International Journal of Advances in Engineering and Management (IJAEM)
Volume 3, Issue 8 Aug 2021, pp: 908-914 www.ijaem.net ISSN: 2395-5252

Effect of Class wide Peer-Tutoring Strategy on Students' Mathematical Problem-Solving Achievement in Electrical Concepts in Physics

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Submitted: 01-08-2021 Revised: 10-08-2021 Accepted: 15-08-2021

ABSTRACT
This study established the Effect of Class Wide Peer-tutoring Strategy on Students' Mathematical Problem-Solving Achievement in Electricity Concepts in Physics in Chanchaga Local Government, Niger State, Nigeria. The study employed Quasi-Experimental Research Design. The target population for the study was 4707 SSSII student from seven (7) senior secondary schools in chanchaga local government area owned by Niger state government. The sample size of the study is 107 SSSII students obtained by using simple random techniques. Two research questions and two research hypotheses tested at 0.05 level of significance guided the study. The instrument used for data collection was Electricity Mathematical Problem Solving Test (EMPST) and validated by two experts. The trait test for determining the coefficient reliability, stand at 0.78 using PPMC statistics. Means was used to answer the research questions and null hypotheses were tested using t-test statistic. The result of the study indicated that Class-Wide Peer-Tutoring (CWPT) was more effective in improving student's academic achievement than the conventional teaching method, the study also revealed that CWPT is not gender bias. It was recommended among others that Mathematics and Physics teachers should endeavour to incorporate CWPT strategy into their teachings.

KEYWORDS: Peer Tutoring, Class wide Peer-tutoring, Conventional teaching method, Mathematical problem-solving achievements, Physics.

I. INTRODUCTION

Teachers of science subjects especially Mathematics and Physics at all educational levels can hardly say that it is well with teaching and learning of Mathematics and Physics. The teacher as the pivot of the teaching and learning process is expected to use measures that would be favourable for classroom activities, and create a conducive environment for meaningful interaction between teacher-students, students-students and learning contents in the classroom. This can only be achieved with innovative teaching methods. One of the innovative teaching methods that teachers of Mathematics and Physics can adopt in the present 21st century is known as Peer tutoring model [1,2]. According to scholars peer tutoring approach model is an alternative method of teaching that support learner's centre. According to [2, 3] Peer tutoring, otherwise known as peer mentoring, is an instructional method that uses paring of high-performing students to tutor lower-performing students in a class wide setting or in a common venue outside of school under the supervision of a teacher. The terms "tutoring" and "mentoring" will be used synonymously, as the role of tutor also includes maintaining a supportive and encouraging relationship with the tutee. There is sufficient research finding on the benefits of peer tutoring as a supplement to traditional instruction. Peer mentoring has been used across academic subjects, and has been found to results in improvement in academic achievement for a diversity of learners within a wide range of contents area. The strategy is effective for science education to facilitate learning without stigmatizing and alienating students [3 & 4]. When peer tutoring is well implemented in a class-wide setting, students are able to approach the curriculum at their individual learning level, using strategies tailored to individual mentees [3]. Peer tutoring promotes higher-order thinking, by explaining concepts in detail, high level questioning, and the use of supportive communication skills. Peer tutors can

assist tutees to master material previously introduced in a traditional module setting and build on their knowledge using higher-ordering thinking skills. According to [1] and [4], social self-concepts and behavioral outcomes were affected positively with the use of peer mentoring. Decrease in disruptive behavior and improvement in social interactions among culturally and developmentally diverse peers. Peer tutoring increases students' sense of internal responsibility for their achievement and improve student's ability to accept constructive feedback from tutors. Consequently, training student in peer tutoring strategies can assist student take responsibility for their learning, and their ability to recognize and accept responsibility for academic failures. There are mainly two types of peer tutoring, namely Incidental Peer Tutoring (IPT) and Structure Peer-Tutoring (SPT). Incidental peer tutoring that take place either at school or at home when they are social activities between peers. Whenever children are interacting, playing or studying and one guide the other. While, structure peer tutoring (SPT) refers to peer-tutoring implemented in specific cases and for specific subject, following a well-structured plan prepare by the teacher. Research as shown that variety of structured peer-tutoring programs are effective in teaching science subjects including Class wide peer tutoring (CWPT), Peer assisted learning strategies (PALS) and Reciprocal same-age peer-tutoring (SAPT) [4]. Successful peer-tutoring approaches may involve the use of different materials, reward systems, and reinforcement procedures, but at their core they share the following characteristics [4]. However, class wide peer tutoring (CWPT) which was adopted in this study involves dividing the entire class into groups of two to six students with different ability levels. CWPT is an instructional strategy develop to assist teachers individualize, while still providing student with ample opportunities to become actively engaged during class room activities, student then act as tutors or both tutors and tutees. CWPT involves highly structure procedures; direct rehearsal and competitive teams [1]. Effective communication and collaboration are components of CWPT and are essential to becoming a successful learner. It is primarily through dialogue and examining different perspectives that students become knowledgeable, skillful, strategic, self-determined and empathetic. Collaborative learning affords learners enormous merits not available from traditional method. Learning groups accomplishes meaningful learning and solve problems better than any individual can alone [5]. Problem solving refers to process in which the learner discovers a combination of previously learnt rules that can be applied to achieve a solution for a novel situation [6]. Problem solving is core to physics and is a complex form of learning that uses hierarchical order, simplex form process that were previously acquired [1], to visualize, imagine, manipulate analyze and associate ideas. Problem solving can be viewed as a teaching method or well integrated activity beginning with a problematical situation, and ends when the problems has been solved and the situation checked. Mathematical problem solving is also a basic skill needed by learners and is higher order cognitive process needed to solve mathematics problems when students are included in learning and participated fully, they tend to understand better and repeat the success recorded whenever they are confronted with similar or related challenges. So it is ability to apply mathematically skills and concept in different situation. As transferable skills in Physics, mathematical problem-solving actively involve students in solving computational problems with well-defined solution and in providing experience to them in solving open-ended problems [1]. Physics as a soul of science plays a vital role in all human endeavor and serves as a pre-requisite for courses such as medicine, geology, computer engineering among others [7]. Physics been one of the basic science subject taught in secondary schools, consists of many branches such as Mechanics, Oscillations and Waves, Thermodynamics, Electricity and Magnetism, light, Modern Physics and others. Physics as a course of study is problem-based owing to its Mathematical nature [8, 9 & 1]. Electricity problems in Physics fall under this category. In regards, examination bodies such as Joint Admission and Matriculation Board (JAMB), National Examination Council (NECO) and West African Examination Council (WAEC) set their questions that require Mathematical problems solving skills and largely contribute to measurable learning achievements in Physics [1]. Unfortunately, student performance in Mathematics and Physics at NECO and WAEC has not been encouraging as reported by chief examiners [7]. Questions drawn from this concept, student indicated there in ability to figure out precisely with understandings, key variable, mathematical relations, mathematical terms, formulae and translations required to arrive at the right solution. Furthermore [1, 10 & 2] observed that females that want to study sciences and related courses often complain that traditional method do not fit their learning styles. Perhaps, one possible way to improve students' achievement and

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encouraging female's participation and performance in science is to address the issue of instructional practice in educational system especially at secondary school level. Several studies such as those of [4] and [11] have shown differential performance in science subjects in secondary schools as a result of gender, while some other studies found no gender influences on achievement at the secondary school level.

Consequently, this ugly situation thus demands for developing learner's problem skill and introducing new teaching methods. This is why the class wide peer-tutoring strategy should be experimented upon in classroom instruction to examine its efficacy on students' mathematical problem-solving achievement in electrical concepts in Physics.

II. THEORETICAL BASIS FOR THE STUDY

Two sets of theories are relevant to this study: Vygotsky theory and Bandura theory. Vygotsky, a developmental theorist and researcher who worked in the 1920s, and early "30s, has influenced some of the current research of collaboration among students and teachers and on the role of cultural learning and schooling. Intellectual functioning is the product of our social history, and language is the key mode by which we learn our cultures and through which we organize our verbal thinking and regulate our actions. Children learn such higher functioning from interaction with adults and other children around them, which could be found in CWPT. The theory emphasizes the social context of learning and that knowledge is mutually built and constructed. The theory proffers' that knowledge is situated and collaborative. That is knowledge is distributed among people and environments, which include objects, artifacts, tools, books and communities in which people live. The theory is seen to be strongly linking with the present study on the basis that students will learn best as they actively construct knowledge through their social dialogue with other peers and self-regulation.

Vygotsky noted that students interacting toward a common goal tend to regulate each other's actions. He observed that when students work together on complex tasks, they assist each other in much the same way adults assist children. In such tasks, dialogue consists of mutual regulation and together, they can solve difficult problems which they cannot solve working independently [12].

Another strong proponent of social learning theory is Albert Bandura, a social psychologist of Canadian descent working in America. Bandura theory commonly referred to as observational or imitation theory is primarily based on what a child learns in his environment as he interacts and observes other. Social learning is regarded as a powerful mechanism of socialization. The child observes another person who serves as a model and then proceeds to imitate what the model does. In social learning, the child learns through listening, observing and imitating. All these are components of class wide peer-tutoring strategy and strongly linked with this research work.

Imitative learning is definitely not past of classical or operant conditioning or even cognitive learning. In social learning, imitation may occur even though the observer does not copy the model's actions immediately they occur (learning without performance) and even though he neither receives a reward himself nor seen the model receive one (learning with reinforcement).

A close examination of Bandura's propositions suggests that they are traditionally considered to be necessary components required for class wide peer-tutoring model-teaching and learning at the centre. So, the class wide peer-tutoring is in line with constructivism theory of learning that views learning as a process in which the learner actively constructs or builds new ideas or concepts [2]. The two theories are linked with this present study.

2.1 Purpose of the study

The purpose of the study was to determine the efficacy of class wide peer-tutoring (CWPT) on students' Mathematical problem-solving achievement in electrical concepts in Physics.

2.2Research Questions.

Two research questions were raised to guide this study, Viz:

1. What is the effect of class wide peer-tutoring and conventional strategies on student's mathematical problem-solving achievement in electrical concepts?
2. Will mathematical problem-solving achievement in electrical concepts of students exposed to class wide peer-tutoring strategy vary on the basis of gender?

2.3 Research hypotheses.

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

Ho_1: there is no significance difference in the mathematical problem solving achievement of students taught electricity concepts using class wide peer tutoring and conventional strategies.

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Ho_2: there is no significant difference in the mathematical problem solving achievement of male and female students taught electricity concepts using class wide peer-tutoring strategy.

III. RESEARCH METHODOLOGY

3.1 Design

The study was a quasi-experimental design that employed pretest-post test control and experimental group design. This design was considered suitable for the study because intact classes (non-randomizes groups) were assigned to the two different group in this study, i.e experimental and control group.

3.2 Population of the study.

The target population for this study consisted of 4707 SSS II students (2416 males and 2291 females) drawn from seven (7) public senior secondary schools in Chanchaga local government Area of Niger State. The reason for choosing SSS II is that the students have covered the curriculum of the subject in their SSS I they could respond to the items. Also all the public schools chosen have the same curriculum, staffing and admission policy, hence allowing for uniformity among the target participants and subject matter.

3.3 Sample and Sampling Technique.

Simple random technique was employed to select sample size of the study. Two secondary schools were randomly selected and randomly assigned to experimental and control groups. The experimental (class wide peer-tutoring) group had an intact class of 58 students (22 males and 36 females) while the control (conventional instruction) group had an intact class of 49 students (23 males and 26 females).

3.4 Research Instrument

The instrument for data collection for this study was Electricity Mathematical Problem Solving Test (EMPST) in physics constructed by the researchers. The content areas tested were: concepts of electric field, electric field intensity, and electric potential, capacitance, measurement of electric current and potential difference. The test instrument consisted of 30 multiple choice objective questions with four options (A-D). The EMPST developed by researchers is of two versions (A) and (B). EMPST (A) contained 30 test items as explained above, the EMPST (B) contained all items in A but has all its items and options reshuffled. This reshufflement is to guide against familiarization of students with and arrangement pattern. The version tagged EMPST (A) was used for pre-test while version tagged EMPST (B) was used as post-test. EMPST was validated by two experts in mathematics education section of FUT, Minna and IBB Lapai. The reliability of EMPST was determined using test-retest method and reliability coefficient of 0.78 was obtained using Pearson Product Moment Correlation Coefficient (PPMCC).

3.5 Experimental procedure

The study lasted for a period of five (5) weeks. The researchers used one (1) week intensive training programme to trained teachers who served as research assistants for the study as well as administration of the pre-test to the two groups (experimental and control groups). After which proper teaching commenced by using two different lesson plans (Peer-tutoring Lesson Plan (PTLP) and Conventional Instruction Lesson Plan (CILP)). The other weeks were used for the actual study. After the study, the reshuffled EMPST (B) was re-administered to the students. The scripts were collected immediately from the students for marking.

3.6 Data Analysis

The data collected from the administration of post-test was analyzed using mean and standard deviation to answer the research questions. The hypotheses formulated for the study was tested at .05 level of significance using t-test.

IV. RESULT OF FINDINGS

The results of the study were presented according to the research questions and hypotheses.

Research Question 1:

What is the effect of class wide peer-tutoring and conventional strategies on students' mathematical problem-solving achievement in electricity concepts?

Table1: Mean and Standard Deviation of Experimental and Control Groups

Group	N	Mean	Std-Deviation	Mean difference
Experimental	58	16.96	2.27	4.45
Control	49	12.51	3.43	

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The descriptive statistics presented in Table 1 revealed the mean scores of 16.96 and 12.51 for students in class wide peer-tutoring and those in conventional strategy respectively. While standard deviations stood at 2.27 and 3.43 respectively. The mean difference obtained was 4.45 in favour of experiment group. This result has shown that experimental group achieved more than the control group.

Research Question 2:
Will mathematics problem-solving achievement in electrical concepts of students exposed to class wide peer-tutoring strategy vary on the basis of gender?

Table 2: Mean & Standard Deviation of Male and Female Students in Experimental Group

Gender	N	Mean	Std-Deviation	Mean Difference
Male	22	17.32	2.85	
				0.54
Female	36	16.88	1.88	

The result in Table 2 shows the mean achievement scores of male and female students 17.32 and 16.88 respectively, with minimal mean difference as at 0.54 in favour of male students.

Research Hypothesis one.
There is no significant difference in the mathematical problem-solving achievement of students taught electricity concepts using class wide peer-tutoring and conventional strategies.

Table 3: Summary indpendent t-test for Experimental and Control Groups

Gender	N	df	Mean	Std-Deviation	t-value	P	Decision
Experiment	58		16.96	2.27			
		105			7.966	0.000	sig
Control	49		12.51	3.43			

The result in Table 3 shows the t-test comparison of the mean achievement scores of the experimental and control groups. The result revealed that there was a significant difference between the experimental and the control group since P is less than 0.05 level of significant. The significant difference is in favour of the experimental group implying that the students taught with class wide peer-tutoring strategy achieved better than those taught with the conventional instructional method.

Research Hypothesis Two
There is no significant difference in the mathematical problem solving achievement of male and female students taught electricity concepts using class wide peer-tutoring strategy.

Table 4: Independent t-test for Male and Female Students Experimental Group,

Gender	N	dt	Mean	Std-Deviation	t-value	P	Division
Male		22	17.32	2.85			
		56			0.87	0.36	Not sign
Female	36		16.78	1.88			

From Table 4 above P-value is greater than 0.05 level of significant, therefore the stated hypothesis is accepted which means there is no significant difference between the mean achievement scores of male and female taught electricity concepts using class wide peer-tutoring strategy.

V. DISCUSSION OF FINDINGS

This study reveals that class wide peer-tutoring strategy is effective than the conventional method with respect to improving students' mathematical problem-solving achievement in electricity concepts in physics in Chanchaga local government area, Niger State. Thus the hypothesis which states that there is no significant difference on students' mathematical problem-solving achievement when taught electricity concepts using class wide a peer-tutoring and conventional strategy was rejected. This finding is in line with the study of [1], [10], [4], and [2]. This is in line with the perception of [4] that class wide peer-tutoring has been used across academic subjects, and has been found to result in improving academic achievement for a diversity of learning and a wide

range of content area. Overall, class wide peer-tutoring in science subjects is most effective in improving academic performance because students are engaged in a thinking curriculum, everyone learns from everyone else, and no student is deprived of this opportunity for making contributions and appreciating the contributions of others. The teacher is a mediator, as knowledge and authority are shared among teachers and students; the role of the teacher increasing emphasizes mediated learning. Successful mediation assists connect new information to their experiences and to learning in other areas, help students figure out what to do when they are stumped, and help them learn how to learn. Above all, the teacher as mediator adjusts the level of information and support so as to maximize the ability to take responsibility for learning [1 & 4].

Furthermore, the study upheld the hypothesis which states that there is no significant difference in the mathematical problem-solving achievement of male and female students taught electricity concepts using class wide peer-tutoring strategy. Class wide peer-tutoring strategy had no gender bias with respect to improving students' mathematical problem-solving achievement in electricity concepts in physics; that is CWPT did not favour male over female or vice versa. This is in agreement with studies of [1] and [2]. These findings supported the reports by [3] and [4] that CWPT can be an effective strategy for educators to differentiate learning without stigmatizing and alienating students. CWPT gives equal opportunities to all learners to interact, share ideas and arrive on common goal. CWPT increases students' sense of internal responsibility for their achievement, and improve students' ability to accept constructive feedback from tutors and adults.

VI. CONCLUSION

It was observed during this study that social, self-concept, and behavioral outcomes were affected positively with the use of CWPT strategy. Additionally, researchers found a significant positive relationship between social and self-concept outcomes and academic achievement. Decreases in disruptive behavior [10] and improvements in social interactions among cultural and developmental diverse peers are also noted outcomes of CWPT strategy [1 & 4].

RECOMMENDATIONS

Based on the findings, the following recommendations are made:

1. Seminars and workshops should be organized for mathematics and physics teachers to educate them on the usage of CWPT strategy.
2. CWPT strategy should be incorporated into mathematics, physics curriculum and text books by curriculum planners and authors of text books.
3. Mathematics and physics teachers should be encouraged to adopt CWPT strategy in the teaching of electricity concept and mathematical problem-solving.

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