USING COOPERATIVE LEARNING TO ENHANCE PUPILS' UNDERSTANDING ABOUT THE SOLAR SYSTEM IN THE AGORTIME-ZIOPE DISTRICT OF GHANA

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ABSTRACT

Cooperative learning is the instructional use of small groups of learners so that they work together to maximize their own and each other's learning. This study investigated the use of cooperative learning to enhance the performance of upper primary pupils in science. A mixed method approach with a quasi-experimental design was used. The access population was upper primary pupils from Kortsrala and Takuve D/A primary schools in the Agortime-Ziope district of the Volta region of Ghana with a sample size of 32 pupils. The sample was divided into experimental and control group with each group consisting of sixteen pupils. A pre-test administered at the beginning of the study, showed that both groups had about the same entry point.

The experimental group was taught using the cooperative learning method while the control group was taught using the old-fashioned way of teaching. At the end of the four weeks treatment, both groups were post-tested. A whole class interview session was conducted with the experimental group after the post test. Post-test results showed that pupils taught with the cooperative learning approach exhibited high academic performance and thus prove that cooperative learning enhances pupil's own understanding of concepts. It also showed that using collaborative techniques such as paired or group modeling go further than simply motivating students through other verbal, coercive and independent (individual) work approaches.

Keywords: Concepts, cooperative learning, primary school, pupils, solar system.

INTRODUCTION

Education is an engine for the growth and progress of any society and its members. The purpose of education is not just to make a student literate but also to equip him with knowledge, self-sufficiency, skills and rationale thinking for a purposeful life. Thus, we have to ensure that learning becomes a process that will generate interest in pupils and motivate them to study hard so that they achieve their goals and aspirations. Education should be fun and thrilling, rather than a burden. It must be seen as an integral part of one's growth that helps one to become a good citizen. Teachers, as propellers or facilitators of education, must therefore come up with innovative and interesting teaching methods which will motivate students to acquire learning skills as they learn in groups as social beings. An effective basic method necessary for acquiring scientific knowledge is the experimental or standard laboratory work. In its absence, other innovative, easily available and cheaper interactive tools and processes such as using micro equipment (Hanson & Acquah, 2014), worksheets (Celikler, 2010) and collaborative methods (Belesanmi & Oludipe, 2012) could be employed. Allowing learners to experience science through various interactive and social processes that

support learning, could motivate and encourage them, even as specific requirements are fulfilled.

According to Ayeni (2011) teaching is a process that involves bringing about desirable changes in pupils through the use of effective methods. Ineffective teaching methods are linked to poor academic performance of many pupils (Adunola, 2011). In order for teaching methods to be effective, Adunola asserts that class teachers need to be conversant with its strategies that take cognizance of the magnitude of complexity of learning concepts to be covered.

From the researchers' observations, the process of learning is effective when it is accompanied by activities so that pupils can acquire knowledge from them, especially in social settings, rather than be asked to remember some information. According to Tortosa (2012) there is considerable evidence that lectures and merely undertaking exercises are not effective methods for learners, especially children. For meaningful learning to take place students must not only remember what they are taught but must be able to make sense of it through application. In view of that, many schools are using cooperative learning in classrooms, as it is interactive. Cooperative learning encourages pupils to debate, discuss, disagree to agree, and inadvertently teach one another in the process to enhance their learning skills. Research shows that using collaborative techniques go further than simply motivating students through other means that makes them work as individuals or independently.

Poor performance in science, limit one's chances of gaining admissions in higher institutions to pursue science related courses. This implies that, their employment prospects would become marginal, which would in turn undermine their standard of living and the prospects of contributing to the economic development of their country (Mwamwenda, 2004). The poor performance of primary pupils in the natural sciences would mean that few pupils would study pure science in secondary schools, and this could translate into fewer pupils gaining admissions into higher institutions to study science related courses. This will not be good for the Ghanaian economy as we require more technology and science professionals with the requisite skills to develop the country.

From the experiences gathered by the researchers over the years as a students, how well pupils retain science concepts can be traced back to the teaching approaches used by their teachers. Pupils at the primary level are at the concrete operational stage. Therefore, using the lecture method which is more appropriate for older students in the secondary and tertiary levels who can think abstractly is inappropriate for the pupils. Primary pupils require more concrete-based, real, practical and interactive lessons to help them conceptualize the concepts in lessons taught them. During this phase in their lives, they like to play, feel, taste, smell, handle and manipulate things, which is characteristic of their age group. However, Ghanaian pupils, especially those within the Agortime-Ziope schools are hardly engaged in science activities. Teachers do not have access to basic science equipment with which they can engage their pupils in science activities. Neither do they engage in improvising the much needed kits for use in science in their schools. They basically resort to the lecture method and teach science in the abstract. This necessitated the need for this research to be carried out in the Agortime-Ziope district of the Volta region of Ghana to investigate whether cooperative learning could enhance the academic performance of pupils in science if they could acquire scientific concepts through a more interactive and social process. It was also carried out to assess the impact of the cooperative learning on the pupils' performance in the district.
The objectives of this study were to:

1. Verify whether teachers integrate cooperative learning into teaching as an innovative tool in science in the Agortime-Ziope district of Ghana.
2. Find out pupils' conceptions about the solar system
3. Find out whether the use of cooperative learning enhances the academic performance of pupils in science in the Agortime-Ziope district.

The research questions that guided the study were:

1. What learning techniques do teachers integrate into their science lessons at the primary school level in the Agortime-Ziope district in the Volta region?
2. What are some of pupils' conceptions about the solar system?
3. To what extent would the use of cooperative learning enhance pupils' understanding about the solar system in upper primary schools in the Agortime-Ziope district?

Null Hypothesis

The null hypothesis formulated for the study was:

1. There is no significance difference in mean scores between the pupils engaged in the traditional method and their colleagues in the cooperative teaching group.

METHODOLOGY

Research Design

The quasi-experimental design was used to collect data in this study. In a quasi-experimental design, the main purpose is to determine cause and effect. Therefore the researcher does not usually randomly assign participants to evaluation groups because random assignment is not feasible (McMillan & Schumacher, 2010). A common situation for implementing quasi-experimental research involves research in which several classes or schools are used to determine the effect of teaching methods. In such a situation, it is possible to give an intervention to some of the classes and treat other classes as the control group (McMillan & Schumacher, 2010).The quasi-experimental design was considered appropriate for this study since it allowed for comparison of the experimental and control groups, manipulation of independent variables, measurement of dependent variables, use of inferential statistics and provision for maximum control of extraneous variables (McMillan & Schumacher, 2010). Items used in tests and class exercises were designed upon Bloom's cognitive taxonomy so that pupils wouldn't only express acquisition of recall of knowledge but evidence of understanding and application of concepts in extended situations. The pre- and post-tests consisted of three basic recall items, three items on comprehension of concepts/facts /procedures and four items on application, reasoning and argument. The structure for the test is simplified below:

Level 1: Basic recall (3 items)
Level 2: Comprehension of facts, concepts, and procedures (3items)
Level 3: Application, reasoning and argumentation (4 items)
Parametric t-test was used after classroom teaching for independent samples.

Population

According to McMillan and Schumacher (2010), target population refers to a group of elements or cases, whether individuals, objects, or events that conform to specific criteria to which researchers are interested in generalizing their conclusions. The target population for this study was all the primary schools in the Agotime-Ziope District. However, the accessible population was a sample of 16 pupils each from Kortsrala and Takuve primary schools which were selected using the convenience sampling technique. Two teachers who teach science in the said schools also participated in the study.

Variables of the study

In this study the variables were as follows:

1. Independent variables – Traditional teaching method and cooperative learning method.
2. Dependent variable – Academic Achievements of the pupils on the topic, 'solar systems'.

Data Collection Procedures

In this study, the researcher used pre-tests and post-tests to collect data. At the beginning of the study, pupils in both the experimental and control groups were pre tested on the topic 'solar system'. Pupils in the experimental group were taught using the cooperative learning method while pupils in the control group were taught using the traditional teaching method. At the end of the treatment which lasted for four weeks, pupils in both the experimental and control groups were tested (post-test) again using a science achievement test so as to determine the effects of the teaching strategies that were used in the study. Both the pre-test and post-tests were administered under similar conditions in both the experimental and control groups. According to Pierce (2009) data collection instrument refers to a survey, test, scale, rating or tool designed to measure the variables, characteristics or information of interest. In this study, pre-test and post-tests on the solar system were used to measure the achievement of pupils in the experimental and control groups before and after the study respectively. The test was designed by the researcher and moderated by a natural science subject specialist for its content validity. The pre-test and post-test were based on the content taught during the study, and consisted of fill-ins, true/false and multiple choice questions. The total marks allocated for the test was 20 and time duration was 20 minutes, which fell within the standard testing time for primary school level pupils. The pupils who participated in the study were also interviewed informally by means of an unstructured interview protocol (Appendix A).

To ensure the validity and reliability of the research instruments used, the researcher made sure that each item in the questionnaire related well to the topic under investigation. The draft questions were given out to the researcher's supervisor for vetting and approval and also to other scholars well vested in teaching science for review. The questionnaires were pilot tested in Atsrulume and Keyime primary schools to ensure their reliability and validity were within acceptable limits. The questionnaire items were modified after the piloting.

The two selected primary schools were randomly assigned one as experimental and the other as a control group. The schools selected were based on their proximity to the researcher. Pupils in both the experimental and control groups did not differ much in academic abilities.

The schools used in this study were far apart from each other to ensure that there would be no cross interactions between them to affect the results. In this way, the diffusion of treatment was controlled. The same pre-test and post-tests were administered to the experimental and control groups. Knowledge testing after teaching consisted of 10 tasks (scored over 20 marks). The test was a paper and pencil assessment arranged in three categories in line with Bloom's cognitive scale. Level one questions required recall, level two questions required comprehension of facts, concepts and procedure, while level three questions required application, reasoning and argument. The two teachers who participated in this study were professionally trained to teach natural sciences in primary 4 in their schools. The teacher who taught in the experimental group was trained for two weeks, prior to the study, on the implementation and assessment of cooperative learning. In this way the threat of experimenter effect on internal validity was controlled.

To test the reliability of the research instruments, pilot studies were carried out in Atsrulume and Keyime primary schools which were considered non-target schools. This aided the researcher to detect aspects of the research instrument that needed improvement before conducting the actual study. The researcher also carried out an informal observation of cooperative learning during the pilot study in order to establish the need for the research work.

Activities carried out in the Treatment and Experimental Groups

In the experimental group, pupils were divided into groups of four members. The decision to form groups of four members was based on research that suggested that groups larger than four presented problems, such as making it easier for unenthusiastic pupils to play a smaller role in group activities (Asherson, 2008). Each group consisted of a mixture of high and low ability pupils of both boys and girls. The rationale for forming heterogeneous groups was to maximize the learning capabilities of the pupils (Asherson, 2008). Pupils in the experimental groups were given orientation about cooperative learning and its importance. In addition, they were taught appropriate social skills needed for them to work effectively as a team. The taught skills included how to communicate effectively, how to help and support each other, and how to resolve conflicts amicably. The researcher then assigned pupils in each group complementary roles such as being a leader, recorder, resource manager or time keeper.

The group leader facilitated group discussions and ensured that group members' discussions were relevant to the learning task. The time keeper ensured that group members stuck to set time during group work. The recorder kept the group's self-assessment records as well as other written records while the resource manager gathered and organized materials for group activities. Complementary roles were assigned to maximize cooperation and learning (Woolfolk, 2010). Woolfolk (2010) stated that simply putting pupils in a group is not a guarantee that they would cooperate and learn.

The cooperative learning method used in this study was pupil group-achievement divisions which consisted of class presentations, groups, quizzes, individual improvement scores, and group recognition (Slavin, 2009). In the experimental group, each lesson began as a whole class instruction during which the science (class) teacher introduced the topic, outlined the learning outcomes and instructed the pupils on what to do during the lesson. Afterwards, pupils moved into their various groups to start with the group activities. Some of these activities were making of models of the solar system, writing of poems, colouring photos of the solar system as they presume them to look like in reality, giving apparent distances between them using a set scale, and watching videos of the solar system. As pupils worked in their groups, the researchers moved around to monitor how learning was taking place in the various groups. By moving around the class, the researchers and class teacher were provided with the opportunity for one-on-one explanations with pupils in their various groups.

In order to assess the various learning outcomes, tests were given to pupils. The tests consisted of 10 questions which covered the various learning tasks that pupils worked on in their groups. Group members were not allowed to help each other during the tests. As a result, individual accountability for learning was strengthened. At the end of the test sessions, the scores of the pupils within the various groups were matched and the team with the highest average scores was recognized and applauded. Time was allocated at the end of each lesson for pupils to discuss how effectively they worked with their team mates.

Control Group

The control group consisted of 16 pupils who were taught using the traditional teaching method. In this method, the teacher presented information on the topic to the whole class while pupils listened and wrote notes at the end of the lesson. Learning activities were expected to be done by pupils individually or in groups if they so wished. There were no rules on that. Neither were there any specific expectations as learning outside the school, in the homes of pupils, could not be monitored. What was obvious was that the teacher in the control school did not practice collaborative learning in class. The topic taught in the experimental and control group were the same. The treatment in the control group also lasted for a period of four weeks.

Data Analysis

Data analysis is a method of categorizing, ordering, manipulating and summarizing data to attain answers to a specific research question (De Vos, Strydom, Fouche, & Delport, 2005). The data collected from the research was analyzed with the help of statistical tools and logical techniques. According to McMillan and Schumacher (2010), t-test is used in a situation when there is a comparison between two values to see if they are different. Therefore, data was subjected to t-test analysis to find out if there was any significance difference between results obtained from the two different teaching processes applied in the study.

Ethical Concerns

Cohen, Manion and Morrison (2007) pointed out that social scientists generally have a responsibility not only to their profession in search of knowledge, but also for the subjects they depend on for their work. Therefore, it is important for the researcher to reveal fully his or her procedures of research to the subjects from the beginning. Permission was sought to embark on the research from the Education Office, the Circuit supervisor, the Head teachers of the selected schools, and the primary four (4) class teachers. In addition, the pupils were fully notified about the purpose and procedure of the study which was to cause no harm to pupils before they were asked to volunteer. They could withdraw their participation at any time without prejudice.

RESULTS AND DISCUSSIONS

The Pre-Test and Post-Test Results

The results of this study were based on pre and post-tests data collected over four weeks. Eight assessments in total were administered during this time to get a better impression of pupils' academic progression. This helped to give parallel results with no advantage bias on any side. The researcher used Statistical Package for Social Science SPSS for data analysis. Results from pupils' performance in both groups are presented in Tables. Table 1 shows a descriptive statistics of the pre-test scores of both experimental and control groups.

Table 1: Descriptive statistics of pre-test scores of experimental and control groups.

	Control Group	**Experimental Group**
	Pre-Test Scores (%)	**Pre-Test Scores (%)**
1	7	3
2	10	4
3	9	6
4	5	2
5	4	6
6	8	7
7	5	6
8	4	4
9	2	3
10	3	7
11	7	10
12	7	7
13	9	8
14	7	5
15	4	9
16	4	6
Mean	**5.94**	**5.81**

It can be observed from Table 1 that the results from the pre-tests from both the experimental and the control groups are about the same, with mean values of 5.81 and 5.94 respectively and standard deviations of 2.23 and 2.38 respectively. This implies that their entry performance points and behaviours were about the same. Assuming equal variances, a t-test confirmed very little, or almost no significance difference between the two groups ($t=0.15$; $p=0.45$). This implies that before the implementation of the treatment, there was no significant difference in performance of both groups. Their conceptual knowledge base about the solar system was poor. Some of their misconceptions about the solar system are as presented below:

Pupils' misconceptions about the solar system

1. The sun is round.
2. The sun is yellow.
3. The sun moves.
4. The sun rises in the east and sets in the west.
5. The moon is round.
6. The earth is still while the sun and moon move around it.
7. The earth does not move.
8. The moon has light and shines at night.
9. The moon is white, blue, ash.

After the four week teaching session, where the experimental group was taught through cooperative activities but the control group wasn't, there was a change in pupils' performances. They all performed creditably better than when they first engaged in this activity because they all went through a learning process. However, there was a significant difference between these improved changes. These changes are as observed in Table 2.

Table 2: Descriptive statistics of post-test of both groups.

	Control Group	Experimental Group
	Post-test Scores (%)	**Post-test Scores (%)**
1	11	7
2	13	11
3	9	14
4	4	13
5	4	14
6	8	15
7	6	13
8	14	10
9	8	9
10	6	15
11	6	16
12	5	13
13	6	16
14	9	14
15	10	17
16	6	14
Mean	**7.81**	**13.19**

It can be seen through the result from Table 2 that the experimental group scored comparatively higher marks as compared to the control group with means of 13.19 and 7.81 respectively. Analysis of answered scripts for those in control group revealed that most of their correct answers were from Level 1 (recall questions). Sometimes these answers were only partially presented. The results suggest that cooperative learning helps pupils better understand the content of the subject as it was the only added external factor in the study. The results of this study demonstrated a difference between the academic performance of the experimental and control groups. This difference may be because traditional learning does not typically allow pupils to become engaged and express their opinions. This finding supports the assertion held by Christian and Pepple (2012) that cooperative learning resulted in enhanced academic performance.

The mean score of the experimental group was higher than that of the scores obtained by pupils taught with the traditional teaching method. Therefore this result rejects the hypothesis that stated that there would be no significant difference between performances of both the control group and the experimental group. It also contradicts the opinion of Lawrence (2006) that there is no significant difference between the achievement scores of pupils in a cooperative learning group and those in the traditional learning group. The post-test scores of both groups were compared to find out if the difference between them were statistically significant. The paired sample test is presented as Table 3.

Table 2: Paired sample test of the experimental and control (Post-test)

Group	Mean	S. D.	Homogeneity of variance F	P	Test of the arithmetic mean difference T	P
Experimental	13.19	2.71	1.697	5.0×10^{-6}	-5.299	0.000
Control	7.81	3.02				

From Table 3, the two tailed P value equals 5.0×10^{-6} at 30 degrees of freedom and at a t-test value of 5.299. By conventional criteria, this difference is considered to be extremely statistically significant. These results suggest that cooperative learning has the capacity to improve pupils' academic performance.

It is important to note that meaningful learning occurs when students not only remember facts but make sense of them and are able to apply them intelligibly in different situations than what they were originally presented with. It was observed during the interview session that the pupils could identify the components of the solar system, describe the movement of the moon around the earth and identify in a more realistic manner, the positions of the Sun, Moon and Earth in the solar system. Their concepts about luminous and non-luminous bodies increased greatly. Colours suggested for painting diagrams of the bodies improved in terms of reality. The interview session further provided them with an opportunity to raise questions and attempt to solve problems that were posed by the researchers. This positively affected their attitudes and process skills. The observations made during the interview session served to confirm the superiority of the cooperative teaching method over the traditional method as the pupils in this cooperative class had become more assertive, open-minded, more investigative, curious and reflective. They also appeared willing to change their opinions in the face of plausible evidence, as had been observed during class.

Consequently, cooperative learning could be viewed as a superior approach that could benefit pupils in the Agortime-Ziope District, if implemented properly. The research regarding cooperative learning has proved that pupils benefit academically in comparison to the traditional teaching method. Subsequently, the research advocates that schools in Ghana should embrace cooperative learning so as to achieve the results stipulated in the research. This result also lends support to the claim made by Parveen and Sadia (2012) Hijazi (2003) and Marinopoulos and Stavridou (2002) among other researchers that cooperative learning can promote academic achievement.

CONCLUSIONS

Findings from the study showed that a learning environment with a presentation from the course teacher accompanied by lecture neither promotes pupils' participation nor builds the required level of reasoning among pupils in the Agortime-Ziope district. Instead, it was realised that pupils build better understanding of concepts more effectively when they are engaged to solve problems during class activities as practiced in cooperative learning. In light of the fact that learning is a process that involves investigation, formulation, reasoning and using of appropriate strategies to solve problems, cooperative learning was found to be more effective in the teaching of science at the Agortime-Ziope district in the Volta region of Ghana. This was evident from the results found from this research.

RECOMMENDATIONS

Based on the findings from the study, it is recommended that teachers in the Agortime-Ziope District should adopt the cooperative learning approach and use it to teach for conceptual understanding and retention.

Workshops should be organised by educational bodies to emphasize and enlighten teachers and science educators in particularly on the importance of the cooperative learning approach. The Agortime-Ziope District Education office of the Ghana Education Service should embark

on proactive programs targeted at incorporating or encouraging cooperative learning among basic school teachers during seminars organised by their outfit.

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Appendix A: Unstructured interview protocol for pupils

Answers were to be explained with reasons

1. The earth, sun and moon are part of the solar system.
2. The moon revolves round the earth.
3. The moon is a luminous body.
4. Artificial satellite are man-made.
5. Look at this diagram of some heavenly bodies. What colours can we use to paint them to make them real?