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PROGRAMMED INSTRUCTIONAL METHOD OF TEACHING ON STUDENTS ACHIEVEMENT IN MATHEMATICS

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ABSTRACT

The study is to investigate the effects of programmed instructional package on secondary school students' achievement in mathematics. The study employed a quasi experimental procedure. The specific design is non-equivalent control group design. The sample for the study comprised of 300 SSII students drawn from four co-educational secondary schools in Awgu Education Zone of Enugu state. The four secondary schools were randomly sampled from a total of 46 secondary schools in the zone as at the time of this study. Two intact classes from the four schools were randomly assigned to the experimental group while the remaining two classes were assigned to the control group. Two research questions and one hypothesis guided the study. The experimental group was taught mathematics using programmed instructional package while the control group was taught the same contents using conventional method. Data for the study on the students' achievement in mathematics were collected using mathematics achievement test. Data were analyzed using adjusted mean, standard deviations and analysis of covariance (ANCOVA). The results of the study revealed that programmed instructional package is superior to the conventional package in improving students' achievement in mathematics. Programmed instruction did not discriminate significantly across gender in terms of achievement in mathematics. The results of the study also revealed that there was no significant interaction between gender and instructional approach on students' achievement in mathematics. Based on findings the researcher made recommendations and suggested areas for further studies.
KEYWORDS: Programmed Instruction, Achievement in Mathematics, Method.

INTRODUCTION

Mathematics occupies a peculiar position in the life of every individual and the society. It plays an indispensable role in the development of arts, humanities, science and technology. Mathematical thinking began in very ancient times. Certainly, it made considerable progress among the Sumerian, and Babylonians (Hussen, 2009). With the development of mathematical thinking and their application in stone monuments in Egypt, mathematical ideas began to spread to all parts of Africa (Sertima, 2009). Today, mathematics has been applied in all spheres of human endeavors – in day-to-day business, leisure activities, agriculture and formal academic disciplines. In fact,

mathematical principles have also been intensively utilized in religious, cultural practices and virtually all life activities (Suleiman, 2010).

A survey of students' achievement in mathematics depicts a very sad situation. Ajai and Imoko (2015) and Ugwuanyi (2016) reported a very poor achievement in mathematics among secondary school students. Adeniyi and Salman (2015) stressed thatachievement controls the motivation to learn and as such should possess a direct positive relationship with achievement in a given field of study. With the realization of the indispensability of mathematics in the survival of our society and the educational system, mathematics educators have been concerned with the ways in which students learn Mathematics. This includes methods of teaching and instructional materials that aid the learning processes, means of identifying and overcoming difficulties encountered in the learning of mathematics, ways of providing for individual differences and the implementation of effectively mathematics instruction (Eshiet, 1992; Soyibo, 1991, Ugama, 2011). Particular emphasis, however, has been placed on theories of learning related to mathematics, motivation, concept formation, sensory learning, transfer of training, drill, individual differences and the implication of learning theories for the improvement of instruction and improvisation (Fischer, 2007; Ugama, 2011).

One aspect of learning, which has been neglected in mathematics instruction but has relevance in experimental learning theory, is the programmed instruction (Staine, 2010). According to Staine (2010), although programmed instructional approach is one of the most basic and recent development in Information and Communication Technology (ICT), it has not formed a part of normal instructional practice in Nigerian schools. While it has also become explicit that a lot of advanced mathematical principles are embedded in programmes of various forms, current emphasis on mathematics instruction has continually ignored programmed instructional approach. One of the greatest contributions of technology to the world today is the development of computers and its application in all aspect of life including education. Erickson and Curl (2008) described computer as an enormously complex teaching machine which functions like the central nervous system. Solaki (2010) indicated that computer is one of the inventions that have placed man in a higher level of capacity. Interactive multimedia technology presents itself as a powerful tool for instruction, since it combines the potential of many new information-related technologies. When such technologies as text, audio, graphics, skill images and full-motion video are mixed into a single, computer-controlled multimedia program, the possibilities for the classroom are virtually unlimited. In particular, the prospects for preparing elementary and secondary school teachers appear especially promising in light of such technology (Sofolaha, 2009).

Professional development programs can profit from interactive multimedia instruction by providing structured observations of students and expert teachers in their classrooms. Being able to observe teaching skills and concepts in action can greatly enhance the acquisition of basic instructional skills by novice teachers as well as perfect the teaching practice of experienced teachers. Analyzing important instructional events helps to develop cognitive frameworks for thinking about the teaching and learning of mathematics. Technology is a highly significant in the society. The mathematics curriculum is rapidly incorporating the increased use of technology change and innovation in teaching of mathematics. The use of concrete materials in teaching mathematics emphasizes meaning in learning content. There are four basic gains for appropriate usage of computers in classroom application. They include:

- Providing interactive learning experiences at appropriate levels of difficulty (individualization of instruction);
- Dispensing information in a novel manner (tutorial assistance);

- Developing program writing skills which can be used to enhance the learning of other materials (programming skills development) and to enable evaluation of learning;
- Enabling evaluation of learning with immediate feedback and reinforcement capacities (Radlow, 2008).

The frequent evaluation and remediation are required in all mathematics classrooms. The use of the microcomputer to assist the classroom teacher in reaching specified objectives has both time-efficiency and professional creativity implications. Computer can be applied in many forms. It could be used in Computer-Assisted Instruction (CAI), Computer-Scheduled Education (CSE), Computer-Based Learning (CBL) and Computer-Managed Learning (CML).

All these are based on learning from computer and learning with computer. Learning from computers involves CAI (Computer-Assisted Instruction). This involves drill and practice, and tutorial programs. In drill and practice, it is assumed that the students have already been taught the appropriate materials and the computer simply provides a large number of practice problems on this material for the students. The computer takes the role of the dispenser of information and may include practice questions on the materials as the tutorial lesson proceeds. This is usually helpful in factual knowledge that may be effectively practical by the use of drill and practice programs.

From culture to culture and within any culture, mathematical instructional programmes appear in various contexts which are either clear-cut or mutually exclusive. With the variations in programmed instructional approaches and obvious differentials in drill patterns, it has been speculated that the impact of such mathematical instructional programmes on male and females may vary. According to Okenyi (2010), the extent to which programmed instruction influences the learning process of males and females still remain a source of concern to the proponents of Computer based learning approach in mathematics.

In fact, the extent to which the programmed instructional approach influences the achievement and interest of secondary school students in mathematics may have some far-reaching implications which are worth exploring hence this study.

LITERATURE REVIEW

TEACHING AND LEARNING OF MATHEMATICS

The classroom is occupied by two principal actors; the teacher and the learner. The concept of teaching and learning therefore, hinge on the activities of these actors in the classroom, which leads to the learner changing his behaviour positively. The concept of teaching can be approached at that angle. Teaching represents two variables; profession and activity. As an activity, teaching involves exploring all available opportunities to bring about positive change in behaviour in the learner. This is the aspect that is of interest here. Teaching, according to Onwuka, Iweka and Monseri (2010), is the creation or provision of experience and guidance of activities designed to promote learning on the part of those engaging in the activities. In support of the above, Iji (2010) commented that teaching is a conscious and deliberate effort by the teacher to provide directions, guidance, activities and materials in order to promote learning.

In the process of teaching, the learner acquires new attitudes, new skills, new knowledge, new values or appreciations. This is to say that in the process of teaching, learning occurs. In the view of Sertima (2009), teaching is a process whereby one person

mediates between another and the substance of this is to facilitate learning. Adaramola (2014) views teaching as a deliberate effort by a mature or experience person to impart information, knowledge, skills etc to an immature or less experienced person through a process that is morally and pedagogically acceptable. Abakpka and Iji (2011) asserted that teaching is a systematic activity, which involves the continuous assessment of learner's progress. Teaching is useless without learning. There are various methods of teaching and materials, which form part of educational technology, also facilitate teaching.

On the other hand, learning according to Abubakar (2015), is independent of teaching and can be facilitated through setting up of activities to that effect. Eze (2008) views learning as a process whereby an organism changes its behaviour as a result of experience. She emphasized that learning is a process. That is, it takes time and that it involves change in behaviour. Azuka (2013) contended that learning occurs through the learner's experiences and reactions to conditions in the environment. For Etukudo (2009) learning should be distinguished from the effects of native response tendencies manifesting as instincts or maturation. He insists that learning is what the learner does, not what the teacher does before the learner. In other words, it is what the learner does that he learns. Suleiman (2010) contended that the learner had to be set and ready for learning to be possible.

The psychology of human learning has done a lot in the improvement of learning. Generally, mathematics is made up of a set of concepts, facts, and principles and operations (with numbers, etc.) that are fundamental to the existence of every individual. Some of these are being used daily, sometimes without people knowing them. It is therefore obvious to learn mathematics. According to Azuka (2013), mathematics is concerned with searching for patterns and relationship among entitles with developing and expressing generalizations in mathematical symbols. This gives a way of looking and analyzing things in the environment around us. Abubakar (2015) considered mathematics as a science, and a way of thinking that has rules, goals and players just like a game. It's learning calls for imagination, participation (practice) and skills. Mathematics as a game is played for intellectual satisfaction, acquisition and practice of skills.

The abstract nature of mathematics is such that, it demands perseverance, constant practice and a lot of thinking both critically and analytically from its learner. Unfortunately, most students lack the patience and the required time to think properly in solving mathematical problems. In addition Adeniyi and Salman (2015) noted that mathematics is a symbolic language of size and others, which many students cannot comprehend easily. Hence, there is the general impression that the subject is difficult, and something to be feared. It has also been observed that Nigerian secondary school students' interest towards mathematics is generally negative (Ale, 1981). Iji, Emiakwu and Utubaku (2015) posit that comparatively, secondary schools student in Nigeria perform very poorly in mathematics. These poor performances in mathematics are not unconnected with the ineffective teaching methods, techniques and procedures (Ajai & Imoko, 2015).

In teaching of mathematics using computer, there is the need to develop the ability of the students to see mathematics in a situation, and to use the knowledge to solve problems that arise from it using computer. Ihendinihu (2013) stressed that the situation in which the problem occurs should involve real objects or simulation of real objects. This will enable the students to see the relationship between a situation or

event and its mathematical model. Azuka (2013) also emphasized the point that students of mathematics should be led to understand concepts and processes so that computer can find applications in various subjects such as mathematics.

ACHIEVEMENT IN SECONDARY SCHOOL MATHEMATICS

The role of mathematics in every facet of human life has been highlighted in the background and under the reference of use of mathematics to life. For this, efforts are being made to improve the teaching and learning of the subject. Despite these major roles of the subject in the society building, progress in Science and Technology of a nation and its importance in our secondary schools as prerequisite for admission into tertiary institutions, it has been observed that students achieve poorly in mathematics every year in G.C.E. O'level, WASC and SSCE mathematics examinations and even in other public examinations (Ugwuanyi, 2016; Abubakar, 2015). The poor achievement has been on the increase for over two decades. Mathematics still appears to be the school subject in which students experience the greatest learning problem and continue to have very low level of achievement. This situation, however, is not peculiar to Nigeria as it cuts across so many developing countries of the world. For instance, Iji, Emiakwu and Utubaku (2015) reported that the performance of all students in many areas involving problem solving or application of mathematical skills to be inadequate.

In Nigeria, this poor achievement in mathematics has been reported by various authorities. For instance, in the Western States of the country, Adeniyi and Salman (2015), observed a general poor performance of secondary school students in mathematics. Iji, Emiakwu and Utubaku (2015) discovered that class three students demonstrated mathematic deficiencies especially in the content area of geometry/mensuration and everyday statistics. A study carried out by Adaramola (2014) showed that the levels of mathematics attainments of secondary school students dropped with increasing class level. Again, Harbor-Peters and Ogomake (1984) in an expository study in primary school indicated that the profiles of primary school teachers in general, operated at the same level in mathematics as the pupils they teach. An investigation has been carried out into the mathematics weakness of secondary school students as viewed by science teachers in 1997 and found that students were finding the solutions of QEs equations difficult.

Similar reports of poor achievement of students in mathematics have been shown by various other authorities (Agwagah, 2016; Ugwuanyi, 2016). The problem could be as a result of the deficient technique of teaching mathematics and the errors committed in these content areas. Specifically, WAEC (2015 and 2016) Chief Examiner's report indicated that the candidate's performances were generally poor as the modal marks for most centers fall between zero and 10%. Also, the WAEC Chief Examiner's report in (2016) revealed that about 63% of the candidates scored between zero (0%) and 27% in the mathematics essay question paper II. It is most likely that students experience greater difficulty in this area since the questions in this area would involve students in the actual understanding of the questions (Agwagah 2016). Paper 1 which usually involves multiple choice formats does not seem to present much difficulty since most students can easily guess the answers and may even peep from their fellow students. Besides, solutions of essay questions involve procedures and actual computation and cannot be easily copied.

Describing the poor achievement of students in mathematics, Abubakar (2015) stated that mathematics education in this country is in a sorry situation. Ajai and Imoko also, described the state of secondary school mathematics education in the contemporary Nigerian system as being deplorable. They further emphasized that poor performance in mathematics is the major deterrent not only to the general scientific and technological development of the Nigerian nation

but also in the realization of the economic goals of vision 2020:20. The type of Mathematics teaching that goes on in the Nigerian Mathematics Classroom Curriculum (Ugwuanyi, 2016) would not achieve the three Nigerian economic goals of vision of self reliance, economic strength and political stability except if the mathematics curriculum changes and teaching methods reverse to mathematics problem solving strategies in the classroom. This implies strategies for effective mathematics education which programmed instructional package is among.

There has been so much concern and outcry from many quarters about the alarming poor achievement of students in mathematics. In another vein, Agwagah (2016), also, confirmed this problem of poor achievement in mathematics when she stated that '…it is sad to say that the state of mathematics teaching in Nigeria today is not encouraging. In the last decade or so, the failure rate by students in the GCE/WASC/SSCE examinations is high'. This view is consistent with that of Ugwuanyi (2016) who indicated, that achievement in secondary school mathematics in Nigeria has deteriorated progressively over the past decade. This is also, consistent with the WAEC Chief Examiners reports of 2015 and 2016 respectively. For instance, the Chief Examiner's report on GCE O'level mathematics (WAEC, 2016), stated that students' achievements in WASC and SSCE mathematics examinations is deteriorating at an alarming rate. For instance, the WAEC Chief Examiner's report on GCE O'level indicated that the modal mark for most centers in Mathematics when computed was either zero or near zero. According to Okoigbo (2009), the status of Mathematics achievement in secondary schools is more deplorable compared to any other secondary school subject.

Available research evidence also, reveals that poor achievement of students in mathematics could be due to lack of knowledge in specific areas (Musa & Bolaji, 2015; Iji, Emiakwu & Utubaku, 2015; Ugwuanyi; 2016). These researchers contended that lack of knowledge in specific areas in mathematics contributed to poor achievement in mathematics. It was also attributed to the socio-economic settings of the students. According to them, students achieve high in mathematics if their socio-cultural settings and their socio-economic status are conducive.

Although students' poor achievement in Mathematics continues to persist, a number of efforts and contributions have been made by mathematicians, Mathematics educators, researchers, Associations, and government, to remedy the situations and improve Mathematics education in our country. For instance, Mathematics Association of Nigeria (MAN), Niger branch, boldly launched "A War against Poor Performance in Mathematics" (WAPAM) in Suleja (Abubakar, 2015). In another contribution towards solution to poor achievement in mathematics, WAEC Chief Examiner in his report (WAEC, 2016/2017), recommended the use of effective teaching as the only remedy to students' poor achievement. Of particular reference is the problem solving approach to mathematics instruction. They rightfully identified that teaching and learning of problem solving is lacking in our mathematics classrooms. Agwagah (2016) stressed, that the use of problem solving approach in teaching mathematics is the most important predictor of success in all college studies. According to Azuka (2013), problem solving in solving mathematics involves some operations in the higher cognitive levels. Therefore, lack of heuristic (Polya's Problem Solving) strategy in solving problems, will make the students who are deficient in solving those problems that lie within the areas of the higher cognitive domain easy to solve.

Although the problem solving approach, has been recommended in mathematics instructions, the fascinating implications of computer packages in boosting problem solving abilities of students has not been fully captured in recent literature. In the same vein also, there are paucity of empirical evidence on the implications of computer programmed packages in teaching and learning of mathematics. In response to the poor mathematics achievement of students, this study intends to urgently arrest the deplorable state of secondary school Mathematics education

(teaching and learning) by introducing programmed instructional packages to teaching and learning of Mathematics.

DESIGN

This study adopted the quasi-experimental design. Specifically this study employed Pre-test Post-test non-equivalent control group design. The design was represented thus:

AREA OF THE STUDY

The study was conducted in secondary schools in Awgu Education Zone of Enugu State, Nigeria. Awgu Education zone has a total of 46 secondary schools. The reason for choosing the zone was because of poor achievement of students in mathematics in the area which could be attributed to low interest in the subject and also for the uniform structure of the public schools in the area.

POPULATION OF STUDY

The population of the study comprised all senior secondary two (SSII) students in the 46 secondary schools located within the area. The choice of SS II students was because their scheme of work contains the topics for which the instructional programmes were developed and it is not an examination class.

SAMPLE AND SAMPLING TECHNIQUES

The study sample comprised 300 SSII students from intact classes of the sampled schools from the study. Two co-educational secondary schools were drawn for this study. The choice of co-educational schools was because coeducational schools are adequate in providing data on variables of gender. The researcher employed simple random sampling technique in selecting the two schools from 46 co-educational schools within the area of the study. Out of the two secondary schools that were used for the study, one was assigned to the treatment group while the other was assigned to the control group through a simple toss of coin. All the intact classes of SS II students in the selected schools were used for the study.

INSTRUMENT FOR DATA COLLECTION

Mathematics Achievement Test (MAT) was used for data collection. The MAT was objective questions of the multiple choice type with options A-E. The instrument had 50 items which were developed from the curriculum of senior secondary school class 2 (SSII).

VALIDITY OF THE INSTRUMENT

The MAT was subjected to face and content validation. The face validation was ensured by two specialists in Mathematics education and one expert in measurement and evaluation while the content validity was ensured using the table of specification (Test of Blueprint).

RELIABILITY OF THE INSTRUMENT

After validation, the instrument was subjected to test of reliability using Kuder-Richardson 20 formula. The instrument yielded reliability co-efficient of 0.81.

METHOD OF DATA COLLECTION

At the onset of the experiment, the researcher administered the pre-test to the students. Scores of the students on the pre-test were recorded and kept for use after the experiment. At the end of the experiment, the post-test was administered to the subjects. For each of the groups, data for the pre-test and post-test were recorded separately. The same test was used at both pre-test and post-test.

METHOD OF DATA ANALYSIS

Research questions were answered using mean and standard deviation while the hypotheses were tested at an alpha level of 0.05 using the Analysis of Co-Variance (ANCOVA) with the aid of Statistical Packaga for the Social Sciences (SPSS version 20).

RESULTS

RESEARCH QUESTION 1

What is the effect of programmed instructional package on students' mean achievement in mathematics?

Data collected with the Mathematics Achievement Test was used to answer this research question. Summary of result is presented in Table 3.

Table 1: Mean Achievement Scores of Male and Female Students at PIP Treatment Level

Group	Mean	Std Deviation	No
PIP	63.56	11.07	162
CTM	30.98	7.98	138

Source: Researchers field work, 2017.

Results on Table 1 showed a mean achievement score of 63.56 with standard deviation of 11.07 for the treatment group and mean achievement scores of 30.98 with standard deviation of 7.98 for the control group. This indicated that the PIP is superior to the conventional approach in fostering students' achievement in mathematics.

Research Question 2

What is the interaction effect of methods and gender on the mean achievement scores of male and female in mathematics?

Table 2: **mean achievement based on interaction between methods and gender**

Gender Scores	PIP	CTM
Male	65.12	47.18
Female	61.55	44.63

Source: Researchers field work, 2017.

Results on Table 2 showed that the mean achievement score of male student taught mathematics using PIP is 65.12 and the female 61.55 the male students taught using CTM IS 47.18 and the female 44.63.

Hypotheses: 1 and 2

Table 3: ANCOVA Result for Ho_1 and Ho_2

Sources of Variation	Sum of Squares	df	Mean square	F-ratio	Sig
Covariates	3414.500	1	3414.500	53.325	
Pretest	3414.500	1	3414.500	53.325	
Main effects	17002.99	2	8501.099	132.740	
Methods	**16968.369**	**1**	**16968.369**	**264.951**	**3.91**
Gender	11.117	1	11.117	.174	
2-way interaction	1.556	1	1.556	.024	
Method and Gender	**1.556**	**1**	**1.556**	**.024**	**3.91**
Explained	9222.255	296	64.048		
Total	**29640.510**	**300**	**200.274**		

Significance at $p<0.05$

Source: Researchers field work, 2017.

Result of data analysis in Table 3 revealed that for hypothesis1, the F-calculated value is 264.951 while the critical value at 0.05 level of significance is 3.91. Based on the decision rule the researchers rejected the null hypothesis and concluded that there was significance difference in the mean achievement scores of students taught mathematics using the PIP and those taught using the conventional teaching method (CTM).

On the test of interaction between methods and gender, finding revealed that the F-calculated value is 0.024 while the critical value at 0.05 level of significance is 3.91. Since the calculated value is less than the critical value, the researchers upheld the null hypothesis and conclude that the interaction of methods and gender on the mean achievement scores of students in mathematics was not significant.

CONCLUSIONS

From the results obtained in the investigation into the effects of programmed instructional package on students' achievement in mathematics, the researchers drew the following conclusions.

a. The programmed instructional package as a teaching method is significantly better than the conventional teaching method in enhancing students' achievement in mathematics.

b. There was no significant interaction between methods and gender on students mean achievement scores in mathematics. For both males and female students, the programmed instructional package is superior to the conventional package in enhancing achievement in mathematics.

EDUCATIONAL IMPLICATIONS OF THE FINDINGS

The result of this study has provided empirical evidence on the efficacy of the programmed instructional package in teaching mathematics. This suggests the need for mathematics teachers to employ programmed instructional package in teaching some concept in other branches of mathematics in senior secondary classes. In other words, concepts from other branches of mathematics being taught using the programmed instructional approach would cease to be mere recall of facts, theories and laws. Students would be able to use their own mental process to solve some algebraic problems and other problems in mathematics.

By involving students in programmed instructional package, the teacher would be providing an environment in which equilibration can occur in the minds of the students. The findings of this study have implication for the government in the provision of in-service training and work hops for mathematics teachers. This will equip them with the knowledge of integrating instructional practices with assessment procedure that ate likely to have positive impact on students' achievement in Mathematics.

The fact that this approach leads to high level of understanding algebraic concepts points unmistakably to curricular implications. It implies that the mathematics curriculum developers should begin to integrate the programmed instructional approach in the curriculum especially at the senior secondary school classes. The absence of interaction between teaching method and gender with respect to achievement indicates that the approach in not gender biased and therefore should be employed to develop creative thinking in boys and girls.

RECOMMENDATIONS

Based on the findings of this study, the researchers made the following recommendations:

1. Both primary and secondary school mathematics teacher should be encouraged to adopt programmed instructional package as part of their teaching methods.

2. State and federal government should encourage and sponsor in-service training for mathematics teachers to learn the tenets of programmed instructional package.

3. The government in collaboration with curriculum developers and mathematics teachers should review the existing curriculum and integrate the basic tenets of the programmed instructional package in the curriculum.

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