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METHOD COMBINATION THERAPY AS INSTRUCTIONAL STRATEGY FOR TEACHING SECONDARY SCHOOL GEOMETRY AND EFFECTS ON STUDENTS' ACHIEVEMENT AND RETENTION IN MATHEMATICS

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ABSTRACT

This study investigated the effects of teachers' use of a Method Combination Therapy whose components include multiple activities and use of games as instructional strategy on secondary school students' achievement and retention of concept in geometry. Four research questions and research hypotheses guided the study. The design was quasi-experimental with a population size of 2554 Senior Secondary One (SSS1) students. The s ample size was 75 comprising 42 males and 33 females in intact classes. Four research questions and four research hypotheses guided the study. A researcher made Mathematics Performance Test (MPT) with reliability coefficient r =.87 was used for data collection using Kuder-Richardson 21 formula. Data was analyzed using Analysis of Covariance (ANOVA) and the hypotheses tested at $p \leq .05$. Findings revealed that: the Method Combination Therapy (MCT) adopted in the experiment significantly enhanced students' achievement and retention of acquired knowledge over time. Consequently, it was recommended among others that teachers in schools should adopt the MCT for the teaching of geometry in schools.

Introduction/Background

The perennial poor performance of students in Mathematics at external examinations in Nigeria is worrisome. The current situation in which students in the schools persistently score low at external or school examinations is unacceptable (Ale, 2003; Obodo, 2004; Buhari, 2006 and Ifamuyiwa, 2007). In the May/June 2015 West African Senior School Certificate Examination (WASSCE) for example, the result released on 11th August, 2015, by the Head of National office of the West African Examination Council (WAEC) reported that

61% of all candidates in the examination failed Mathematics. The remaining 39% that passed include those candidates who obtained ordinary pass in the subject whereas, the minimum requirement for admission into science, engineering and technology at the tertiary level is a credit pass in mathematics.

There are several factors responsible for this poor situation. These include the phobia for mathematics by students, uninspiring mathematics teaching, the dearth of mathematics teachers generally in the country and more (Obioma, 2004; Enukoha, 2005; Ogwuche, 2002). Learners' had also been reported to be exposed to inadequate mathematics experiences in the early formative stages of life and this had affected them in later life in school mathematics (Awodeyi, 1999; Fakuade, 2000). However, this present study is based on the assumption that the mathematics teacher is one of the most important factors in the success or failure of students. Students' outcome depends on the effectiveness of the teachers' method of teaching.

There are several methods of teaching in the classroom. Corwin (2011) listed some of these methods as: direct instinct, question and answer, discussion, mental modeling, discovery learning and inquiry. Eric (2013) appeared to re-brand these methods of teaching as teaching styles thus: authority or lecture styles, demonstration or coach style, facilitator or activity style, delegator or group style, and hybrid or blended style. In addition to these, some researchers have pointed out that games may be used as a method to give students 'drill and practice' on knowledge or concept already formed through class activities. Examples of such games are Pack to Palace or Ludo (Awodeyi, 1999); Snake and Ladder or Algebraic Snadder Joint Game (Ibe, 2005); Trigoludo (Ikafia, 2006) and Mathematical Palace Game (Udo, 2016). Every game is guided by rules of operation, such that students' response to questions on knowledge or concept attracts point score. When a student correctly responds to questions, he scores points and when answer is wrong he loses points. In so doing, it is possible to

determine the winner of the game among two or more players within a specific time frame. Game(s) also serves as a motivator to students.

A teacher may use a combination of these methods or techniques in the course of a single lesson and this depends on his instructional flexibility or dexterity. All the teacher need do is to structure his lesson(s) adequately). Isaac (2011) calls the lesson plan that accommodates two or more methods of teaching a strategy. The teacher should remember that it is one thing for a student to acquire knowledge through activities but it is a different thing for knowledge so acquired to remain with the learner or extinct for lack of drill and practice. The poor performance of students in Secondary School mathematics has reached a level we may call an illness. The illness requires treatment. A Method Combination Therapy (MCT) can be administered as a possible remedy. In a MCT, as many methods of teaching as possible that are students' activity oriented are combined together. The MCT is therefore a strategy that is learner cantered. Games too are essentially for ensuring effective drill and practice which in turn aids retention and recall of knowledge among students. It is suspected therefore that if a MCT is used by the teacher to develop concepts for students, and games follow to offer drills and practice, then students will be better off in mathematics learning. For this reason, the present study is designed to empirically investigate the effects of the use a Method Combination Therapy (MCT) on students' mathematics learning.

School mathematics in Nigeria is organized in themes. These are: number and numeration, algebraic processes, geometry, statistics and calculus. The extent to which a Method Combination Therapy will make the teaching of these themes effective is the concern the present team of researchers. The therapy is bound to vary from one theme of topics to another.

Gender difference in mathematics learning has been a recurring issue in education circles. The males were sometimes said to be superior (Alio and Harbour-Peters, 2000; Galadima, 2003; and Ifamuyiwa, 2007). There is also the argument that male superiority over females is not real (i.e.virtual) because the females only see mathematics as a domain of the males (Fenema and Sherma, 1978; Fenema and Carpenter, 1981; Awodeyi and Harbour-Peters, 2000). It is worthwhile to check how the gender argument will play out under a Method Combination Therapy.

Definition of Method Combination Therapy (MCT) as it Applies to School Geometry

In operational terms, Method Combination Therapy is a strategy that is used for teaching mathematics in Secondary School mathematics. It involves using various methods in which activities are the main components for developing mathematical concepts, and the use of game(s) for drill and practice. The following are steps in MCT as it applies to geometry:

- Constructing the nets of 2-dimensional objects to specification (in the current study a cylinder and a cone).
- Folding the nets to shape by joining the ends with masking tape.
- Measuring with a ruler or a tape-rule to ensure accuracy (in this case of cylinder and cone both should be of same height and on same base).
- Experimenting and recording to find out the number of cones filled with sand that will completely fill up the cylinder.
- Formulating the equation that connects the objects, e.g. the relationship between the volume of a cone and volume of cylinder.

- Applying the formula obtained to solve live problems, making generalisation and inference to volume of other types of pyramid whose base is rectangular.

- Using a game to do drills and practice to aid remembering and recall.

The choice of school geometry in this particular experiment is informed by the fact that students have problems learning certain geometry topics. Mensuration is one of such topics in geometry. For example, the teaching of "mensuration" requires students to determine the relationship between objects, such as the sector of a circle and the curved surface area of cone carved out from it.

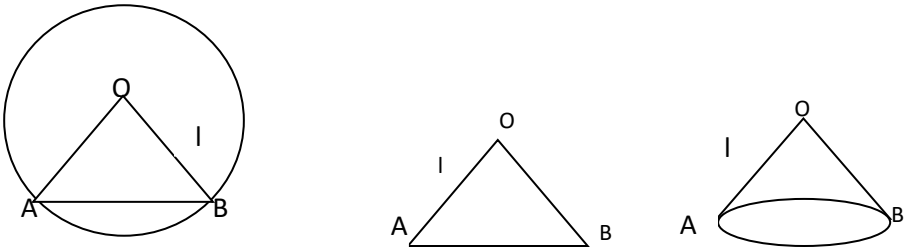

Figure1.

The centre of the circle is at 'O', and the slanting side OB is denoted by l.

Area of the minor sector AOB ($\triangle$) = $\pi r^2 \Theta/360^o$.....α

The curved surface area of the cone = πrR .....ß (Rich, 1963)

Teachers are expected to guide students to see the relationship between the lengths of the minor segment AB of the circle and the circumference of the circular based cone AOB. This may be achieved by carrying out the necessary construction work using the set of students' mathematical instruments. The relationship between radius 'AO' of the circle and the slanting height 'l' of cone AOB should also be verified as equal in dimension. At a higher cognitive level, the determination of the relationship between the volume of a cylinder and the volume of a cone which are of the same height and on the same base (Figure 2) requires a higher cognitive thinking and processes compared with Figure 1. The new task requires constructing,

verifying, experimenting, and exercise. These are activity based. This is a way the mathematics teacher may fulfil the requirement of the cognitive, the affective, and the psychomotor domains of students learning.

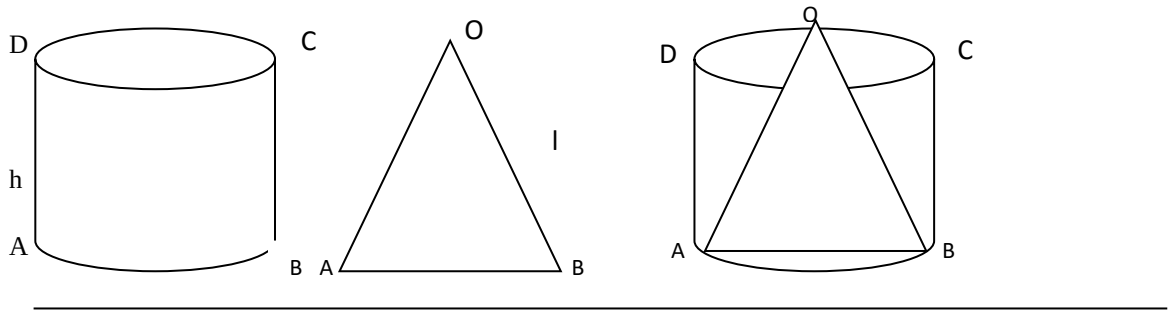

Figure 2.

Volume of cylinder = Base area x Height, and Volume of cone = $\frac{1}{3}$ x Base x Height.

The Problem of the present Study

Many teachers still use 'teacher centred' techniques in schools. In their mathematics lessons, teachers have been observed to introduce lessons by providing learners with sets of formulae; use the formulae to solve examples of related problems for students; and finally issue out practice exercise to students to do, using the teachers' example as template. These steps are typical of a lecture method or what is sometimes called the traditional method or still, what some authors call the expository method. Unfortunately, this procedure hardly gives students the required conceptual knowledge that is required to solve related problems. There is a need therefore to provide a template of a well defined Method Combination Therapy as a strategy for lesson delivery in geometry.

Purpose of the Study

The main purpose of this study is to develop a teaching strategy that will be adequate for lesson delivery in school geometry. Specifically, the objectives of the study include:

1. To compare the achievement of students on the concept of mensuration when taught using a strategy otherwise called Method Combination Therapy (MCT) and when taught using the expository method.
2. To determine the difference in students' achievement by gender when taught mensuration using the Method Combination Therapy.
3. To determine the difference in students' retention scores when taught mensuration using the Method Combination Therapy and when taught using the expository.
4. To compare the retention scores of students by gender when taught mensuration using the Method Combination Therapy.

Research Questions

The following research questions were raised to guide the study:

1. What is the difference existing between the mean achievement scores of students who were taught the concept of mensuration using the Method Combination Therapy and when taught using the expository?
2. What is the difference existing between the mean achievement scores of students by gender when taught the concept of mensuration using the Method Combination Therapy?
3. What is the difference existing between the mean retention scores of students who were taught the concept of mensuration using the Method Combination Therapy and using the expository method?
4. What is the difference existing between the mean retention scores of students by gender when taught the concept of mensuration using the Method Combination Therapy?

Research Hypotheses

The following null hypotheses were formulated to help answer the research questions:

1. There is no significant difference ($p \leq 0.05$) between the mean achievement scores of students who were taught the concept of mensuration in geometry using the Method Combination Therapy and using the expository method.
2. There is no significant difference ($p \leq 0.05$) between the mean achievement scores of students by gender when taught the concept of mensuration using the Method Combination Therapy
3. There is no significant difference ($p \leq 0.05$) between the mean retention scores of students who were taught the concept of mensuration using the Method Combination Therapy and using the expository method.
4. There is no significant difference ($p \leq 0.05$) between the mean retention scores of students by gender when taught the concept of mensuration using the Method Combination Therapy.

Research Method:

The design of the study was quasi- experimental. It was carried out in Ikot Ekpene Local Government Area (LGA) of Akwa Ibom State, Nigeria. The population size of all Senior Secondary School, class one (SSS1) students in the LGA was 2000. Two secondary schools were randomly sampled for study from among the existing 50 in the LGA. Similarly, two intact classes of JSS3, one from each school were randomly sampled and used for the study. The sample size was 75. **Instructional materials** used in the study were cardboard sheets, masking tape, smooth White Sea Sand (WSS), the set of students' mathematical instruments, and pair of scissors. **Activities** in which students were involved in the study include the **construction** of cylinder and cone using cardboard sheets. The dimensions of the constructed

geometric forms were such that the height of the cylinder and the cone are exactly the same. The circumference of the base of cone is also the same as that of the cylinder. The number of cones of sand that filled the cylinder was determined **experimentally**. **Observations** were made and data recorded. Students could state the **conclusion** that the volume of cone is one-third of the volume of the cylinder. The teacher guided students to infer that same result holds for pyramids on a square or rectangular base.

Lesson plan and notes: A lesson plan for teaching the topic was structured to contain three lessons of 40 minutes each. The two intact classes were randomly assigned into experimental and control groups. Separate lesson notes were prepared for the groups with applicable distinct features, though content taught were exactly the same in both groups.

The experimental group was facilitated to carry out activities stated earlier. In addition, the group played the Mathematical Palace Game (Udo, 2016) with a set of structured study questions. The purpose of the game was to motivate students to aid their remembering of facts and recall of formula. The control group were taught the same content as in the experimental group. The expository method essentially followed steps characteristic of lecture method i.e. providing students a chart of pictures/diagrams of cone, cylinder, cone and cylinder filled with White Sea Sand; a list of formulae for students; giving worked examples, and finally issuing out structured study questions to students to do for practice.

Results

Research Question One: What is the difference existing between the mean achievement scores of students who were taught the concept of mensuration using the Method

Combination Therapy and using the expository method? This research question was answered using data in Table 1**.**

Table 1: **Descriptive Statistics of Students' Post-test Scores with Pre-Test Scores as Covariate by Teaching Strategy and by Gender.**

Variable	Dimension	N	$\overline{X}$	Std. Error	Mean diff. by Dimension
Method	MCT	47	60.917[a]	2.881	
	Expository	28	35.650[a]	3.738	**25.357**
	Total	75	48.238[a]	2.187	
Gender	Male	29	53.113[a]	3.181	
	Female	18	43.365[a]	3.412	**9.748**
	Total	47	48.239[a]	2.482	

a. Covariates appearing in the model are evaluated at pre test =12.27

In Table1, the mean achievement score of the 47 students (irrespective of their gender) who were taught using Method Combination Therapy was 60.917[a] with a standard error of 2.881. The corresponding mean score of the 28 students taught using the expository method was 35.560[a] with a standard error of 3.738. The symbol 'a' appearing as a superscript in the two means indicates that the covariate used with post test are evaluated at pre test = 12.27. The difference between these two mean scores is 25.357.

Research Question Two: What is the difference between the mean achievement scores of students by gender when taught the concept of mensuration using the Method Combination Therapy? This research question was answered still on Table 1.

On Table 1, there were 29 male students in the group of students taught mensuration using the MCT and their mean achievement score is 53.113[a] with a standard error of 3.181. Also, the mean achievement score of 18 females in the group is 43.365[a] with a standard error of 3.412. All means are obtained using pre test scores with mean = 12.27 as covariate. The difference between the mean achievement scores of males and females is therefore 9.748.

Research Question Three: What is the difference existing between the mean retention scores of students who were taught the concept of mensuration using the Method

Combination Therapy compared with the expository method? This research question was answered using data in Table 2.

Table 2: Descriptive Analysis of Students' Retention-Test Scores with Pre-Test Scores as Covariate by Teaching Strategy and by Gender.

Variable	Dimension	N	$\overline{X}$	Std. Error	Mean diff. by Dimension
Method	MCT	47	61.916[a]	2.625	
	Expository	28	39.250[a]	3.406	22.666
	Total	75	50.583[a]	2.105	
Gender	Male	29	53.858[a]	2.899	
	Female	18	47.307[a]	3.109	6.551
	Total	47	50.582 [a]	2.235	

a. Covariates appearing in the model are evaluated at pre test =12.27

In Table 2, the mean retention score of the 47 students (irrespective of their gender) who were taught using MCT strategy was 61.916[a] with a standard error of 2.625. The mean score of the 28 students taught using the expository was 39.250[a] with a standard error of 3.406. The symbol 'a' appearing as superscript in all means indicates the covariate used with the post test are evaluated at pre test = 12.27. Hence, the difference between the mean scores of students in the two groups is 22.666.

Research Question Four: What is the difference existing between the mean retention score of students by gender when taught the concept of mensuration using MCT strategy? This research question was answered on Table 2.

On Table 2, there were 29 male students in the group of students taught mensuration using MCT and their mean retention score in the group is 53.858[a] with a standard error 2.899. Also, there were 18 females in the group and their mean retention score is 47.307[a] with a standard error of 3.109. Both means are obtained using pre test = 12.27 as covariate. The difference between the mean retention scores of males and females is 6.551.

Hypotheses:

Hypothesis One: There is no significant difference ($p \leq 0.05$) between the mean achievement scores of students who were taught the concept of mensuration in geometry using the strategy involving active learning with a game and using the expository method. This hypothesis was tested and the results shown in Table 3.

Table 3: ANCOVA Analysis of Students Post Test Scores by Method and by Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	14885.619[a]	4	3721.405	10.268	.000
Intercept	50599.667	1	50599.667	139.607	.000
pretest	76.604	1	76.604	.211	.647
method	10126.822	1	10126.822	27.940	.000
gender	1566.156	1	1566.156	4.321	.041
method * gender	489.276	1	489.276	1.350	.249
Error	25371.128	70	362.445		
Total	247028.000	75			
Corrected Total	40256.747	74			

a. R Squared = .370 (Adjusted R Squared = .334).

In Table 3, the computed F value for students' achievement by method of teaching is 27.940 (row5, col.5). The significance of F at 5% probability level is .000 (row5, col.6). Method is therefore significant. In other words, the observed difference between mean achievement scores by groups as show earlier on Table 1, is not by chance.

Hypothesis Two: There is no significant difference ($p \leq 0.05$) between the mean achievement scores of students by gender when taught the concept of mensuration using the MCT strategy. This hypothesis was tested and the results is shown in Table 3.

On Table 3, the computed F value for gender is 4.321 (row 6, col.5). The value of significance of F is .041 ($p \leq 0.05$). Gender is not significant. The observed difference between the mean scores of male and female students as observed earlier in Table 1, is due to chance.

Hypothesis Three: There is no significant difference ($p \leq 0.05$) between the mean retention scores of students who were taught the concept of mensuration using the MCT strategy and using the expository method. This hypothesis was tested and the result is shown in Table 4.

Table 4: ANCOVA Analysis of Students Retention Test Scores by Method and Gender

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11399.919[a]	4	2849.980	9.470	.000
Intercept	58773.614	1	58773.614	195.291	.000
pretest	268.369	1	268.369	.892	.348
method	8091.383	1	8091.383	26.886	.000
gender	707.406	1	707.406	2.351	.130
method * gender	1038.751	1	1038.751	3.452	.067
Error	21066.748	70	300.954		
Total	255508.000	75			
Corrected Total	32466.667	74			

a. R Squared = .351 (Adjusted R Squared = .314)

On Table 4, the computed F value for students' retention of knowledge by method is 26.886 (row 5, col.5). The significance of F ($p \leq .05$) is .000 (row 5, col.6). Method Combination Therapy is therefore significant. The difference earlier observed between the two means on Table 1, which was to the advantage of MCT did not occur by chance.

Hypothesis Four: There is no significant difference ($p \leq 0.05$) between the mean retention scores of students by gender when taught the concept of mensuration using the MCT strategy. This hypothesis was tested and the result is shown in Table 4.

In Table 4, the computed F value for students' retention of knowledge when taught using the Method Combination Therapy (MCT) by gender, was 2.351 (row 6, col. 5). The computed significance of F was .130 (row 6, col.6). Gender is therefore not significant. In other words, males and females are equal in ability to recall acquired knowledge over time.

Summary of Findings

1. Students who were taught geometry using Method Combination Therapy performed significantly better than their counterparts taught using the expository method.
2. The MCT significantly favoured students' retention of acquired knowledge, over time, unlike the expository method.
3. There was no significant gender difference between the achievement scores of males and females at the post test following the use of the Method Combination Therapy.

Discussion of the Findings

The Method Combination Therapy as investigated in this study took two unique procedures. The first was the use of sequenced activities to develop the concept of mensuration, among students. Secondly, the use of game which was played with structured study questions to enhance drill, practice, retention and recall of knowledge.

The effects of the use of Method Combination Therapy (MCT) on students were subsequently compared with when the expository method was used. The MCT was significantly superior to the expository method. This agrees with Ibe (2005) and Ikafia (2006) who found out that games enhance students' achievement because of the activities it afforded. It also agrees with Isaac (2011) that the use of instructional strategy in which two or more activity based instructional methods are involved would bring about greater achievement among learners as against using one rigid method. Furthermore, this finding agrees with other previous finding that when a combination of methods are blended in a strategy with the teacher facilitating and students responding, the better for students achievement (Adeniran, 1994; Awodeyi, 1999; Akinsola and Animasahun, 2008; Alemu, 2010; Ogwuche, 2012). The Method Combination Therapy also favoured retention and subsequent recall of knowledge previously learnt as the difference between the mean achievement scores of the two groups of students was significant.

Also compared were male and female students within the group taught with the Method Combination Therapy**.** First, at post test, the males and females were equal in their achievement. This finding is at variance with Alio and Harbour-Peters (2000), Galadima (2003), and Ifamuyiwa (2007) that males were superior to females in mathematics learning. This present result may be attributed to the effect of the use of the Method Combination Therapy. The result however agrees with Fenema and Sherma (1978); Fenema and Carpenter (1981); Awodeyi and Harbour- Peters (2000) that any observed difference between achievement of males and females in mathematics learning, to the advantage of males was due to the fact that the females viewed mathematics as the domain of the males. At the retention level, test scores also showed no significant difference between the mean achievement scores of males and females. This is a feat attributable to the use of the Method Combination Therapy.

Conclusion

This study has discovered that a Method Combination Therapy (MCT) which involves the structuring of lesson plan and notes with sequenced activities including the use of suitable game(s) would sufficiently facilitate students' academic achievement, retention and recall of knowledge in geometry, compared with the use of the expository or lecture method. The method facilitated both males and females adequately without bias. The MCT that structures the activities of students to involve: constructing, folding, measuring, experimenting, formulating, applying, and generalising; is good enough to fill the gap discovered in the teaching of mathematics generally and the teaching of geometry in particular.

Recommendations

The following recommendations are made:

1. The Faculty of Education and indeed concerned teacher training institutions should prepare their pre- service teachers adequate enough to enable them teach geometry to Secondary School students, using the Method Combination Therapy (MCT), as suggested in this study.
2. School Inspectors for Mathematics should in particular ensure that serving teachers teach geometry to students in Senior Secondary School using the Method Combination Therapy, which makes use of the seven steps of: constructing, folding, measuring, experimenting, formulating, applying, and generalizing, as template.
3. Proprietors of schools should endeavor to sponsor serving teachers to workshops where they could learn new approaches such as the MCT to teach geometry.

Recommendation for Future Study

The extent, to which the Method Combination Therapy (MCT) may close the gap between high and low achievers in a geometry class setting, may be investigated.

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