# EFFECTS OF THINK-PAIR-SHARE AND NUMBERED HEADS TOGETHER TEACHING STRATEGIES ON JUNIOR SECONDARY SCHOOL STUDENTS' ACHIEVEMENT IN MATHEMATICS IN SOUTH WEST NIGERIA

**Tella Adedeji**

**Dr. Tella Adedeji**
Teacher Education Department
Faculty of Education
University of Ibadan
E-mail: dejtell@yahoo.com
Mobile phone number: +2348037235517, +2348055676526

**Abstract**
*Mathematics is one of the core subjects both at primary and secondary school levels in Nigeria. The importance accorded to mathematics in the curriculum reflects the recognition of its vital role towards national and technological development and the role it plays in contemporary society. Despite the importance of Mathematics to societal development, it is a subject that many students dislike and fail. Therefore the issue of poor achievement of students in Mathematics has become a perennial problem in Nigeria. The persistent failure of students has remained a major concern to Mathematics educators. This calls for strategies that will create hands-on/mind-on learning activities such as Think-Pair-Share and Numbered Heads Together Teaching strategies. This study therefore determined the effect of Think-Pair-Share and Numbered Heads Together Teaching strategies on students' achievement in Mathematics. The moderating effect of mental ability and gender influence on students' achievement in Mathematics are also examined. The study adopted pretest-posttest control group quasi-experimental research design. Intact classes of JS2 comprising of 310 students from six purposively selected secondary schools in Osun west senatorial district of Osun state, Nigeria were the participants of the study. The schools were randomly assigned to treatment of Think-Pair-Share, Numbered Heads Together and conventional teaching strategies. Seven instruments were used to gather data for the study and seven null hypotheses were formulated and tested at 0.05 level of significance. Data were analysed using Analysis of Covariance and Scheffe post-hoc analysis. Treatment had significant main effect on students' achievement in Mathematics. There was no significant main effect of mental ability and gender on students' achievement, likewise two-way interaction effect. However, three-way interaction effect is significant. The study therefore recommends that Mathematics teachers in secondary schools should adopt Think-Pair-Share and Numbered Heads Together Teaching strategies for improving achievement in Mathematics. Government should retrain secondary school teachers on how to use Think-Pair-Share and Numbered Heads Together Teaching strategies. Also curriculum planners and experts in Mathematics should design curricular that are student activity-based.*

Keywords: Think-Pair-Share, Numbered Head Together learning outcomes and Mathematics.

## Introduction

Mathematics is one of the core subjects at the primary, junior and senior secondary school levels in the Nigerian educational system. The importance accorded mathematics in the curriculum

reflects the recognition of the vital role it plays in contemporary society. Mathematics is an everyday subject because it appears every day in the school timetable which is also the recognition accorded to it and lies many daily uses. Mathematics is central to intellectual discipline such as science and technology. In fact, it has been the basic strength for development of science and technology particularly in this age of computer technology but unfortunately there has been a constant rapid drop in the subject despite the important of mathematics to societal development. It is a subject that many students fear, fail and possibly dislike. The issue of poor achievement of students in mathematics has becomes a perennial problem in Nigeria.

As important as the subject, the persisted failure of Nigerian students has remained major concern to its learning. In Nigeria, the performance of students in external examinations has not been impressive. Students continue to manifest weak understanding of mathematical concepts, problem solving ability skills, generalization among others not only in external examinations, but also in classroom exercises/setting. This view is supported by West African Examinations Council chief Examiners' Report 2002-2011 on senior secondary school certificate examination results (WEAC, 2011) which recorded very low percentage passes in mathematics at credit level in those years as presented in Table 1.

**Table 1: Analysis of WASSCE in Mathematics Results of May/June 2002 – 2011 in Nigeria**

| Year | Total Enrolled for Exams | A1 - C6 Higher Passes | % Higher Passes | D7 – E8 Poor Passes | % Poor Passes | Total Failed (F9) | % Failed |
|---|---|---|---|---|---|---|---|
| 2002 | 908, 235 | 309, 409 | 34.06 | 308, 369 | 33.95 | 290, 457 | 31.98 |
| 2003 | 926, 212 | 341, 928 | 36.91 | 331, 348 | 35.11 | 229, 878 | 23.74 |
| 2004 | 832, 689 | 287, 484 | 34.52 | 244, 571 | 28.22 | 300, 134 | 34.74 |
| 2005 | 1, 054, 853 | 402, 982 | 38.20 | 276, 000 | 25.36 | 363, 005 | 3.41 |
| 2006 | 1, 181, 515 | 482, 123 | 41.73 | 366, 801 | 31.55 | 292, 560 | 25.13 |
| 2007 | 1, 249, 028 | 583, 921 | 46.75 | 333, 740 | 27.72 | 302, 764 | 24.24 |
| 2008 | 1, 292, 890 | 726, 398 | 52.27 | 302, 266 | 23.83 | 218, 618 | 17.23 |
| 2009 | 1, 373, 009 | 634, 382 | 47.04 | 344, 635 | 25.56 | 315, 738 | 23.41 |
| 2010 | 1, 306, 535 | 548, 065 | 41.95 | 363, 920 | 26.85 | 355, 382 | 27.20 |
| 2011 | 1, 508, 965 | 608, 866 | 40.40 | 474, 664 | 31.50 | 421, 412 | 27.90 |

**Source: West African Examination Council 2002 – 2011**

Table 1 gives the analysis of students' performance at the senior secondary school certificate Examinations between 2002 – 2011 in Mathematics. The table shows poor performance of students, with grades A1 – C6 recording the highest of 52.3% in 2008 and failure grade F9 reaching the peak of 34.7% in 2004. There were noticeable improvements from the year 2002 to 2008 but in 2009 to 2011. There was also noticeable decline in the performance of students with grades A1 – C6 from 47.0% to 40.4% and the failure rate increased from 23.4% to 27.9% within these years. This implies that academic performance in Mathematics education is still at deplorable condition, both in primary and secondary school examinations. Many researchers identified unfairness in school-based assessment (Grifith, 2005; Njabili, Abedi, Magesse and Kalole, 2005; Asiru, 2007), which may result from teachers' incompetency in assessment (Asiru, Kalu, Idoka and Bassey, 2007), as well as psycho-cultural factors among others as being responsible for this anomaly (West African Examination Council, 2002).

Several factors have been identified as militating against students' performance and achievement in Mathematics. One group is teachers' factors, like poor teacher preparation, shortage of qualified Mathematics teachers, teachers' limited knowledge of the subject matter, poor method of teaching and teachers' negative attitudes towards Mathematics as a subject (Adetunji, 2000; Adegoke, 2003). Another group is students' factors, like poor background, anxiety, attitudinal problems, lack of interest in Mathematics, poor self-concept, poor study habit, poor motivation, disadvantaged background, wrong techniques of solving problems, low intellectual ability, failure to adhere to examination instructions, gender factor and insufficient preparation for Mathematics examination (Ifamuyiwa, 1998; Esan, 1999). There are also problems associated with techniques of teaching Mathematics (Akinsola, 1994; Adebayo, 1995; Onabanjo, 2000; Oteyemi, 2001; Odogwu, 2002 and Ojo, 2003). Also included are school- and society-related factors such as inadequate instructional materials and inadequate relevant Mathematics textbooks. Lastly, there are governmental factors (Ogunsilire, 1997; Abimbade, 1987; Akinsola, 1999; Oyedeji, 2000). Popoola (2002) and Akinsola (1994) are unanimous in their submissions that secondary school students often show negative attitudes toward Mathematics and that such negative attitudes often result in lack of interest in the subject leading to poor learning outcomes in the Senior School Certificate Mathematics examinations.

A lot of solutions have been proffered to enhance meaningful teaching and learning of Mathematics. This study therefore suggested one of such strategies to awaken and arouse the attitude of students to learn Mathematics. The Nigerian system of education is geared towards producing students who will not only possess the capability to solve their problems that will contribute to the development of the society. Studies have revealed that teaching method and attitude of mathematics teachers have made some students loose interest and shown negative attitude to the subject. These factors contributed to the low level of students' performance in Mathematics. Practical, meaningful and creative strategies of teaching effectiveness would result in bringing the realization of the goals of Nigerian education as stated in the National Policy on Education (NPE), Federal Republic of Nigeria (FRN, 2004).

Consequently, to improve the quality of Mathematics teaching in Nigerian Secondary Schools, there is need for science educator to show concern over teacher's presentation. Classroom interactions between the teachers and learners should be examined including teachers' demonstration, and teaching strategy. However, classroom interaction is the organization and presentation of lessons in such a way that all learners are engage in active and productive work (Taiwo, 2002). Classroom interaction involves both student-student interaction and student-teacher interaction. The impact of classroom interaction system on student learning cannot be over emphasized. Students develop competency and become critical thinkers in classroom that provides opportunities for intensive, structured interaction among students.

In other words, for an interactive classroom, whether by small group or whole class discussion, teacher's role is most important because, she is the key factor in the operation. Therefore, "a teacher must be equipped with the potential require for the meaningful contribution to the developing of the curriculum for achievement of the desire learning result" (Erinosho 2008).

Cooperative learning is the umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together (Wendy, 2005). It requires a small number of students to work together on a common task, supporting and encouraging one another

to improve their learning through interdependence and cooperation with one another (Larry and Hartman, 2002). The cooperative learning groups usually comprises of two to five students in a group that allows everyone to participate in a clearly designed task (Sarah and Cassady, 2006; Wendy, 2005). Students within small groups' cooperative learning are encouraged to share ideas and materials and divide the work when appropriate to complete the task. Small group competitive learning provides students with opportunity to explore and discuss topics with peers in a Bonds-on, interactive environment (Larry and Hartman, 2002).

Researchers like Ochi and Sugie (2001) have found the results of cooperative learning to include higher self-esteem of students, more positive peer relationships including improved inter-ethnic/cross-cultural relationships and lowered levels of prejudice, and equal or higher academic achievement, compared to classrooms where students worked without cooperation (independently) or structured competitively (negative interdependence). Gillies, (2004) affirmed that students benefit academically and socially from cooperative small group learning.

There are many cooperative teaching strategies in existence but the basic characteristics and components of cooperative teaching do not change in those strategies. Amongst the numerous cooperative teaching strategies, the following eleven, according to (Roger and Mary, 2000; David and Hartman, 2002; Alebiosu, 2003; Wendy, 2005; Sarah and Cassady, 2006), have received the most prominent attention. Teams Games Tournaments (TGT), Group Investigation (GI), Constructive controversy, Numbered Heads Together, Jigsaw Procedure, Students Teams Achievement Divisions (STAD), Complex Instruction, Team Accelerated Instruction (TAI), Cooperative Structures (CS) and Learning together (LT).

Cooperative Structure strategy as well, was developed by Spencer Kagan (Nakagawa, 2000 and 2001). Many of the structures publish by him were used and improved upon by other cooperative learning specialists. Cooperative structure is based on the creation, analysis, and systematic application of structures, or content free-ways of organizing social interaction in the classroom. Structures usually involve a series of steps with prescribe behaviour at each step. An important corner stone of the approach is the distinction between "structures" and "activities" Once the teacher knows any one structure, tire teacher can easily generate an infinite number of activities, (Kagan, 2001).

The basic formula in cooperative learning structure is structure + content = activity. A cooperative learning setting that is well structured create a new engaging activity for students because the structure has the basic principles of cooperative learning. Teachers who are well versed in a variety of team structures can create skillful lessons that engage and enlighten their students. (Kagan, 2001).

The structures are flexible, powerful tools which make teaching easier and learning more engaging and successful across the range of grades and academic content area. Cooperative learning structures can be used to create equal opportunities for all students in the classroom; cooperation among students; positive interpersonal relationships; listening, turn-taking, self-expression, and other appropriate communication and social skills; critical thinking: respect for diverse persons and abilities; appreciation of various viewpoints; and consensus-building (Kagan, 2000).

Kagan (2000) believes that using the structures can help build personal character, because while students are performing the activities, they can, at the same time, practice skills, or fulfil roles,

such as leadership, helpfulness, earing, impulse control, understanding, praising, kindness, cooperation, courtesy, citizenship, and others associated with virtuous character. (Woodward, 2002).

Kagan (2001) developed roughly 200 classroom "structures", which may be thought of as steps to classroom activities. These structures stress positive interpersonal peer relationships, equality, self-esteem, and achievement. Students can work together by following the steps to the structure, using material or content selected by the students themselves or by the teacher. Example of them are; (1) 3 - Step Interview (2) Rally Robin (3) Round table (4) Rally Coach (5) Think-pair-share (6) Corners (7) Numbered-head-together (8) Pairs check (9) Stand up, hand up, pair up and so on.

However in the light of all the above cooperative learning strategies neglect of other useful cooperative strategies, the following mode of cooperative learning will be selected by the researcher for the experimentation: Think-Pair-Share, Numbered-Heads-Together among other, because they allow more active involvement of students in the teaching and learning process than other cooperative learning teaching strategies which is in line with the design of Mathematics curriculum as stated earlier.

Think-pair-share is a relatively low-risk and short collaborative learning structure. It introduces into peer interaction element of cooperative learning the idea of "what" or "think" time, which has been demonstrated to be a powerful factor in improving students' response to questions. Think-pair-share can be modified to fit any class size and any situation. Students do not have to move from their current seats, and discussion can be guided (Wendy, 2005). The method is designed to promote discussion and helps students to help each other fill in the gaps or ask questions that they may not ask publicly in class. Also, the think-pair-share structure gives all students the opportunity to dress their ideas. This is important because students start to construct their knowledge in these discussions and also find out what they do and do not know. This active process is not normally available to them during traditional lecture method. The method also enhances the students' oral communication skills as they discuss their ideas with one another. Student have the opportunity to think aloud with another student about their responses before being asked to share their thinking with at least one other student; this in turn increase their sense of involvement in classroom learning.

In Think-pair-share, the instructor poses a question to the class. The students think about the question individually and then they share with a partner. Once they have shared with their partner they then share their thoughts with a small group of 4-6 members (Naested et al., 2004). Think-pair-share according to Brodesky (2004) is an active learning strategy that engages students with materials on an individual level, in pairs, and finally as a large group. According to Gunter (2003), Think-Pair-Share consists of three steps. First, the instructor poses a prepared question and asks individuals to think (or write) about it quietly. Student share their responses verbally when paired up with someone sitting near them. Third, the teacher chooses a few pairs to briefly summarise the idea for the benefit of the entire class.

Wasler (2007), observes when used at the beginning of a lecture, a Think-Pair-Share strategy can help students organise prior knowledge and brainstorm questions. When used later in the session, the strategy can help students summarize what they're learning, apply it to novel situations, and integrate new information with what they already know. The strategy works with groups of various

sizes and can be completed in as little as two three minutes, making it ideal active learning strategy for classes in which lecture is the primary instructional method.

When students talk about their thinking, meaning is enriched and metacognitive strategies are shared (Albright and Ariail, 2005). Think-Pair-Share allows students to construct their own ideas and share them with a partner. Bromley and Modlo (1997) discuss the use of Think-Pair-Share as a cooperative learning activity. They stated that "students become more active learners as they process, evaluate and respond to oral language." Willis (2006) writes, "Students should have opportunities to interact with the information they need to learn. The goal is for them to actively discover, interpret, analyse, process, practice, and discuss the information so it will move beyond working memory." She continues to say that "strategies that can achieve these goals include partner discussions and Think-Pair-Share." Think-Pair-Share is a brain compatible learning activities which Tate (2003) refers to as strategies to promote learning. It only seems practical to implement Think-Pair-Share, it increases participation in classroom discussion ("Classroom strategies: Think-pair-share," 2010; Jones, 2006; Tate, 2003).

Numbered-Heads-Together is a cooperative strategy that offers an alternative to the competitive approach of whole-class question-answer, in which the teacher asks a question and then calls on one of the students with a raised hand. Numbered-Heads-Together is a cooperative learning strategy that holds each student accountable for learning the material. In the numbered heads together approach, students are placed in groups and each person is given a number (from one to the maximum number in each group) The teacher has students number off (e.g. 1-4), the teacher poses a question and then tells the students to "put their heads together" to develop a complete answer to the question, students "put their heads together" to figure out the answer. The teacher calls a specific number to respond as spokesperson for the group. When the teacher calls out a number, the students with that number raise their hands to respond. This structure facilitates positive interdependence, while promoting individual accountability. It also gives confidence to lower achievers because they know they will have the correct answer to give to the class.

In this activity, students benefit from the verbalization, from the opportunity to exchange differing perspectives and from the peer coaching that help high and lower achievers. By having students work together in a group, this strategy ensures that students become actively involve with the material and each members knows the answer to problems or questions asked by the teacher. Since no one knows which number will be called by the teacher, all team members must be prepared so each has a vested interest in being able to articulate the appropriate response. Those chosen randomly as spokes persons (often students who do not volunteer during a whole-class discussion) feel fearless threatened giving a team, rather than an individual answer.

This strategy is beneficial for reviewing, retrieving information that has been previously taught and integrating subject matter. Students with special needs often benefit when this strategy is used. After direct instruction of the material, the group supports each member and provides opportunities for practice, rehearsal, and discussion of content material. This is a flexible strategy that can be used on a variety of levels. The teacher may start with factual information questions and as students become more familiar with this strategy, ask questions that require analysis or synthesis of information. In Numbered-Heads-Together, student in each team are numbered. Student coach each other on the material to be mastered. Teacher poses a question and call a number at random. Only student with that number are allowed to answer and earn point for their teams.

Despite the availability of so many other methods to teach and learn, the conventional teaching method is still with us. McKeachie notes, 'The conventional teaching method is probably the oldest teaching method and still the method most widely used in universities throughout the world" (McKeachie and Svinicki, 2006, p. 57). McKeachie's statement is supported by IDEA student rating data (The IDEA Center, 2009). Instructors, when asked to identify their primary approach to the course being rated, indicated "lecture" in 58.6 percent of the 178,034 classes for which there was complete data. The second most frequently selected option was "discussion," chosen by 13.6 percent of respondents. However, when asked to identify their secondary approach, "discussion" was chosen first by 27.0 percent of the 149,687 classes for which there was complete data; "lecture" was second, at 14.9 percent.

We need to ask exactly what we mean by "lecture." Perhaps Davis's (2009, p. 148) description is applicable: "The classroom lecture is a special form of communication in which voice, gesture, movement, facial expression, and eye contact can either complement or detract from the content." In addition, "lecture" courses certainly may include question-and-answer, if not discussion, along with various media options.

Writers have argued against the effectiveness of lecturing as a teaching technique. Anderson and Krathwohl (2001), argued that lecturing is not suited for higher levels of learning: comprehension, application, analysis, synthesis, evaluation and creativity. The most serious perhaps equally limiting, in a traditional lecture, the students are mostly passive. This results in learners' attention waning quickly. If a lecture consists solely of the teacher talking, lack of student feedback can be a big problem. An added constraint is that, while the lecturer may assume students are relatively similar in important ways (rate of learning, cognitive skills, relevant background knowledge, interest in the subject matter), students may actually differ greatly in their level of understanding.

Nevertheless, this paper has examined conventional teaching strategy as a general teaching method, relying on the spoken word with emphasis on one-way communication: the teacher talks, the students listen.

In this research, mental ability was considered as one of the moderator variables. Some researchers reported that mental ability has no effect on students' achievement while some argued it. Aremu and Sangodoyin (2010) reported that mental ability has significant effect on learning while Aremu and Tella (2009) observed that mental ability has no effect. Meanwhile, Olagunju and Chukwuka (2008) found that students with mental ability performed better than their counterparts of low mental ability when exposed to moral dilemma and problem solving instructional strategies and the students exposed to the strategies are the ones with high mental abilities.

However, gender has been an issue of concern to researchers and educators due to its impact on education. It has been proven by various studies to also be a strong predictor of academic achievement in science but with difference conclusion. Some researchers observed that boys performed better than the girls and their achievement scores are significantly higher than that of girls Becker (2010). Aremu (2010) asserts that there is no relationship between achievement in Mathematics and gender. Abubakar and Ejimaaji (2010); Dimitrov (2010); Abubakar and Adegboyega (2012); Olaniyi (2009); Oduwaye (2009); found no relationship between achievement in science and gender while Akinsola and Odeyemi (2014) examined the effects of gender on students' achievement in Mathematics when exposed to Mnemonic and Prior-Knowledge instructional strategy. The result from their study showed that gender had significant

effect on students' achievement in Mathematics as male students performed better than their female counterparts. In view of this, the moderating effect of gender on students' achievement was also examined.

**Hypotheses:**
Ho1: There is no significant main effect of treatment on students' achievement in Mathematics

Ho2: There is no significant main effect of gender on students' achievement in Mathematics

Ho3: There is no significant main effect of mental ability on students' achievement in Mathematics

Ho4: There is no significant interaction effect of treatment and gender on students' achievement in Mathematics

Ho5: There is no significant interaction effect of treatment and mental ability on students' achievement in Mathematics

Ho6: There is no significant interaction effect of gender and mental ability on students' achievement in Mathematics

Ho7: There is no significant interaction effect of treatment, gender and mental ability on students' achievement in Mathematics

## Methodology

**Research Design**
A pretest-posttest, control group, quasi-experimental design, using a 3x2x3 factorial matrix was adopted for this study. The independent variable are the teaching strategy at three levels, Think-Pair-Share, Numbered-Heads-Together and Conventional teaching strategies, Mental ability at two levels (low and high) and gender at two levels (male and female). The design is reported thus:

| | | | |
|---|---|---|---|
| E1 | O1 | X1 | O2 |
| E2 | O2 | X2 | O4 |
| C | O5 | X3 | O6 |

Where;

O1 O3 – represents pretest observations for the experimental and control groups.

O2 O4 – represents posttest observations for the experimental and control groups.

X1 -- represents Think-Pair-Share cooperative strategy

X2 -- represents Numbered-Heads-Together cooperative learning strategy

X3 – represents Conventional lecture method

**Variables of the study**
The independent variable:

Is the cooperative learning strategy varied at two level and one control group:

i. Think-Pair-Share cooperative learning strategy
ii. Numbered-Heads-Together cooperative learning strategy
iii. Conventional lecture method

Moderator variables:

i. Gender (at two levels; male and female)
ii. Mental ability (at two levels; low and high)

Dependent variables:

a) Achievement in Mathematics

**Sample and Sampling Procedure**
All JS 2 students in all the secondary schools in thirty-three local government areas in Oyo state constituted the target for the population for the study.

First, the study adopted stratified random sampling technique on the basis of the geographical zones in Oyo state. There are four geographical Zones in Oyo State, viz; Ibadan, Ibarapa, Oyo and Ogbomosho. One geographical Zone was selected at random from the list. Two local government areas from the geographical zone were selected at random and were used for the study.

Three Secondary Schools were randomly selected from each of the selected local government areas. Thus, a total of six secondary schools were selected for the experiment out of all the secondary schools in the State.

The study made use of intact classes in order to avoid disruption of the normal academic programmes of the schools that were used in the study. One intact class was chosen from each school and two schools were randomly assigned to each of the two experimental and the control groups.

**Research Instruments**
Six instruments were developed by the researcher in this study to collect the relevant data. They are:

- Mathematics Achievement Test (BAT)
- Mental Ability Test (MAT)
- Teacher Instructional Guide on Think- Pair-Share Strategy (TIGTPS)
  Instructional Guide on Numbered-Heads-Together Strategy (TIGNHTS)
- Teacher Instructional Guide on Conventional Lecture strategy (TIGCLS)
- Evaluation sheet for Assessing Teachers during training (ESAT)

**Mathematics Achievement Test (MAT)**
The Mathematics Achievement Test was designed for both pretest and posttest assessment. The test contains two sections: Section A and Section B. Section A elicits on the name of the school of the participant, sex of the participant, and class of participant. -

Section B contains 30 items completion type objective test which measured the students' achievement in Mathematics. Each test item is followed by four option (A- D) from which students selected the correct answer. The test items covered the topics that were taught during the study in the three level of cognitive domain of remembering, understanding and thinking (Okpala and Onocha, 1995).

**Mental Ability Test (MAT)**

The Mental Ability Test was a multiple type objective test on simple analogy with one key and four distracters. It has two sections A and B. Section A seeks personal information on the student with respect to age, gender. Section B consisted of twenty multiple choice objective test items on analogy each test items was followed by one key and four distracters from which the students selected the correct answer.

## Findings

### Testing of Hypotheses

**Ho1:** ***There is no significant main effect of treatment on students' achievement in Mathematics***

Table 2 represents the summary of ANCOVA results on subject's posttest achievement scores.

**Table 2: ANCOVA table showing the effects of Treatment, Gender and Mental Ability on Students' Pre-Posttest Achievement**

| Source | Sum of Squares | DF | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|
| Corrected Model | 934.668 | 12 | 77.658 | 17.656 | .000 | .416 |
| Pretest Achievement in Mathematics | 283.466 | 1 | 283.466 | 64.257 | .000 | .178 |
| Main Effect: Treatment Group | 57.721 | 2 | 28.610 | 6.485 | .002* | 0.42 |
| Gender | 4.871 | 1 | 4.871 | 1.104 | .294 | .004 |
| Mental Ability | 45.550 | 1 | 45.550 | 1.798 | .181 | .006 |
| 2-way Interactions: Treatment x Gender | 8.583 | 2 | 4.291 | 0.973 | .379 | .007 |
| Treatment x Mental Ability | 14.474 | 2 | 7.237 | 1.641 | .196 | .011 |
| Gender x Mental Ability | 15.546 | 1 | 15.546 | 3.524 | .061 | .012 |
| 3-way Interactions: Treatment x Gender x Mental Ability | 40.474 | 2 | 20.489 | 4.644 | .010* | .030 |
| Error | 1310.199 | 297 | 4.411 | | | |
| Total | 2244.868 | 309 | | | | |

Table 2 revealed that there was significant main effect of treatment ($F_{(2,297)} = 6.485$, $P < .05$, $\eta^2 = .042$) on achievement. The effect size of 4.2% was fair. Therefore the null hypothesis is rejected. This means that there was a significant difference in the mean achievement scores of subjects

exposed to treatment on the basis of these findings, hypothesis l was rejected. To find out the magnitude of the mean scores of the group's performance the table 1.3 is presented as follows.

**Table 3: Estimated Marginal Means of Posttest Achievement Scores by Treatment and Control Group**

| Treatment | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| Think-Pair-Share | 13.99 | .242 | 13.890 | 14.99 |
| Numbered-Heads-Together | 11.79 | .224 | 11.17 | 12.45 |
| Conventional | 12.33 | .200 | 11.83 | 12.56 |

Table 3 revealed that students in the Think-Pair-Share treatment group had the highest adjusted posttest mean achievement scores ($\bar{x}$ =13.99) followed by the Conventional group ($\bar{x}$ = 12.33) while students in the Numbered-Heads-Together strategy group had the least adjusted mean achievement scores ($\bar{x}$ = 11.79).

Further, the source of the significant difference obtained in table 4.3 was traced using Scheffe post-hoc test.

**Table 4: Scheffe Post-hoc tests Analysis of Post-test Achievement Score according to Treatment Group**

| Treatment | N | Mean | 1. Think-Pair-Share | 2. Numbered-Heads-Together | 3. Conventional |
|---|---|---|---|---|---|
| Think-Pair-Share | 109 | 13.99 | | * | * |
| Numbered-Heads-Together | 97 | 11.79 | * | | * |
| Conventional | 104 | 12.33 | * | * | |

Pairs of group significantly different at P<.05.

The result from post-hoc analysis in Table 4 revealed that group 1 (Think-Pair-Share) was significantly different from Numbered-Heads-Together and Conventional teaching strategy in their achievement scores. Conventional was significantly different from Numbered-Heads-Together strategy in achievement scores, these revealed that the direction of increasing effect of instructional strategy (treatment) on achievement was Numbered-Heads-Together<Conventional strategy<Think-Pair-Share strategy.

**Ho2: There is no significant main effect of Gender on Students' Achievement in Mathematics**

The results from table 2 above shows that there was no significant difference between gender groups on students' achievement in Mathematics ($F_{(2,297)} = 1.104$, $P > .05$, $\eta^2 = .004$). The effect size of 0.4% was negligible. Therefore, hypothesis 2 was not rejected.

**Table 5: Estimated Marginal Means of Posttest Achievement Scores by Gender**

| Gender | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| Male | 12.69 | .23 | 12.24 | 13.14 |
| Female | 12.81 | .20 | 12.41 | 13.21 |

From table 5 female students had higher mean =12.81 while the male students had a lower mean =12.69, but the difference was not significant.

**Ho3: There is no significant main effect of Mental Ability on Students' Achievement in Mathematics**

The results from table 2 above shows that there was no significant difference between mental ability group on students' achievement in Mathematics ($F_{(1,297)} = 1.798$, $P > .05$, $\eta^2 = .006$). The effect size of 0.6% was negligible. Hence, the null hypothesis was not rejected.

**Table 6: Estimated Marginal Means of Posttest Achievement Scores by Mental ability**

| Mental Ability | Mean | Std. Error | 95% Confidence Interval | |
|---|---|---|---|---|
| | | | Lower Bound | Upper Bound |
| Low | 49.00 | .54 | 47.93 | 50.08 |
| High | 48.15 | .35 | 47.46 | 48.38 |

**Ho4a: There is no significant interaction effect of Treatment groups and Gender on Students' Achievement in Mathematics**

The results from table 2 above shows that there was no significant difference between treatment and gender group on students' achievement in Mathematics ($F_{(2,297)} = .973$, $P > .05$, $\eta^2 = .007$).The effect size of 0.7% was negligible. Hence, the null hypothesis was not rejected.

**Ho5: There is no significant interaction effect of Treatment and Mental Ability on Students' Achievement in Mathematics**

The results from table 2 above shows that there was a significant difference between treatment and mental ability on students' achievement in Mathematics ($F_{(2,297)} = 1.641$, $P > .05$, $\eta^2 = .011$). The effect size of 1.1% was negligible. Hence, the null hypothesis was not rejected.

**Ho6: There is no significant interaction effect of Gender and Mental Ability on Students' Achievement in Mathematics**

The results from table 2 above shows that there was no significant difference between gender and mental ability group on students' achievement in Mathematics ($F_{(4,305)} = 3.524$, $P > .05$, $\eta^2 = .012$). The effect size of 1.2% was negligible. Hence, the null hypothesis was not rejected.

**Ho7: There is no significant interaction effect of Treatment, Gender and Mental Ability on Students' Achievement in Mathematics**

The results from table 2 above shows that there was significant difference between treatment, gender and mental ability group on students' achievement in Mathematics ($F_{(2,297)} = 4.644$, $P < .05$, $\eta^2 = .030$). The effect size of 3.0% was fair. Hence, the null hypothesis is rejected.

## Discussion of findings

### Effect of Treatment on Students' Achievement in Mathematics

There was significant difference in the effect of treatment on student achievement of the students exposed to Think-Pair-Share and Numbered-Heads-Together as shown Table 2. This finding shows that both strategies Think-Pair-Share and Numbered-Heads- Together enhanced students' achievement over and above the Conventional Teaching Strategy. This result suggests that the Think Pair Share effectively impacted concept in Mathematics of learner exposed to it than those exposed to Conventional Teaching Strategy. These may be attributed to the nature of the Think-Pair-Share and Numbered-Heads- Together developed and implemented in the course of the study in which the learner were allowed the freedom to engage in various learning activities that enable them to construct their own knowledge of the concept selected for the study as they individually in their group used their thinking skills to recall facts, observe, collect and group objects and resources in the environment as well as defined explain and debated on issues. They also evaluated, summarized and drew conclusions on the lessons all by themselves with minimal teacher inference. These real life activities must have enormously influence and as such impact their Mathematics achievement.

This finding is in relation with the findings of research conducted by Wendy (2007), using Think-Pair- Share Learning Strategy, It was found that students' achievement scores on reading was significantly improved. According to her, Think-Pair-Share is a strategy that can be adapted to suit the learning focus and the needs of particular groups of students. This finding is supported by Jones (2001) which acknowledge the use of Think-Pair-Share in Mathematics classes as it avails students opportunity for peer tutoring, due to the importance of "other" in a social constructivist learning environment.

Numbered-Heads-Together strategy when compared with Conventional Teaching Strategy by Burcin and Leman (2007), on ninth grade students understanding of metallic bonding, the results of the students' t-test indicated that the mean score of the students in Numbered-Heads-Together group was significantly higher than the mean score of their colleagues in control group. The findings of this study support the research work of Samuel and John (2004) that students' achievement correlation highly.

Andreas (2006) confirmed the efficacy of Numbered-Heads-Together in the teaching and learning process. He explored the effectiveness of Numbered-Heads-Together approach, where students

work Together and elaborate concepts of Physics. The result indicated that Students in Numbered Heads Together group performed better than their colleagues in the control group.

The poor performance of the Conventional Teaching Strategy (control group) in the post test cognitive achievement mean score when compared with the other treatment groups' mean scores may not be unconnected with the fact that the group was taught with the method that is teacher-centred. Also, it may be as a result of inadequate practice on the part of the students which is an attribute of the Conventional Teaching Strategy. That is, the Conventional Teaching Strategy does not seem to involve students with related steps and activities which they need to go through in an attempt to accomplish a given task.

Conventional Teaching Strategy appears to only allow students to listen passively, with little or no interaction with the teacher. Thus the relatively low achievement in conventional teaching strategy group repeats itself in this study as it was the findings of Olagunju (2002) and Adesoji (2004). This is because the Conventional Teaching Strategy subjects the learners to the position of passive recipient of fact handed down to him by the teacher.

**Effects of Gender on Students Achievement in Mathematics**

The findings shown that there is no significant main effect of gender on students' achievement. Gender does not seem to influence the variations in Mathematics achievement. These findings revealed that the treatment had about equal effect on both the male and female students.

The implication is that the two instructional strategies seem to contain essential element to enhance both male and female learning outcomes in the classroom. In other words, the two instructional strategies could have given the students equal opportunity regardless of their gender differences. This finding corroborate with the research findings of Bilesanmi-Awoderu (2002), Viann (2004) and Pandian (2004) that gender did not have a significant main effect on students' achievement in Biology. Alebiosu (2006) also found no significant effect of gender on students learning outcomes in Secondary School Ecology.

These findings however differ from other gender-related research findings of Kolawole (2007), Billing (2000) and Croxford (2002) who found significant difference between the male and female subjects with regard to achievement post-test mean scores of the experimental and control groups. The reason for this result might be that the teaching strategies used by the researchers were gender biased thereby favouring one sex than the other.

However, the reason for the non significant different between male and female in the post test achievement score could be attributed to the fact that both sexes were given the same opportunity to participate actively in the process of knowledge development and acquisition which are part and parcel of the two strategies. Also the fact that trained teachers of the experimental groups make sure that both male and female students participated actively together in all the stages of the two instructional strategies without discrimination may have accounted for this equal gain in knowledge.

**Effects of Mental Ability on Students' Mathematics Achievement**

The findings revealed that there was no significant effect of mental ability on students Mathematics achievement. That is, mental ability does not influence the variation in Mathematics achievement.

Mental ability is a term used psychologically to describe the intellectual ability of individual. Students' mental ability described different manners in which student think, perceive, remember, and analyse information. Mental ability is the information processing unit which represent the learner typical modes perceiving, thinking, remembering and problem solving. Cultures provide people with a range of cognitive style that are appropriate for different mental tasks in different context. The students' responses to concept in Mathematics had no significant effect on their achievement.

This study is disagreement with the result of other researchers which have significant effect on students' achievement. Salami (2002) and Raimi (2003) have shown that students mental ability have influence on learning and retention and subsequence scholastic attainment of such learning. According to them mental ability expertise the interaction process which is characterized by the initial learning phase by enhancing efforts and readiness to learning.

**Interaction Effects of Treatment and Gender on Students Achievement in Mathematics**
Treatment and students gender had no significant interaction effect on students' achievement. This could mean that the treatment is suitable to both sexes with respect to the Mathematical concepts. It does not vary from male to female. This result agrees with the findings of Chambers and Andre (2007) that used interest as one of the dependent variables and found significant effect of gender but no gender interaction with prior knowledge, experience and interest. This result is also at variance with the result of Olaniyi (2003), who reported that there is a significant interaction effect of teaching strategy (Treatment) and gender on student's cognitive achievement in Biology.

**Interaction Effect of Treatment and Mental Ability on Students' Achievement in Mathematics**
There was no significant interaction effect of treatment and mental ability on students Mathematics achievement. This could mean that the treatment is suitable to both low and high students with respect to the Mathematical concept. This result disagrees with Olajengbesi (2006) and Awofala (2002) that the personal variable of mental ability interacts to instruction to produce results.

**Interaction Effect of Mental Ability and Gender on Students Mathematics Achievement**
The result in table 2 revealed that there was no significant interaction effect of mental ability and gender on students Mathematics achievement.

**Interaction Effect of Treatment, Gender, and Mental Ability on Students' Achievement**
The result in table 2 reveals that the 3-way interaction effect of treatment, gender and mental ability was significant on students' achievement in Mathematics. In other words, understanding and utilizing the core principles of cooperative learning strategies is influenced by students' gender (male and female) and also by their mental ability differences.

This finding negates the works of Olaitan (2006) who reports that gender is not a deciding factor in learning, it all depends on the nature of the environment where the students' studies, the teaching and learning strategy used. And also that of Casey and Young (2005) who asserted that not minding the mental ability of students, either low or high, the cooperative learning strategy interest in teachers by the students and their learning environment determines their success after evaluation.

## Recommendations and Conclusion

**Recommendations**

The following recommendations are advanced:

Think-Pair-Share and Numbered-Heads-Together cooperative learning strategies should be adapted as viable strategies for studying concept in Mathematics as they involve the students in monitoring their learning process. These are viable teaching strategies need for improving students' achievement in Mathematics. There should be organization of in service training, workshops and seminars where these innovative methods will be discussed and made practical for effective teaching and learning of Mathematics.

Teaching strategy such as Think-Pair-Share and Numbered-Heads-Together that reduced the gender difference in Mathematics as recorded in this research could be used as basis for bringing about a reduction in anxiety in learning for both male and female students. Teachers should make their lesson more of practical activities than theory as to make the students work in a cooperative manner which benefit and help in crossing and holding their interest.

## Conclusion

In a nut shell, findings of Think-Pair-Share and Numbered-Heads-Together cooperation learning strategies should be disseminated to all schools in Nigeria to encourage other teachers to consider these instructional approaches. Although, these strategies cannot cure all the problems faced by teachers in teaching and learning of Mathematical concepts, but it may serve as an alternative to traditional method of teaching. Therefore, effort should be taken now to direct presentation of Mathematics lessons away from the traditional method to a more student centred approach.

## References

Adegoke, B.A. (2000). 'Test response mode, numerical ability and gender as determinants of students' cognitive achievement in senior secondary school Physics'. Unpublished M.Ed Project, University of Ibadan.

Adesoji, F.A. (2004). 'Science and Curriculum Development'. Unpublished Ph.D Thesis, University of Ibadan.

Akinsola, M.K. and Odeyemi, E.O. (2014). 'Effect of mnemonic and prior knowledge instructional strategies on students' achievement in Mathematics'. *International Journal of Education and Research*, 2 (7): 675-217.

Albright, L.K. and Ariail, M. (2005). 'Tapping the potential of teacher read-alouds in middle schools'. *Journal of Adolescent and Adult Literacy* (48): 582-591. Retrieved from http//:dx.doi.org/10.1598/JAAL.48.7.4

Anderson, L.W. and Krathwohl, D. (2001). *A taxonomy for learning, teaching and assessing: A revision of Bloom's taxonomy of educational objectives*. New York: Longman.

Aremu, A. and Sangodoyin, A. (2010). 'Computer Animation and the Academic Achievement of Nigerian Senior Secondary School Students in Biology'. *Journal of the Research Centre for Educational Technology* (|RCET) 6 (2): 148-161.

Aremu, A. and Tella, A. (2009). 'The reaction between gender, age, mental ability, anxiety, mathematics, self-efficacy and achievement in mathematics'. *Journal of Educational sciences* (4): 113-124. Retrieved Jan. 15, 2015 from http://www.world-education-center org/index.Php/cjes.

Arigbabu, A.A and Mji, A. (2004). 'Is gender a factor in Mathematics performance among Nigerian preservice teachers?'. *Sex Role,* 51 (11&12): 749.

Awofala, A.O.A. (2002). 'Concept mapping problem-solving paradigms and achievement in secondary school mathematics'. Unpublished M.Ed Thesis, University of Ibadan.

Bilesanmi-Awoderu, J.B. (2002). 'Concept mapping, students' locus of control and gender as determinants of Nigeria high school students' achievement in Biology'. *Ife Psychological*, 10 (2): 98-110.

Billings, D. (2000). 'Women's way of knowing and the digital divide'. Presented in an interactive paper presentation.

Bromley, K. and Modlo, M. (1997). 'Using cooperative learning to improve reading and writing in language arts'. *Reading and Writing Quarterly: Overcoming Learning Difficulties*, 13 (1): 21-35.

Burcin, A. and Leman, T. (2007). 'Effect of cooperative learning strategies on students' understanding of concepts in electro-chemistry'. *International Journal of Science and Mathematics Education*, 5 (2): 349-373.

Casey and Young, M. (2005). 'Potential solution to various attitude problems in the classroom'. Cambridge University Press.

Cohen, B.P. (2003). 'From group work among children to R & D teams: interdependent, interaction and productivity'. In E.J. Lawler (Ed.). *Advances in Group Processes,* 8: 205-226.

Croxford, L. (2000). *Gender and national curricular: Shifting agendas in the UK and Europe*. London: Routledge.

Davis, B.G. (2009). *Tools for Teaching* (2nd Edition). San Francisco: Jossey-Bass.

Federal Republic of Nigeria. (2004). *National Policy on Education*. (4th Edition.) Lagos: NERDC Press.

Gunter, M.E., Estes, T.H., and Schwab, J. *(Eds.)* (2003). *Instruction: A Models Approach*. (4th Edition). Allyn and Bacon.

Gilies, R. (2004). 'The residual effect of cooperative learning experiences: a two year follow up'. *Journal of Educational Research*, 96 (1): 105-115.

Howe, S. and Rua, J. M. (2000). 'Gender differences in students' experiences, interest and attitudes toward science and scientists'. *Science Education*, 84 (2): 180-192.

Jones, R.C. (2006). 'Strategies for reading comprehension: think-pair-share'. In *Reading quest: making sense in social studies*. Retrieved from http//:www.readingquest.org/stat/tps.html.

Kagan, L. (2001). *Multiple intelligence, structures and activities*. San Clemente, CA: Kagan Publishing.

Kagan, M. (2001). *Logic line-u ps. Higher-level thinking activities*. San Clemente, CA: Kagan Publishing.

Kagan, S. (2000). 'The structural approach to character development'. In *Kagan Online Magazine*, Winter 2000.www.kaganOnline.com.

Kagan, S. (2001). 'Structures are brain based'. In *Kagan Online Magazine*, Winter 2001. www.kaganOnline.com.

Kolawole, E.B. (2007). 'Effects of competitive and cooperative learning strategies on academic performance of Nigerian students in Mathematics'. *Educational Research Review* 3 (1): 33-37.

Maitland, K.A and Goldman, J.R. (2005). 'Moral judgement as function of peer group interaction'. *Journal of Social Psychology*, 107: 117-183.

McKeachie, W.J. and Svinicki, M. (2006). *McKeachie's teaching tips*: *Strategies, research and theory for college and university teachers* (12th Edition). Boston: Houghton Mifflin.

Nakagawa, J. (2000). 'Instant student-centred reading and discussion'. *IATEFL Issues*, 155: 20-21.

Nakagawa, J. (2001). 'Writing pop song lyrics'. *The Language Teacher*, 25 (5): 31-32.

Ojo, O.J. (2003). 'Relative effects of self-regulatory and cooperative learning strategies on learning outcomes in Senior Secondary School Mathematics'. Unpublished PhD Thesis, University of Ibadan.

Ogunkola, J.B. and Bilesanmi-Awoderu, J.B. (2000). 'Effect of laboratory and lecture methods on students' achievement in Biology'. *African Journal of Education*, 5 (2): 247-260.

Okpala, N.N. and Onocha, C.O. (1995). 'Difficulties in Students Performance of Hierarchical cognitive Tasks. A function of Time to Learn'. *Journal of the Dakar UNESCO Regional Office,* No. 11.

Olajemgbesi, A. (2006). 'Effects of concept Mapping and Problem Solving on the Achievement of Senior Secondary Students in Chemistry'. Unpublished M.Ed Dissertation, Faculty of Education, University of Ibadan.

Olagunju, A.M, (2002). 'Modern Trend in Secondary School Biology Teaching'. *Teaching Strategies for Nigeria Secondary School*s. Ibadan: Powerhouse Publisher: 187-198.

Olagunju, A.M. and Chukwuka, E.V. (2008). 'Effects of moral dilemma and problem-solving strategies on students' achievement in conservation, waste management, pollution and overpopulation concepts in Biology'. *African Journal of Educational Research*, 12 (7): 55-67.

Onyeizugbo, E.U. (2003). 'Effect of gender, age and education on assertiveness in Nigerian sample'. *Psychology of Women Quarterly*, 27: 1-16.

Osborne, J., Simon, S. and Collins, S. (2003). 'Attitudes towards science: a review of the literature and its implications'. *International Journal of Science Education*, 29 (9): 1049-1079.

Raimi, S.M. (2003). 'Gender difference in acquisition of practical skills'. Unpublished paper presented at the 1st National Conference on Science, Technology and Mathematics Education. School of Science, St Andrew's College of Education, 17-20 July.

Salami, M.O. (2002). 'Students' Mental Ability and Gender as Determinants of Achievement in Chemistry Practical'. B. Ed Project, University of Ado-Ekiti.

Samuel, W.W and John, G.M. (2004). 'Effects of cooperative class experiment teaching method on secondary school students' chemistry achievement in Kenya's Nakuru District'. *International Education Journal*, 5 (1): 26-35.

Sharan, Y. and Sharan, S. (1992). *Expanding cooperative learning through group investigation*. New York: Teachers College Press.

Spall, K., Stanisstreet, M., Dickson, D. and Boyes, E. (2004). 'Development of school students' constructions of **Biology** and Physics'. *International Journal of Science Education*, 26 (7): 26-35.

Tate, M.L. (2003). 'The concept of individualised instruction: implications for science teaching in Nigeria. Journal of Staff Development, 22 (1): 46-54.

Viann, E. (2004). 'Gender differences and the effects of cooperative learning in college level mathematics'. Unpublished Ph.D. Thesis. Cartin University of Technology Meltzer.

West African Examinations Council (2002-2011). 'Chief Examiner's Reports (Nigeria) SSCE', May/June Examinations.

Wendy, B. (2005). 'Name of active learning strategy: think-pair-share'. Schreyer Institute of Teaching Excellence, Pennstate.

Wendy, D.C. (2007). 'The effects of using think-pair-share during guided reading lessons'. M Ed Thesis, University of Waikato Hamilton, New Zealand.

Willis, J. M. D. (2006). Research-based strategies to ignite student learning. Alexandria, VA: Association for Supervision and Curriculum Development.