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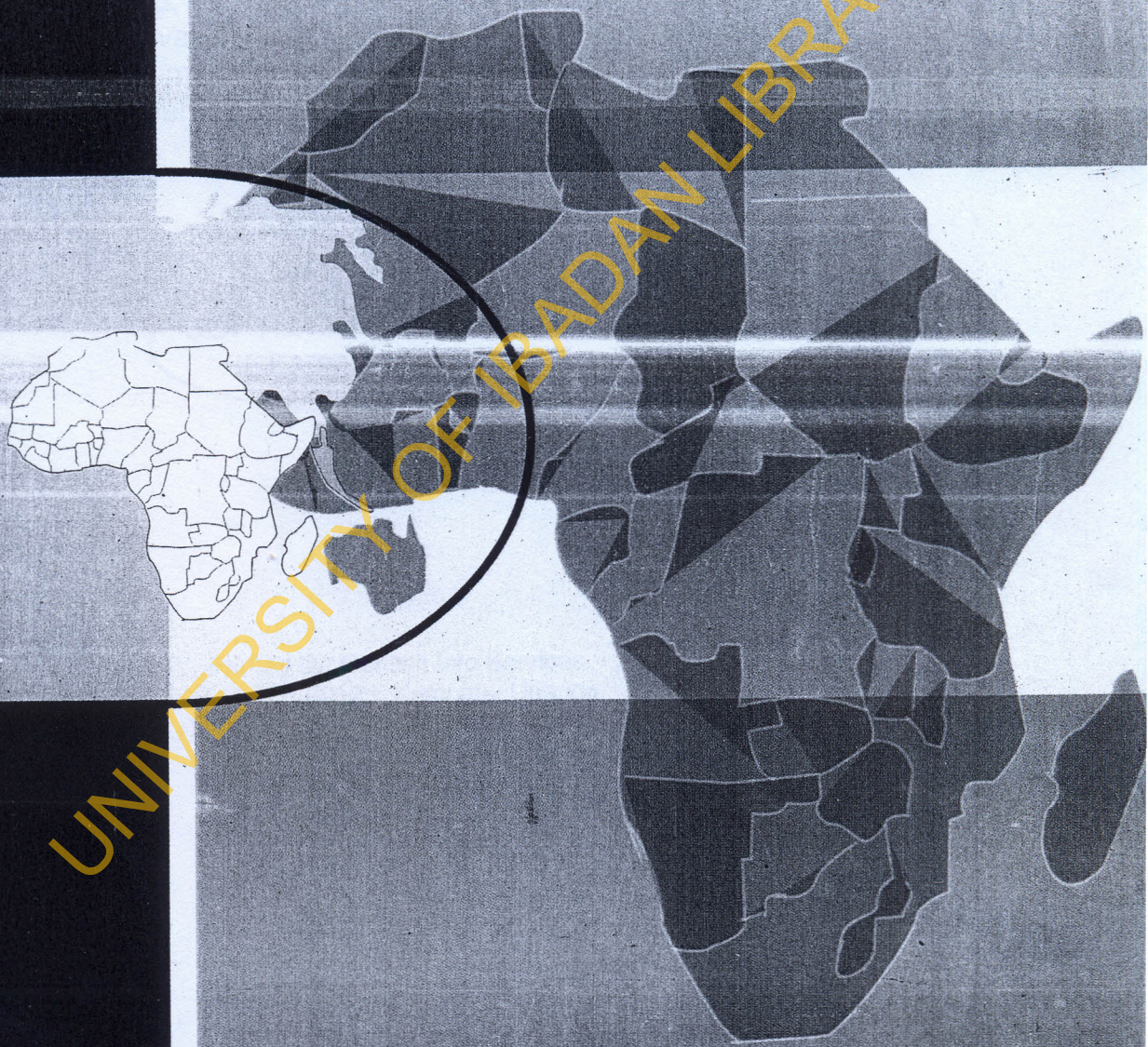

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Effect of Peer Tutoring Instruction on Students' Achievement in Some Physics Concepts: A Study in School Effectiveness

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Abstract

Without the knowledge of physics, discovery of hydro-electric power, gas turbine, thermo-nuclear power plant, submarine, aeroplane, jet fighter, intercontinental ballistic missile, x-ray in the treatment of cancer, constructions of telephone, ICT, diodes, valves, rectifiers, amplifiers, integrated and logic circuits which are widely used in electronic systems and computers would have been impossible. Unfortunately, students are not registering for physics and those who register are not performing well in the subject. Many attempts were made to correct the abnormality; yet, the desired outcomes have not been achieved, probably because there are no enough physics teachers in schools. Therefore, this study is designed to find the effect of peer tutoring instruction on students' achievement in some physics concepts. It also examined the main effect of physics ability and their interaction effects on students' knowledge of the selected physics concepts. A 2x2 quasi-experimental, pre-test, post-test, control group factorial design was used for the study. The samples used in this study were 161 SS1 Physics students selected from four stratified randomly selected secondary schools in Ibadan Municipal. Data obtained were analyzed using mean, standard deviation and Analysis of Covariance (ANCOVA). The results show that students in the peer tutoring instruction performed better in physics achievement test than their counterparts in the control group. Students with high mathematical ability performed better than their counterparts with low mathematical ability. Therefore, for effective teaching, learning, understanding and mastering physics concepts, the use of peer-tutoring is recommended for the physics teachers and students.

Key words: Peer Tutoring, Students' Achievement, Physics Concepts, School Effectiveness

Word count: 241

Introduction

Physics is one of the basic sciences in the school curriculum (FRN, 2004). It is a vehicle for achieving the long-term goals for the study of science because physics is instrumental to technological and socio-economic growth across the globe. The knowledge of physics contributed immensely to the discovery of hydro-electric power, gas turbine, thermo-nuclear power plant, submarine, aeroplane, jet fighter, intercontinental ballistic missile, x-ray in the treatment of cancer. The principles of physics are employed in the constructions of telephone, Information and Communication Technology (ICT), vehicles – cars, ship, etc. The principles of semi-conductor devices led to the developments of diodes, valves, rectifiers, amplifiers, integrated and logic circuits which are widely used in electronic systems and computers. Without the knowledge of physics, superstitions and ignorance would have been the order of the day (Okoronka, 2004).

Although, the importance of physics cannot be enumerated one after the other, the problem faced in physics education can be described as a two dimensional one (length and breath representing quantity and quality respectively). The quantity dimension is evident in the low enrolment pattern of students in the subject, although, the enrolment pattern in the subject does not assume any particular pattern (rising some years and falling in some other years) but the consistent pattern is that not many students register for the subject (Farombi, 1998). The second dimension – quality, is the students' achievement in physics which has constantly become a source of worry to government, teachers, parents and students themselves (Adewale, 2002). WAEC Chief Examiners' (1998, 2002 and 2006) reports show that candidates' achievement in physics is generally poor. If this situation is to be stemmed, then teachers have an important role to play.

Teacher has been recognized as an indispensable human resource, and in fact, the single most important element in the school system, more important than the quality and quantity of equipment and materials or the level of financing (Bowels, 1970). School effectiveness research pays high premium on teachers as the only workforce that can produce quality instruction. The teacher and his role are perceived so important that provost of a College of Education, who was justifying the hiring of a particular lecturer in Chemistry who was known to be useless, said that "... I had to recruit just anybody. I would not have minded having a dummy standing in front of the students to assure them that they had a teacher" (Obanya, 1982). This claim is important because the presence of professionally teacher is linked with students' learning outcome (Haycock, 2005). Obanya's (1982) assertion was buttressed by Hallak (1990) and Farombi's (1998) summation that the quality of the educational system depends on the quality of its teachers and the number of hours devoted to teaching. The Nigerian Government, being aware of the vital role teachers' play in a nation's educational system indicates in the policy document on education (FGN, 2004) that no educational system can rise above the quality of its teachers and as such, teacher education will continue to be allowed a major emphasis in all the government educational planning. The assertion corroborates the views Manson (1981), who observed that teachers are very vital in any educational system, as they are the ones who interpret the aims, goals and plans of education and also ensure that children are educated in the direction of those aims and goals. He advises that this important work force should be available in sufficient number so as to be able to cope with constant increase in enrolment at different levels and in addition, they should be adequately trained. As important as teachers are, Farombi (1998) found that teachers are limited in the Nigerian schools. The situation is even critical with respect to physics teachers.

Apart from the fact that there exists the dearth of physics teachers, teachers' attitude to teaching is negatively significantly related to students' achievement (NAEP, 2007). Attitudes of the teacher, either positive or negative, have been documented by many researchers to have significant

influence on students' achievement in school subjects (Obanya, 2002; Farombi, 1998; Aghadiuno, 1992 and Okpala, 1985). Generally, in Nigeria, teachers have negative attitude to teaching this invariably affects their teaching and impacts on students' learning and achievement negatively. The combination of dearth of teacher in Nigeria secondary schools and teachers' negative disposition to teaching necessitate an alternative way of teaching school subject like physics. Although, teacher cannot be completely eradicated in a school setting but they can serve as facilitators where students are used as teachers (peer tutoring) in the classroom.

Peer tutoring is the process by which a pupil, with guidance from a teacher, helps one or more students at the same grade level learn a skill or concept. Many benefits of peer tutoring programs include: learning of academic skills, establishment of a rapport with the tutee in a way that a teacher cannot, development of appropriate social skills, and enhancement of peer relations. Peer tutoring programs can help students who have equal but different expertise or students who have more skills or ability and who teach others who are less skilled. The students work together to achieve common goals and work to achieve mastery of the prescribed tasks by sharing ideas of how best to accomplish the tasks. A peer tutor is anyone who is of a similar status as the person being tutored. Peer tutoring is usually considered less threatening and intimidating. Because the peer tutor is seen by the tutee as being more at their own level, advice given by the peer tutor may be accepted more readily than advice from a teacher. Another key reason for this is that a peer tutor does not give any grade on the paper, whereas a teacher serving in a tutor role may still be perceived as someone who grades papers. ("http://en.wikipedia.org/wiki/Peer_tutor, 2008"). Peer-tutoring is a powerful educational tool if well organized by professional.

Studies have revealed that peer tutoring could be a single instructional strategy that shows great promise for meeting the complex academic needs of students (Bruffree, 1978). The reports on studies which

assessed the effect of peer tutoring on academic achievement of college students have also demonstrated that this instructional strategy benefits both the students being tutored, although the tutor is associated with greater cognitive gains than the student being taught (Bargh an Schul 1980; Lambiotte et al, 1987).

A Based on the assumption that candidates who performed well in mathematics would surely perform well in physics, another variable considered in this study was the student mathematical ability. This claim is based on the fact that the manipulation of figures has its practical application in the field of physics. Most physics topics are mathematically oriented. Ogunsulire (1977) finds that physics, apart from being an intellectually stimulation discipline, is a corner stone in nearly every field in education. Mathematical ability has also been shown to influence students' achievement (Emeke & Adegoke, 2001, Adu, 2002). Adu (2002) tests the influence of mathematical ability and gender among other independent variables on students' academic achievement in Economics and his study found a significant influence of mathematical ability on students' academic achievement. Emeke and Adegoke (2001) examine the effect of test response mode, students' mathematical ability and gender on the cognitive achievement of senior secondary school mathematics students. The study of Farombi (1988) reveales that the higher the mathematical ability of students the better their achievement in the physics achievement test. This may be expected in the sense that physics is quantitative in nature. Therefore, students with high mathematical skills are likely to record higher achievement in physics achievement test than their counterparts with low mathematical ability.

This study on peer tutoring in physics is hinged on school effectiveness. Almost every society assigns many of its instructional tasks (teaching students to read, write, physics and so forth) to schools. If children are to achieve levels of productivity, citizenship, and personal comfort that exceed the parents' own, they will have to be better educated. Much of that improved education must be provided in schools through a teacher's guidance. Therefore, schools must become more effective to be able to

carry out these functions (Owen, 2004). Basic definition of school effectiveness by Stoll and Mortimore (1997) is the production of a desired result or learning outcome. It is clear from research literature that the quality of teaching is at the heart of effective schooling. This quality teaching can be achieved through peer tutoring as considered in this study.

Statement of the Problem

This study investigated the optional utilization of human resources (students) in facilitating effective learning of some selected secondary school physics concepts. Specifically, the study attempted to determine whether there will be any difference in the achievement of the selected concepts between students exposed to the two teaching conditions. Furthermore, the study also investigated the interaction influence, if any, of mathematical ability of students and the treatment on students' achievement in physics. Three hypotheses postulated were:

HO1: There will be no significant main effect of treatment (peer-tutoring and conventional) on mean post-test students achievement in some physics concepts.

HO2: There will be no significant main effect of students' mathematical ability (low and high) on their mean post- test achievement in some physics concepts.

HO3: There will be no significant interaction effect of treatment and students' mathematical ability on their mean post- test achievement in some physics concepts.

Methodology

The study adopted quasi experimental design with pre test – post test control group. Two treatment groups were used (the experimental group and the control group). The students in experimental group were assigned to the peer-tutoring instruction while the students in the control group

were exposed to the conventional instruction and the same topics were taught to both groups. The moderating variable was the students' mathematical ability at two levels (high and low). The dependent variable was the students' achievement in physics.

The target population of the study comprised the Senior Secondary School physics year one students in Ibadan municipal. Three Local Government Areas (LGAs) out of 5 were randomly selected to participate in the study. For schools to qualify to participate in the study the following criteria were set: (i) they had 35 or more physics student in SS1 class: and (ii) they had at last a full–time physics teacher at the SS1 class. Out of the 20 schools that satisfied the conditions, six (two fro each of the three selected LGAs) were randomly selected to participate in the study. An arm of the Senior Secondary School one (SSS 1) was randomly (where there are more than one arm for science) chosen with all the students (intact classes) as the samples. One school in a LGA was randomly assigned to the experimental group and the second school in the LGA was assigned to the control group. The same process was repeated in the remaining two LGAs. Samples for the study were 161 senior secondary students drawn from the six randomly selected secondary schools in the three LGAs.

The instruments used for this study were classified into two, the response instruments and the stimulus instruments. The response instruments are two – Physics Achievement Test (PAT) and Mathematical Ability Test (MAT). PAT is a thirty question constructed under density, relative density, thermal expansion and process of heat transfer. These are topics in the SSS 1 Physics syllabus. The choice of these topics was based on the fact that some of the students in the four schools expressed that the topics were difficult to understand. The test items were in form of multiple choice items with 4 options A to D from which the students were to choose the correct option. The thirty items were picked from a pool of 200 items developed and validated by Farombi (1990) after they had been exposed to face, content and empirical validations. Some of the items were wrongly worded, and corrections were made on them. This

instrument was revalidated on students from Ibadan south East Local Government Area by the researcher and item analysis was carried out. Some items had very low facility indices (too difficult items) and some of the items had very high facility indices (too easy items). The too difficult and too easy items were removed to get the thirty items used for this study. The thirty items had facility indices ranging from 0.2 to 0.6 as suggested by Thorndike (1997) with a reliability co-efficient of 0.78 using Kuder – Richardson formula 20 (which according to Thorndike (1979) is appropriate for reflecting the internal consistency of dichotomously scored item).

Table 1: Table of Specification for Physics Achievement Test

Content	Level of Cognitive Operation			Total
	Knowledge	Comprehension	Application	
Density	4	1	2	7
Relative density	2	2	2	6
Thermal expansion	4	3	2	9
Process of heat transfer	3	3	2	8
Total	**13**	**9**	**8**	**30**

Since mathematics is the language in which Physics is expressed (Farombi, 1988), mathematical topics encountered in the Physics concepts were listed, such as fractions; substitution or change of subject. These topics formed the mathematical ability test. MAT is a twenty-five multiple choice items with 4 options A to D from which the students were to choose the correct option. These twenty-five items were selected from a pool of 200 items developed and validated by Onwuapka (1990). This instrument was revalidated on students from Ibadan South East Local Government Area by the researchers with a reliability coefficient of 0.81 using Kuder-Richardson formula 20.

Data Collection Procedure

After the due process of determining the sampling frame, and selecting the participating schools, arrangement were made with principal of the

selected schools as well as the teachers on the procedure of the study. The teachers facilitated contact with their student, thereafter, discussions were held with the students on the importance of the research and what they were to gain from the research.

PAT and MAT were administered on the experimental and control groups prior to the instruction. The scores obtained after administering PAT served as pre-test while the scores from MAT was used to classify the students into high and low ability groups. The students who scored below the mean score in MAT are classified as low ability students while those whose scores range between mean score and above were classified as high ability students. The students in the two groups – the experimental group with the use of peer-tutoring strategy and the control group with the use of conventional method were taught the 4 concepts in SSS 1 physics for six weeks.

Data Analysis Procedure

Three sets of data were collected- the mathematical ability test scores and scores on the pre and post Physics achievement test. The mathematical ability test contained 25 items. The scores on them were converted into percentages and those students who scored 50% and above were categorized as high mathematical ability group while those who scored below 50% were categorised as low mathematical ability group.

At the end of the six weeks, the post test achievement test in Physics was administered on the two groups. A two-way Analysis of Covariance (ANCOVA) was used to analyze the data obtained. Normally, one would have used a t-test analysis to compare the experimental and control groups; and at the same time use t-test to compare low and high mathematical ability students, but the researcher is also interested in interaction effect. Moreover, ANCOVA was used to remove initial differences between the students in the experimental and control groups.

A Multiple Classification Analysis was also employed to show the strength of differences in the treatment and mathematical ability groups.

Treatment Procedure

The participating teachers were given a short training on the use of the peer- tutoring Programme as put together by Ogundipe (2000). In this Programme, the teacher gave the students the topic to be taught before hand and ask them to read and master them The students then were arranged into group of 4 or 5 (depending on the class size) with one of them serving as the tutor. The teacher did not participate in the class lessons but (s)he made sure that the students were doing what they were supposed to do – (s)he served as a facilitator). In the control group, the teachers taught the identified four concepts in physics.

Results and Discussion

Hypothesis 1

There will be no significant main effect of treatment on mean post-test scores of students in some physics concepts.

The summary of the ANCOVA on this hypothesis is presented in Table 2:

Table 2 Summary of Analysis of Covariance on the Post-Test Achievement Scores of Students by Treatment and Mathematical Ability

Source of Variation	SS	Df	MS	F-ratio	Sig F
Covariance	2933.372	1	2933.372	308.386	0.000
Main Effects	12570.204	3	4190.068	440.503	0.000
Treatments	356.959	1	36.959	37.527	0.000
Mathematical Ability	400.013	1	400.013	42.052	0.000
2 Way-Interaction	212.870	2	106.435	11.190	0.000
Treatment x	212.870	2	106.435	11.190	0.000

Mathematical Ability					
Explained	12783.305	5	2556.661		0.000
Residual	1471.305	155	9.512		
Total	**14257.379**	**160**	**89.104**		

From the summary of the ANCOVA shown in Table 1, it could be observed that treatment was found to have contributed significantly to the variation in students achievement scores in physics ($F_{(1,155)}$ =37.527; P < 0.05). To obtain a better description of the achievement of the students in each of the treatments, a multiple classification analysis was carried out. This is shown in Table 3:

Table 3 Multiple Classification Analysis of the Post-Test Achievement Score of Students by Treatment and Mathematical Ability Grand Mean = 39.37

Variation +Category	N	Unadjusted Deviation	ETA	Adjusted	BETA
Treatment					
Peer-Tutoring	81	8.63		8.62	
Control	80	-8.02		-8.03	
			0.70		0.78
Mathematical Ability					
High	58	6.71		6.27	
Low	103	-6.79		-6.30	
			0.21		0.24
Multiple R^2					0.882
Multiple R					0.939

From Tables 2 and 3, the students exposed to peer-tutoring performed significantly better (39.37 +[1] 8.62 = 47.99) than those exposed to conventional strategy (39.37 + (–8.03) = 31.34). This result implies that the experimental group performed significantly better than the control group in the post test and that their performance also improved significantly after the treatment. This show that the peer-tutoring

[1] + is used for adding the grand mean and the adjusted mean deviation

instruction strategy provided a favourable effect on the experimental group and the effect leads to improvement in student's achievement in physics. The treatment accounted for 60.8% of the variance in the achievement in the physics concepts.

Hypothesis 2

There will be no significant main effect of mathematical ability of students in some physics concepts.

From the result presented in Tables 2 and 3, it could be observed that mathematical ability has significant influence on the variation of the student's test score in some physics concepts ($F_{(1,155)} = 42.052$; $P < 0.05$). Table 3 described the achievement of the 2 mathematical ability group with mathematical ability group (39.37 + 6.27 = 45.64) performing better than the low ability group (39.37 + (-6.30 = 33.07). The mathematical ability accounted for 5.8% of the variance in the achievement in the physics concepts.

Hypothesis 3

There will be no significant interaction effect of treatment and mathematical ability of students in some Physics concepts.

Table 2 shows that treatment and mathematical ability had a significant interaction effect on the test score in some physics concepts with an F-ratio of 11.190, significant at $P < 0.05$.

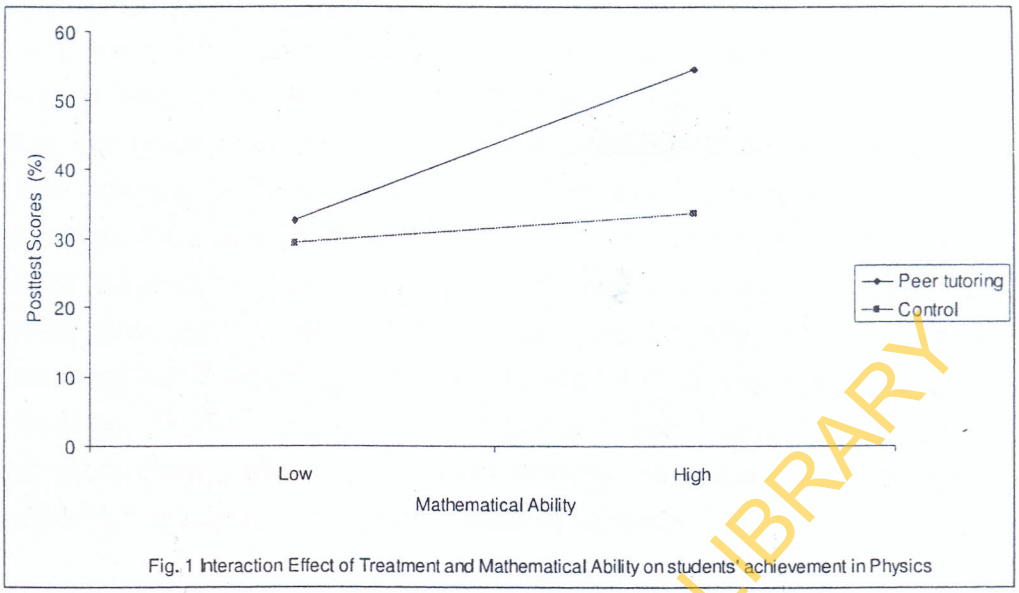

Fig. 1 Interaction Effect of Treatment and Mathematical Ability on students' achievement in Physics

Fig. 1 is an ordinant interaction effect of treatment and mathematical ability on students' achievement in physics. The figure shows that the students with high mathematical ability became better when exposed to peer-tutoring treatment than the comparable group (control) in achievement in physics. The students with low mathematical ability did not perform well in the achievement test in physics even when they were exposed to the peer-tutoring intervention. There is a little gain between students with low and high mathematical ability in their achievement in physics in the control group with high mathematical ability students having a hedge over the low ability students in physics achievement. The combination of treatments and mathematical ability accounted for 88.2% of the variance in the achievement in the physics concepts.

Discussion

The main focus of this study was to determine whether or not there would be any significant difference in the achievement of students exposed to peer tutoring and those taught in the conventional method in some Physics concepts. Students exposed to peer-tutoring instructional strategy performed better than those in the control group. This confirms the report of researchers who had been involved in the use of peer-

tutoring strategy on students' achievement with this conclusion that peer-tutoring improves students' achievements, attitudes, maximize intellectual potentials and ability to understand and solve real life problems. This finding has given further empirical support to the finding on the usefulness of per tutoring learning programme over the conventional method (Ogundipe, 2002 and Bruffree, 1978). The result from this study indicates the clear superiority of peer tutoring learning programme in teaching some Physics concepts to students because peer-tutoring is a powerful educational tool if well organized by professional (Topping, 1987). Studies of Bruffree, (1978) and Bargh and Schul (1980) revealed that peer tutoring could be a single instructional strategy that shows great promise for meeting the complex academic needs of students.

The study also reveals that students with high mathematical ability perform better than those with low mathematical ability in the Physics concepts. The result is not a puzzling one because Physics is quantitative in nature, so, students with high mathematical skills are expected to return higher scores in Physics achievement test than their counterparts with low mathematical ability. This corroborates the study of Saayman (1991) who concludes that students' proficiency with mathematical tools and formal logic operations are the basic requirements for students studying college Physics. This is in line with Emeke and Adegoke (2001) study where they reveal that the higher the mathematical ability of students the better their performance in the mathematics achievement test. Iroegbu (1998) also shows that high mathematical ability students achieved significantly higher mean score that than either medium ability and low ability students in Physics achievement test. Mathematical ability has also been shown to influence students' achievement in other subjects in the social sciences like Economics and Geography. Adu, (2002) finds a significant influence of mathematical ability on students' academic achievement in Economics. Also, this study corroborates the findings of Falaye (2006) where she finds that students with high mathematical ability outperformed their counterparts with low mathematical ability in Geography achievement test. In addition, Eriata (1994) reports that students' performance in some

Geography courses was dependent on their mathematical abilities. According to Farombi (1988) students are likely to find it difficult to represent their ideas correctly if they do not possess enough mathematical ability needed for developing good ideas in physics concepts.

Conclusion and Recommendations

The result of this study shows that peer-tutoring is a potent interactive instructional strategy that can be used when teachers are not readily available. Peer-tutoring as an instructional strategy is less time consuming and produces immediate benefits as reflects high achievement scores for students who may find the study of physics uninteresting because it is easier to complain lack of understanding to fellow students than to the teachers. Use of peer-tutoring is likely to lead to better retention, transfer and higher future achievement because learning takes place in a relaxed environment where teachers' presence which may be a threat to students' understanding is removed. Therefore, for effective teaching, learning, understanding and mastering physics concepts, the use of peer-tutoring is being recommended for the Physics teachers and students.

The joint effects of peer-tutoring and mathematical ability yielded a stronger result. Students with high mathematical ability performed better than the students with low mathematical ability both in the experimental and control groups. However, students exposed to the peer-tutoring with high mathematical ability performed extra ordinarily in the Physics concepts achievement test. It is thus recommended that if peer-tutoring is used as an interactive instructional strategy for students with high mathematical ability, their performance will be further enhanced.

This study reveals that most physics learners have had difficulty in the subject, because of their low mathematical ability (Table 2 for every high mathematic ability students, there were 2 low mathematic ability students). Due consideration should be taken to remediate this deficiency in students with low mathematic ability. This could be done if the physics

teacher identifies mathematics topics needed to be understood by the students in teaching new concepts in physics, arrange such mathematics topics and give them out to peer-tutors to teach the rest of the students before exposing them physics concepts where mathematics lessons are required.

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