such as anatomy, botany, physiology, biochemistry, ecology and zoology. Some students had difficulty in learning some biological concepts such as respiration, ecology, photosynthesis, evolution and genetics which is the basis for choosing photosynthesis for this study. Aşcı, özkan & Tekkaya, (2001); Çapa (2000) reported that photosynthesis is one of the most difficult topics perceived by secondary school students. Students most probably memorize the definition and chemical formula of photosynthesis. However, photosynthesis is seen as a complex procedure which includes a number of concepts in the areas such as the anatomical, biochemical, ecological, energy change and physiological concepts that are connected with each other.

Photosynthesis as a topic in Biology curriculum is perceived by students as difficult to learn, and the reason lies in the field of nature of it concepts. Some concepts like chemical reactions, organic and inorganic molecules in chemistry subject needs to have been mastered for students to understand the chemical nature of photosynthesis. And to achieve this, teachers should use appropriate learning strategies that will help the students in better understanding of the difficult concepts in photosynthesis.

Learning strategy according to Schumaker and Deshler (2006) is an individual's approach to a task. Learning strategy includes how an individual thinks and acts when designing, performing and evaluating the performance on a task and its outcomes. Clarke (2008) opined that there are three essential components of learning strategies studied by many researchers and practitioners on how to implement the instruction which is knowledge of what the strategy really is, how to apply the strategy, and when and where to use the strategy. Effective learning strategy must discuss all three components mentioned. Varieties of learning strategies are used to help organize and remember both key elements of the learning process. Thus, there is wide range of different learning and instructional strategies researchers know in terms of number and how well we use them.

Cooperative learning strategy is a learning strategy which involves the use of small groups of students who work together to improve classroom learning and achieve shared learning goals (Liang & Gabel 2005). Agashe (2004) noted that cooperative learning strategy is a teaching method which includes students' involvement in a group where learning that stress positive interaction will take place. Effandi and Zanaton (2007) also noted that cooperative learning strategy represents a change in the educational model from teacher-centered approach to a more student-centered approach, grouping students in small team and makes good opportunities for them to involve in problem-solving with the help of their teammates. Therefore, cooperative learning strategy involves grouping of students with different learning abilities to improve others in the process of their discussion.

In the research of Esiobu (2011) and Slavin (2015), it was noted that cooperative learning strategy had lots of benefits with respect to academic achievement in many subjects, language procurement, sharing of power and authority among peers, social unity and acceptance of diversities, gender equity and decline in absenteeism. Cooperative learning helped students to work together to accomplish group goals (Zakaria & Iksan, 2007). Students encourage each member of the group during discussion of subject matter and help each other learn. Zakaria, Solfitri, Daud and Abidin (2013) noted that students should be given the chance to interact with their group members and develop abilities to share with friends the cooperative learning activity so that students' abilities in the area of cognitive and affective development of in science can be improved. Learning styles have insinuated that cooperative learning is more corresponding with the techniques that students need in real-world experiences. There are many types of cooperative learning strategies developed over the years by different scholars and which are put into practice by teachers in schools. Some common cooperative

learning techniques include Learning Together developed by David Johnson & Rogar Johnson in 1987, Students Team Achievement Division and Team Game Tournament (STAD and TGT) developed by Robert Slavin in the year 1986, Complex Instruction by Elizabeth Cohen, Think-Pair-Share by Spencer Kagan, Jigsaw developed by Elliot Aronson in 1971 and Group Investigation by Sharan & Sharan in 1976. Cooperative learning strategies vary widely in their details.

Learning together (LT) strategy was developed by David W. Johnson and Roger T. Johnson in the year 1987 at the University of Minnesota. It involves students working in a group of four-five heterogeneous groups on a given material. The groups will hand in a single completed assignment and receive marks based on the group work presented. This type of learning strategy emphasizes team-building activities and enables students to work together in a group and discuss with groups members about how well they are working together.

The most important characteristics of learning together are the existence of group goals, sharing of the opinion and materials. Division of labour and group rewards are other features of the strategy. Working in groups will bring about sharing of ideas, materials, and asking each other questions before teacher evaluate and supply group reward.

Gokkurt, Dundar, Soylu and Akgun (2012) carried out a study on the effects of learning together strategy based on cooperative learning on students' achievement in mathematics. They found out that learning together promoted better achievement of students in mathematics compared to the control group using t-test statistical analysis. They concluded that learning together brought about a significant interaction between students of the same group.

Learning together technique of cooperative learning encourages students to interact and communicate with teammates in harmony and promotes values, such as honesty, cooperation, mutual respect, responsibility, tolerance, and willing to sacrifice a consensus. Learning together technique can develop self-confidence in students (Ghazi, 2003). Ghazi (2003) investigated the effects of learning together strategy in improving English as a Foreign Language reading achievement and academic self-esteem. The researcher carried out an experimental design research with a pre-test-post-test control group experiment. The result showed a significant difference in favor of the experimental group. This showed that when learning together of cooperative and constructivist learning environment are matched together in a classroom situation, the students' achievement can be improved.

Kuri (2013) conducted an experimental study assessing the impact of cooperative learning on students' academic achievement. Learning Together was used to teach the experimental group in geography class. Data analyzed showed the effectiveness of learning together strategy in terms of academic achievement. Viann (2002) conducted a study on effects and differences in cooperative learning in mathematics classroom setting. The researcher used quasi-experimental design to compare a control group using individualized learning strategy with three treatment groups using cooperative learning strategy based on the Learning Together Strategy. The results showed no significant differences based on gender, but female students performed slightly higher than the male students.

Researchers in previous studies in science found out a clear gender gap achievement scores of students at middle school and high school (Good, Woodzicka, & Wingfield, 2010; Sanchez & Wiley, 2010). Aluko (2005) found out that some of the learning strategies used to teach in schools were gender bias while some were gender friendly. Therefore, the degree of gender-related differences in learning varied from one method of instruction to the other. Pandian (2004) also conducted a study on the effects of cooperative computer-assisted learning method on male and female students' achievement in biology. The students were selected randomly and placed into cooperative computer-assisted learning and traditional method groups. The results analyzed that gender did not have any significant influence on biology achievement. However, male and female students who were instructed through cooperative computer-assisted instruction showed remarkable significant post-test mean differences over their counterparts who were taught the same Biology concepts through traditional method. By setting up cooperative learning environment in schools, students feel safe and supported, and they are able to recognize the importance of working together as a community.

Statement of Problem

The trend of poor performances might change positively if the problem of difficulty of some Biology topics and concepts are tackled through teachers' instructional strategies. To improve meaningful learning of science subjects, teachers should use innovative learning strategy. The teaching of Biology requires an innovative strategy to make the students understand difficult concepts easily. Innovation, therefore, is something new and which is full of creativity. Learning together strategy is one of the innovative learning strategies that can facilitate the students to learn in groups (Aronson, 2016).

David and Stanley (2000) conducted a study using eight cooperative learning strategies on the effectiveness of meta-analysis. The impact of the eight cooperative learning was compared with competitive learning. In the study, it was found out that Learning Together (LT) promoted the greatest effect followed by Academic Controversy (AC), Student-team Achievement (STA), Team-Game-Tournaments (TGT), Group Investigation (GI), Jigsaw, Team Assisted Individualization (TAI) and Cooperative Integrated Reading and Composition (CIRC). When the cooperative learning strategies were compared with individualistic learning, LT promotes the most effective learning activities, followed by AC, GI, TGT, TAI, STA, jigsaw and CIRC in that order.

Freedman (2002) carried out a similar study on the influence of laboratory instruction on junior secondary school students' science performance and attitude on gender by using Student Team-Achievement Division (STAD), Jigsaw II and Learning Together instructional strategies. The result showed that both the male and female students improved in their performance and developed a favourable attitude towards mathematics with the jigsaw method. Luu (2010) investigated the effects of learning together on reading competence of 77 Vietnamese tertiary institution students over a seven weeks period. The result showed that experimental group outscored the control group on the posttest scores in reading competence. There is inconclusive evidence on the effect of learning strategies on the performance of students based on gender, hence the need for this study

Research Questions

On the basis of the purposes raised above, the following research questions were raised and answered in this study.

1. Is there any difference in the mean achievement scores of senior school students in Offa Local Government Area of Kwara State when taught photosynthesis using learning together strategy and those taught using conventional method?

2. What is the difference in the achievement of senior school students taught photosynthesis using learning together strategy based on gender?

Research Hypotheses

The following null hypotheses were raised and tested in this study:

H_{01}: There is no significant difference in the mean achievement scores of senior school students in Offa Local Government Area of Kwara State taught photosynthesis using learning together and those taught using conventional method.
H_{02}: There is no significant difference in the achievement of male and female senior school students taught photosynthesis using learning together strategy.

Methodology

A pretest, posttest, experimental and control group design was employed in this study. Two levels of independent variables were investigated (Learning Together and Control Group) and students' gender (Male and Female) were also investigated in Biology. The target population for this research was 173 SSI students

(experimental group 85, control group 88) offering Biology in Offa that were purposely selected from four co-educational schools.

Instruments

Four researcher-designed instruments were used for this study. One of such instruments is a Biology Achievement Test on Photosynthesis (BATP) which consisted of 35 multiple-choice items drawn based on the school curriculum and WASSCE and NECO syllabi to elicit response from the students. The items were modified through restructuring by three biology teachers who are WASSCE and NECO examiners.
Also, the second instrument was researcher-designed learning modules, teacher training manual and lesson plans which were prepared for the study based on the topic that served as guides for both the students and teachers respectively. Two types of lesson plans were prepared for this study. The lesson plans consisted of four lessons which were prepared for the experimental group (two lesson plans for learning together and two other lesson plans for the conventional group).

Findings

To test for the hypotheses, the data collected were analyzed using t-test using Statistical Package for Social Sciences (SPSS) version 24 at 0.05 alpha level. The results are presented based on the research hypotheses.

Research Question1: Is there any difference in the mean achievement scores of senior school students in Offa Local Government Area of Kwara State when taught photosynthesis using learning together strategy and those taught using conventional method?

The mean and standard deviation of Table 1 shows that the performance of senior school students taught photosynthesis using learning together (33.09) and conventional methods (20.52) were both improved after the treatments with learning together having higher mean gain score12.57. To further ascertain if the difference was significant, the corresponding hypothesis was tested and reported in Table 2.

Table 1. *The Mean scores of Pre-test and Post-test of Experimental Group 1 and Control Group*

Treatment	N	Pre-test		Post-test		Mean	Gain	Differences
		Mean	SD	Mean	SD			
Control	88	15.22	3.83	20.52	3.15	5.30		
								10.19
Learning together	85	17.60	4.05	33.09	3.97	15.49		

Hypothesis 1: There is no statistical significant difference in the achievement of senior school students' taught photosynthesis using learning together strategy and those taught using conventional method of teaching.

Table 2 shows the t-test analysis result of the difference in the experimental and control group. From the table t=4.93 at p<0.05, since the P-value 0.01 is less than 0.05. The result indicated that there was a significant difference between those students taught with learning together and those taught using conventional method of teaching in favor of learning together with higher mean score of 33.09 as against that of the control 20.53. Hence, hypothesis 2 is rejected.

Table 2. *The t-test Analysis of the Difference in the Achievement of those Taught with Learning together and Conventional method of teaching when Taught Photosynthesis*

Treatment	N	Mean	SD	Df	*T*	Sig.	Remark

Control	88	20.52	3.15				
				168	4.93	0.01	S
Learning-Together	85	33.09	3.97				

$p<0.05$

Research Question 2: What is the difference in the achievement of senior school students taught photosynthesis using learning together strategy based on gender?

The result from Table 3 revealed the mean scores for the male respondents with 24.44 and female respondents with 22.20 in learning together strategy. This implies that male counterparts performed better than the female counterparts with 0.64 difference.

Table 3. *The Mean Scores of Learning Together Based on Gender*

Learning Together	N	Pre-test Mean	SD	Post-Test Mean	SD	Mean Gain	Differences
Male	34	18.56	3.86	24.44	2.30	5.88	
							0.64
Female	51	16.96	4.08	22.20	4.30	5.24	

Hypothesis 2: There was no statistical significant difference in the achievement of senior school students' taught photosynthesis using learning together strategy based on gender.

Table 3 shows t-test analysis result ($t_{(83)}$=1.81; $p>0.05$) of senior school students exposed to learning together strategy when taught photosynthesis based on gender. The result indicates that there was no significant difference between the male and female respondents as the p-value
0.08 is greater than 0.05 significant levels. Therefore, the null hypothesis is not rejected.

Table 4. *The t-test Analysis of Senior School Students Taught Photosynthesis Using Learning Together Strategy Based on Gender*

Learning Together	N	Mean	SD	Df	*T*	Sig.	Remark
Male	34	24.44	2.30				
					83	1.81	0.08
Female	51	22.20	4.30				

P>0.05

Discussion

This study was conducted to investigate the effects of learning together the conventional method of teaching on senior school students' achievement based on gender. Based on hypothesis one, the findings of this study also showed that there was a significant difference in the achievement of students taught photosynthesis using learning together and those taught using conventional method of teaching. The students' performance was enhanced significantly better when taught using learning together strategy than their counterparts taught using conventional method. This could be as a result of students having access to group discussion with their teammates which increases their curiosity to learn and bring about face to face interaction that helps to facilitates mutual success among the group members.

This is in line with the work of Ghaith (2003) who reported the positive effects of learning together strategy on English achievement, academic self-esteem and feelings of school alienation while Keramati

(2009) and Kaul (2010) found that learning together strategy is more effective than traditional teaching methods. The effects of Learning together are significant on mathematics achievement between the students' learning cooperatively and students' learning conventionally. Luu (2010) found out similar report that learning together group outscored the control group on the post-test scores in reading competence. Ghazi (2003) also found out that learning together group outperformed the conventional group in improving English as a Foreign Language reading achievement and academic self-esteem. David and Stanley (2000) found out Learning Together (LT) advocated the greatest effect out of the eight cooperative learning strategies used in a meta-analysis study.

The finding from the study revealed that there was no significant difference in the achievement of male and female students who were exposed to learning together and jigsaw learning strategy. Both male and female senior school students in the experimental groups achieved almost equally. There was no wide gap in their achievement after treatment. Gender has been identified as one of the factors influencing students' achievement in sciences at senior secondary school level. Research on gender in cooperative learning strategy has been in disagreement for long this could have been as a result that cooperative learning strategies gives the learners opportunity to acquire and develop new knowledge, talents and skills, and perfects teaching-learning interactions amongst male and female students and between learners and teachers.

The study of Olson (2002) reported females performed better than male students when taught mathematics using cooperative learning which in contrary to this present work. In contrast, Aguele and Agwugah (2007), Adeyemi (2008), Kolawole (2007) and Khairulanuar, Nazre, Sairabanu, and Norasikin (2010) found gender differences in favor of male students. On the other hand, Annetta, Mangrum, Holmes, Collazo and Cheng (2009), Ajaja and Eravwoke (2010), Kost, Pollock and Finkelstein (2009), Oludipe (2010) and Yusuf and Afolabi (2010) Yusuf, Gambari and Olumorin (2012) reported that gender had no effect on academic performance of students in cooperative learning which is in line with this present study. Wachanga and Mwangi, (2004) found no significant differences in the achievement of male and female students that were exposed to cooperative learning in chemistry which is also in line with this study.

Conclusions and Recommendations

The following conclusions were drawn from the findings of the study based on the study variables.

Based on the findings of this study, it was concluded that the use of cooperative learning strategies enhanced positive students' academic achievement in biology than the conventional method of teaching. Also gender did not influence students' achievement as both are capable of competing and collaborating in the classroom activities and having the ability to create their knowledge. The study showed that learning together strategy could serve as effective approach to achieving desired learning outcomes in teaching. The use of learning strategies to teach photosynthesis in Biology curriculum was effective in the improvement of students' knowledge, understanding and academic achievement. The learning strategy brings about active learning within the students which enable them to learn how to help one another and also improve motivation through success.

Based on the findings of the study, the following recommendations were made. Learning together strategy should be used in cooperative learning classes to bridge the gap among male and students. Also, training, seminal and workshops should be organized for secondary school teachers on implementation of cooperative learning strategies so as to improve students' performance in Biology and other field of sciences such as Chemistry and Physics.

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