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Abstract

Experimental research works on mathematics teaching methodology abound. These efforts were to minimize teaching-learning difficulties and poor learning outcomes of the students. Incidentally, most of the 'beautiful' research reports have not received feedback from users simply because survey research on this is rare. This study filled the gap by examining various teaching methods and strategies been used in the teaching of Mathematics in secondary schools of southwestern Nigeria. An elegant and indirect approach was adopted in doing this. Multistage sampling approach was used to select the 117 mathematics teachers involved in the study. The study gave an empirical evidence that lecture method is commonly used in the teaching of content of Mathematics curriculum due to lack of adequate instructional materials and teachers unskilfulness in the use of other methods and strategies. Recommendations were made on how to get the instructional materials and train the teachers on the use of other effective methods and on the handling of these materials to improve learning outcomes.

Keywords: Teaching Methods, Instructional Materials, Southwestern Nigeria and Senior Secondary School**.**
Word Count: 163

Introduction

Recent emphasis on pedagogical approach has been that of paradigm shift in favour of learners' participatory activities. However, many research endeavours on teaching methods have not been transferred to classroom practices. Teaching method can be defined as the totality of pedagogical procedures and processes carried out in the classroom by the teacher with the aim of developing cognitive, affective and psychomotor domains of the learner. The way, procedure and process of achieving this educational objectives could be referred to as a teaching method. There are as many teaching methods as we have the teachers.

According to Ndubuisi (1981) as cited by Ogunbiyi (2004), teaching methods can be regarded as the sum of all the principles of good teaching that are known to have been proved from psychological, biological and educational research.

There is an ample evidence to suggest that many modern methods of teaching are in fact, adaptations of instructional procedures that were probably used in the past (Ogunbiyi, 2004). The Greeks used such methods as group discussions, field trips and excursions, games and sports, forum, debate, argumentation, rhythmic activities through participation.

Plato's approach made use of dialectic and intuitive reasoning. The dialectic (question and answer) approach according to Ogunbiyi consisted of a five-step proposition with reference to an idea; question, analysis, reason, conclusion and generalization which should be more emphasized in teaching. Vitterine De Feltre commonly regarded as the father of secondary education placed great attention on individual differences and practical education.

Johann Heinrich Pestalozzi (father of elementary education) placed emphasis on the use of variety of activities in the immediate environment for learning through observations, sense impression and investigation. Herbert (1986) introduced a new psychology of learning and he identified five formal stages of instructions. These are; preparation, presentation, comparison/association and abstraction/systematization, generalization and application (Osokoya. 1989; Ogunbiyi, 2004). Fredrick (1995) is known to be the originator of kindergarten, this placed emphasis on play, games, motor, expression, songs, language symbols, self-activities and participation in the natural environment.

The foundational ideas, perceptions and methods of teaching by these philosophers, psychologists and educators of old have provided a platform upon which several modern teaching methods are built. Modern teaching methods are based on certain normative principles or axioms. Some of the normative principles which any teaching method should follow have been outlined, these are; proceeding from simple to complex, from easy to difficult, from concrete to abstract, from known to unknown, from particular to general (Oyeniran, 2003), from whole to part, from empirical to rational, from psychological to logical, from actual to representative (Kochhar, 1985), from common language to subject language (Afolabi, 2008). These are also referred to as maxims of teaching.

The teaching methods adopted by a teacher have the potency or otherwise of making the learner to cope with the challenge of global dynamics. With respect to the challenge of globilisation, Marsh (1999) as cited by Mansaray and Amosun (2002) postulated a global world as one in which nations will network for mutual progress and prosperity and the same time a world characterized by increased and dynamic competition. In such a situation, it is the nations that have the greatest number of critical decision makers that will be at the peak. It will then be necessary to gear our educational system towards the development of critical thinking capabilities of all learners. To develop a critical thinking learner, the teacher should be capable of using teaching methods as stimulus that will elicit a thought provoking response from the learners. This implies that a teacher can use his teaching method to evoke critical thinking from the learner. Thus, making him to become a critical decision maker who can competently face the challenge of global dynamics. To develop such critical thinking capabilities of the learners, there is need for emphasizing teaching methods that will encourage critical analysis of issues, and a democratic classroom atmosphere that makes for free exchange of ideas and opinions (Obanya, 1999). Attempt made by the Japanese teachers in mathematics classroom is akin to this approach thus; giving them superiority to other countries during the Second International Mathematics Study for age 12.

The studies by Antonoplos (1985) and Stevenson (1987) revealed the superiority of Japanese children in mathematics when compared with their counterparts from Sweden, Australia, England and the United States but not in other subjects such as Science and Geography. It was explained that the Japanese teachers are enthusiastic in their classroom practices (Stevenson, 1987). They engage the attention of the pupils in discussions and debate on mathematics. A large time of the lesson is used in seeking answers and explanations from the pupils. The children were encouraged to make meanings and connections through discussions and giving various meanings on the same idea or concept to be leant (Stigler, Lee and Stevenson, 1987; Antonoplos, 1985). The length of hours put into mathematics teaching and learning was highest when compared with those other countries. The commitment has also justified their cultural believe in hard work for success in mathematics rather than innate ability.

The problem of mathematics teaching and learning is a global phenomenon. In most part of the world, it has been discovered that lecture method or traditional expository method of instruction is being used by the teachers (Ogunbiyi, 2004); this is one of the reasons that is responsible for poor attitude and poor achievement. In response to such a fundamental problem, Sharma (2001) was of the opinion that there are three factors to consider in order to provide students access to optimal Mathematics

instruction. And that any teacher of Mathematics should know these factors. These are; (1) understanding the nature of Mathematics; (2) understanding who is being taught; (3) understanding teaching models and teacher characteristics. Here, Sharma counts the content, the learner, the teacher variables and his pedagogical skill to be of paramount importance in improving Mathematics instructions and consequently, improved learning outcomes of the learners. And to improve Mathematics instructions for all, he said three questions should be answered by the teachers of Mathematics;

(1). How does one learn Mathematics?

(2) How does learning difficulties occur in Mathematics?

(3) What can one do to improve Mathematics instruction?

This view of Sharma expresses the concern for teachers to include not only pedagogical skill but that of sociological and psychological knowledge of the classroom environment in his classroom practices to ensure successful teaching. It is believed that an attempt to find answers to these questions by the teacher will make an improvement in Mathematics teaching.

There are many methods and strategies that have been identified in teaching of Mathematics. However, some of these methods and strategies considered in this study include:

1. Problem solving strategy 2) Advance organizer strategy.
3. Question and Discussion method 4) Discovery/ inquiry method
5. Concept mapping strategy 6) Individualised teaching strategy
7. Demonstration Strategy 8) Enhanced Mastery learning strategy
9. Cooperative teaching strategy 10) Laboratory method
11. Lecture method 12) Project method.
13. Mental imagery strategy

Teaching method is here defined as a specific instructional process which differs from any other by the diversity of specialized activities. Teaching strategy is considered as an instructional process which follows a skilful routine. Both terms have been used synonymously in this study.

A study on survey of teaching methods used by classroom teachers is uncommon and close to none. However, teaching methods used by Mathematics teachers was investigated by Igbokwe (2000) among 44 Mathematics teachers selected over all the 36 states of Nigeria during national Conference of Science Teachers' Association of Nigeria (STAN). He reported the degree of use as: Demonstration method > Discovery method >textbook exercises method> discussion method> expository method> inquiry method> individualized method> project method. The limitation of this approach is that teachers themselves do not know details, meanings and applications of these methods and strategies. They could not clearly define the activities that make up each method and strategy. There is a need for an improved approach in determining the methods used by the mathematics teachers. This was done by making an explicit outline of various steps or activities that make up these 13 methods/strategies (without writing out the methods in an explicit way) under consideration, (appendix I). This study approach has therefore filled the gap left out in a similar study by Igbokwe (2000).

The problem

Researchers have reported that poor instructional strategy is one of the factors responsible for poor learning outcome. There have been many research works on Mathematics teaching strategies, most of which established relative effectiveness more than the conventional or expository method. Most of these methods and strategies yield significant effect of variation on achievement. However, limited work has been done to survey the methods that characterize our classroom pedagogical activities, which could have served as feedback on experimental researches on Mathematics teaching methods. There is the need to know whether these methods and strategies are being used and also to what extent is their use. In a bid to do this, the study was guided by answering the question "**What teaching methods do the Mathematics teachers use in the teaching of the contents of**

senior secondary school Mathematics curriculum?"

Population and sampling procedure

The population was all Mathematics teachers throughout the six states of southwestern Nigeria. Southwestern geopolitical zone of Nigeria was purposively selected for the study due to its high inclination and commitment to education. All the 6 states in the southwestern geopolitical zone were used for the study. 6 secondary schools were selected from each state based on stratified random sampling along the axis of the existing senatorial districts of each state. Equal numbers of schools (two) were selected from each senatorial district. Unequal number of schools exist among the states and among the senatorial districts notwithstanding, the researchers found it appropriate and convenient to select equal number of schools in each of them. However, purposive sampling technique was used to select mathematics teachers within the schools to be all those who teach senior secondary level mathematics in the sampled schools. The respondents consisted of 117 Mathematics teachers from the 36 schools.

Instrumentation

The instrument used for data collection has two sections, (Appendix I). Section A solicited information on teachers' profile such as; school name, state and local government of the school location, teachers' qualification, specialization, experience etc.

Section B of the instrument used for data collection consisted of 63 activity-steps of items that make up of 13 teaching methods and strategies. These activity-steps were numbered serially from 1 to 63. The teaching methods and strategies were not written out alongside with the activity-steps under them in order to avoid choice by ego-trip. This approach would offer a better understanding by teachers rather than mentioning the methods/strategies of which most of them did not understand the meaning. The approach also represent a way of presenting the methods in a more simplified and explanatory form. The Mathematics teachers were to respond on a 4-point Likert rating scale type of 'very often', 'often', 'occasionally' and 'never' to indicate the intensity at which they carry out or take such steps in their classroom pedagogical activities. The activity steps for each methods and strategies were used as found in literatures. The teaching methods/strategies included in the survey and the number of activity-steps under each of them are outlined thus: Enhanced (Akinsola, 1994) Mastery Learning, 8 steps), Advanced Organizer (2 steps), Problem solving strategy (Polya, 1957 modified by Arigbabu, 1995; 6 steps), Demonstration strategy (6steps), Individualized teaching strategy (5 steps), Laboratory strategy (5 steps), Discovery teaching strategy(3steps), Lecture method (4 steps), Concept mapping (6 steps), Co-operative teaching strategy (2 steps), Questioning and discussion strategy (5 steps), Mental imagery strategy (6 steps), Project method (5steps).

The scoring was rated as; 'very often' (4), 'often' (3), 'occasionally' (2), 'never done' (1). The researcher later measured the intensity of the use of each method, analyzing their responses by aggregating the activities (items) under each method/strategy. The instrument was subjected to content validity through mathematics educators, experts and researchers. The rating scale has more than 2 points; hence, Cronbach alpha method was used to obtain the reliability coefficient of 0.91 after trial tested on eleven (11) secondary school Mathematics teachers.

Data Collection and Analysis

The data was collected from the six states of southwestern geopolitical zone in conjunction with the support of five trained research assistants. The intensity of method use was found by aggregating the responses of activities (items) under each method. The responses were coded and analysed using the descriptive statistics such as mean, percentages and standard deviation.

To actually find out the methods used by the teachers in the teaching of the contents of senior secondary school mathematics curriculum, a survey method and the instrument used is considered more suitable and appropriate than using classroom observation schedule or time clack approach. This is because a teacher is expected to use as many convenient methods as possible during a lesson. For a researcher to generalize the conclusion that the teachers use certain methods in teaching the contents of the

curriculum, the researcher must have observed all the teachers in many lessons as they teach ***all the topics*** in the curriculum. (This is almost impossible even in a longitudinal study with the number of teachers spread over a wide geographical area). With any other approach, one may not be able to include many teachers sufficiently enough as to generalize that some particular methods have been in use to a particular extent. Whereas, with the approach in which the activities in each method had been laid out, the teachers can always remember the activities he carried out at one time or the other over the years as he teaches various topics. This has made the self-reported approach in data collection to be of most relevant here. It has helped the researchers to cover wider sample appropriately to generalize in this type of study. The style of presenting the instrument by not writing out or mention the methods has tried to bridge the gap between self-reported approach and actual enacted approaches in schools by the teachers.

Findings and Discussions

The table below (table 1) shows the profile of the qualifications of the teachers in the study.

Table-1: Qualification of the Mathematics Teachers.

Qualification	**Frequency**	**Percentage**
Nigerian Certificate in Education (N.C.E)	24	20.5
B.Sc. /B.A	17	14.5
B. Sc. (Ed)/ B.A. (Ed)	62	53.0
Higher Degree	6	5.1
None in Mathematics	8	6.8
Total	**117**	**100**

Table 1 above reveals that the majority (more than half) of the teachers were trained university graduate of education. Among these 117 teachers, 101 (86.3%) specialized in Mathematics while 16 others specialized in other subject areas such as statistics, engineering etc. With these qualifications profile one would expect to see a high degree of use of specialized methods and strategies.

Table-2: Intensity of Method Used by the Mathematics Teachers. N = 117

	Teaching method	Score obtainable	Mean Score obtained	Mean %	Std. Dev	Rank
1.	Enhanced Mastery learning	32.00	24.43	76.34*	5.40	2nd
2.	Advance organizer	8.00	5.32	66.50	1.80	7th
3.	Problem solving	24.00	17.77	74.04	4.43	3rd
4.	Demonstration	24.00	16.12	67.17	3.90	6th
5.	Individualized teaching	20.00	11.03	55.15	3.79	13th
6.	Laboratory method	20.00	12.47	62.35	3.65	11th
7.	Discovery method	12.00	7.92	66.00	2.55	9th
8.	Lecture method	16.00	12.29	76.81	2.96	1st
9.	Concept mapping	24.00	14.19	59.13	5.11	12th
10.	Cooperative teaching	8.00	5.24	65.50	1.93	10th
11.	Question & Discussion	20.00	13.23	66.15	4.28	8th
12	Mental image	24.00	17.05	71.04	4.64	5th
13.	Project method	20.00	14.47	72.35	4.05	4th

* Enhanced Mastery Learning with 4-point rating 4,3,2,1 has a maximum of 32 point-step. A single-valued score (mean) =24.43 indicates the score obtained by the teachers out of 32 points obtainable. This is equal to 76.34% use of mastery learning.

Table 2 is a report of methods used by the Mathematics teachers. It is a reflection of the degree to which each method /strategy is been used by these Mathematics teachers in the teaching of Mathematics. The mean scores were obtained by aggregating responses to all the items under each method.

Column 6 of table 2 is the standard deviation of each teaching method. The standard deviation is the statistic that shows the spread of a distribution of scores. The values in column 6 show the spread in variation of mean responses to the items under each method. The lower the standard deviation, the more reliable the mean. As it were, these values of standard deviations could not be directly compared for inferential purpose until the number of items in each method is considered. More useful information could be obtained from the standard deviation when each standard deviation is compared with the number of items in the method. This is because there is a possibility of having a wider spread of responses where the number of items (steps) under consideration is more. This is thus reflected in mastery learning, problem solving and mental imagery strategies. And the standard deviation could be lower where the number of items is fewer as reflected in advanced organizer, cooperative teaching strategy and discovery teaching strategy.

The activities (steps) under mastery learning have the highest mean variation of responses. This does not make the mean score weaker in its rank (2nd) of intensity of use. The reason for the high spread of response could be explained by many items (8) involved in this method. It of course has the highest number of steps. Whereas, methods such as cooperative teaching, advance organizer with 2 steps/items each had low standard deviations 1.80 and 1.93 respectively. This does not make their mean superior to those with higher standard deviations. This could be as a result of few items under each. Thus, these standard deviations have reflected consistency of the respondents.

The findings as shown in the table indicate that all the teachers make use of most of the steps that lead to one method or the other as they teach various topics in senior secondary school Mathematics curriculum. Obviously, at one time or the other the teacher might have made use of such relevant steps in a method. Mostly used among all teachers are; lecture method (76.81%), mastery learning strategy (76.34%), and problem solving (74.04%). The least been used is the individualized teaching method (55.15%).

The findings on the methods used by the Mathematics teachers revealed that (76.81%) of Lecture method is been used. This ranked first in intensity of use. This is the mostly used method in teaching Senior Secondary Mathematics curriculum. This is similar to the findings of Ogunbiyi (2004) in the teaching of mathematics and that of Alade (2006) who also condemned the use of lecture method more than projects and practice methods in teaching Technical Education in Colleges of education. What less for the teaching of Mathematics at the senior secondary school level? Afolabi (2009), Afolabi and Adeleke (2010) identified the two major factors among others, which are responsible for the use of lecture method by the Mathematics teachers. These are; 1) inadequacy of instructional materials both in quantity and quality and 2) teachers' lack of knowledge of other methods and strategies. Generally, lecture method (the traditional or expository method as called by some) has been condemned by many researchers as been less effective in teaching and specifically not encouraged for the teaching of mathematics at the secondary school level. Making instructional materials and resources available would enable the teachers to use more efficacious and proven methods. On this, Afolabi and Adeleke (2010) recommended among others; i) improvisation by students and teachers, ii) government, iii) Parent Teacher Association (P.T.A), iv) lovers of mathematics, v) philanthropists as means of sourcing instructional materials for school mathematics teaching.

Second in rank is the enhanced mastery learning strategy. 76.34% of the activities around this method are been used. If the teachers profess the use of mastery learning, one would expect high achievement of his learners. This may however not be so if a crucial step of setting the desired mastery level is omitted by the teachers or a poor review of

previous lesson before introducing new one. Other methods considered have the magnitude of intensity of their use thus: problem solving (74.4%) > project method (72.35%) > mental imagery strategy (71.04%) > demonstration method (67.17%) > advance organizer (66.50%) > question and discussion (66.15%) > discovery method (66.0%) > cooperative teaching (65.50%) > laboratory method (62.35%) > concept mapping (59.13%) > individualized teaching (55.15%). The least method used is the individualized teaching. The report on the use of individualized method could be justified due to small time schedule for lesson in our formal educational system. Unlike in Japan which was reported that the number of working school-day per year is 240 days (Lynn, 1992), while in Nigeria, it is about 180 days with about 3.1 hours per week for the teaching of mathematics (Afolabi, 2010a). The high pupil-teacher ratio in most Nigerian public schools might as well be an inhibition to this method therefore; individualized strategy might of course not often used.

Conclusions and Recommendations

Lecture method is mostly used in the teaching of Mathematics. In another study by Afolabi (2010b) it was reported that the available instructional materials and teachers' inability to handle modern methods are the foremost factors that determine the methods used by teachers. That is, instructional resources and materials are the crucial determinants of methods used in Mathematics teaching. Therefore, these resources and instructional materials should be provided through; government and education agencies, improvisation by school teachers and students, request from lovers of Mathematics, philanthropists, unified efforts of parents and teachers commitment of a unit of National Mathematical Centre to the provision of standardized instructional materials for the whole nation and the same disseminated to the schools through the states' ministries of education and Mathematical Association of Nigeria. Training and re-training of Mathematics teachers on the use of instructional materials should be put in place as a part of lifelong learning. Teacher education curriculum should be embellished to incorporate ***at least a course*** in which the pre-service teachers are taught the construction, improvisation and uses of instructional materials for all courses before their graduation from their educational institutions. There should be collaborative efforts of secondary school managements with colleges of education and faculties of education to pass down their constructed materials on students' projects to secondary schools. The ministries of education and local education authorities can be the linking agents among these groups.

The in-service teachers should be retrained on the use of instructional materials and they should also be taught new teaching methods and encouraged to attend relevant workshops, conferences and seminars such as those of Mathematical Association of Nigeria (MAN) and Science Teachers 'Association of Nigeria (STAN).

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Appendix

Mathematics Teaching Methods Rating Scale (Matmers)

Please respond to the items in this instrument as honest as possible. This is to indicate some activities/steps involved in your classroom lesson

Section A (Teachers' Personal Data)

Where there are options make your choice by marking (x)

1. Name of school
2. Local Government Area of school 3 .State
4. Sex: Male ( ) Female ( )
5. Qualification in Mathematics: NCE ( ); B.Sc\B.A ( ); B.Sc(Ed)\B.A(Ed) ( ) Higher Degree ( ); None in Mathematics ( )
6. Mathematics Teaching Experience:
   0-3 yrs( ); 4-7 yrs( ); 8-11 yrs( ); 12-15 yrs( ); 16+yrs ( )
7. Area of Specialisation (*if not Mathematics*)
8. Have you taught SSS Mathematics before? Yes( ); No( )
9. Which level of SSS Mathematics have you taught in the past 3 years?
   SS1 ( ) SS2 ( ) SS3 ( )
10. Present class of teaching Mathematics **JS**1 ( ); 2( ); 3( ); **SS1**( ); 2( ); 3( )
11. What is the average size of your Mathematics class? < 30( ); 30-44( ); 45-60( ); >60( )

Section B

Instructions: Below are some activity-steps involved in some selected teaching methods. You are to choose by marking 'x' in the ones that you do make use. The frequency of such activity is rated as 'A' – if you do it Very Often; 'B' – if you do it Often; 'C' – if you do it occasionally; and 'D' if you don't carry out the activity. You may leave out any one that is not applicable.

	A	**B**	**C**	**D**
1. Setting the desired level of performance				
2. Brief Review of Previous lesson via other methods				
3. Stating objectives of new lesson				
4. Teaching of new lesson				
5. Test and class exercise				
6. Feedback				
7. Reteach				
8. Test				
9. Searching for the subsumer (previous knowledge) in form of question, quiz presentation of organizer in advance of learning materials				
10. Teaching new lesson by conventional or expository method				
11. Analysis of the problem				
12. Identification of basic/ relevant facts				
13. Identification of appropriate techniques/formula				
14. Carry out solution by using technique and formula adopted				

15. Checking the solution				
16. Generalizing the result				
17. Teacher solving problem on the board or deductive proofs of theorems				
18. Teacher engaging in practical skills like constructing or measurement				
19. Making use of improvised instructional materials where necessary				
20. Engaging in group discussion with the students				
21. Organizing mathematical quiz, games & puzzle				
22. Experimenting in Mathematics laboratory where available				
23. Students proceed at their own speed through segment of the programme				
24. Student select alternative lessons to meet a given set of instructional objectives				
25. Students are instructed as individual or in small groups for all or a major portion of class time				
26. Students (can) select when they wish to study a given subject and how long they want to spend in a given study session				
27. Students select or design their own learning activities				
28. Learner's involvement in discovery of mathematical relations and properties				
29. Engagement of the learner's in some thinking as he collects data, plays a game or conducts an experiment				
30. Exploration of mathematical applications, by providing facilities for incorporating experiment and practice in learning math				
31. Explanation of mathematical applications in other discipline relevant to the ones they are exploring				
32. Engagement of the learner in the evaluation, and acquisition of special practical skills for dealing with given content areas of Mathematics.				
33. Instructional materials or hints provided				
34. Guide students to use instructional materials or hints				
35. Students identify/ find out facts for themselves				
36. The teacher clearly state the purpose and major theme of the lecture				
37. Develop the lecture/lesson in a logical fashion that the learner can follow				
38. Include clues that point out the logical development of the concepts step-by-step.				
39. The teacher endeavour to provide concrete examples with some sort of summarizing device				
40. Select the item for mapping/problem to solve				
41. Choose and underline relevant facts or concepts				
42. Arrange the concept from the complex to simple				
43. Cluster the concepts based on level of criteria like same level of complexity or abstraction and those that				

are closely inter-related				
44. Concept arranged in form of a two-dimensional array analogous to a road map.				
45. Linking related concept with lines, which are labeled in proposition form				
46. Division of syllabus/topics				
47. Division of students				
48. Graded questions prepared				
49. Brief students for direction				
50. Grouping (of Students)				
51. Outlining discussion rule				
52. Teacher going round/monitoring groups				
53. Teacher makes his own visual imagery of what the students can envision when reading or completing other academic task				
54. Seek to model imagery strategy to your students by discussing with them what you have in mind				
55. Encourage students who have mental imagery skills to use them and teach those who do not have the skill how to do so.				
56. Use simple methods to support the use of mental imagery				
57. Provide initial background knowledge to anchor the new one with aids of the imagery				
58. Help students to interpret their drawings and its importance to their understanding information recall and for prediction of what can happen next.				
59. Decide/ design the project theme				
60. Itemise/ provide the raw materials				
61. Give guidelines for activities				
62. Evaluate learners performance				
63. Give corrective measures				