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Effects of IEPT Constructivist Instructional Model on Students' Academic Performance in Mathematics

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Abstract

The study explored the effects of IEPT constructivist instructional model on students' Academic performance in Mathematics. The study adopted a pre-test post test control group design. One hundred and ninety Junior Secondary two (JS2) students in two co-educational schools in Umuahia Education Zone of Abia State were used for the study. The experimental group was taught using invitation, exploration, proposing explanation, taking action (IEPT) constructivist instructional model and the conventional method (CM) served as control. The main instrument for data collection was the Mathematics Achievement Test (MAT). The pre-test was administered before the experiment while the post-test was administered at the end of the study. One research question and one hypothesis guided the study. The research question was answered by mean and standard deviation while hypothesis was analyzed with the use of analysis of covariance (ANCOVA). The result obtained shows that students who were taught using IEPT constructivist instructional model performed significantly better than students taught with conventional method. It is recommended among other things that there should be a "paradigm shift" from the traditional expository method to active teaching/learning where teachers will be able to help students create cognitive maps, link ideas, address misconceptions and reinforce meaning.

(Keywords: Constructivist, instructional model, academic performance, mathematics)

Introduction

All stakeholders in Nigerian Education System are concerned about students' performance and academic standard. This is probably because success in education is highly instrumental to the development of a nation. The recurrent poor performance of secondary school students in Senior School Certificate Examination (SSCE) and National Examination Council (NECO) in Nigeria is disturbing and embarrassing. For instance, the result released by WAEC in 2010revealed that about 80% of the candidates that sat for the examination did not have credit passes in five subjects including

English Language and Mathematics. Similarly, about 98% of candidates that sat for Nov/Dec, 2009 did not have credits in five subjects including English and Mathematics (Okpala, 2010). Furthermore, in the year 2008 only 1.8% of the candidates that sat for senior secondary school examination passed (Uwadiae, 2008). These reports are worrisome because secondary school students of today are expected be become leaders tomorrow.

Although many studies have identified study habits, teachers qualification, school environment, government, students self concept, students' interest, teaching method as factors influencing students' academic performance (Aremu & Sokan,2003;Askhia, 2010); research findings have shown that teaching method or instructional approach adopted by teachers in presenting instructions has been implicated as the fundamental factor responsible for the poor performance of students in Mathematics (Odogwu, 1995) .

On guided discovery instructional method (Federal Ministry of Education, FME, 1985). This instructional method is activity oriented and involves practical demonstration. Students are guided by material and leading questions from the teacher to discover mathematical concepts. Yet, over the years, students' performances in Mathematics have not improved

More so, Nzewi (2000) asserted that effective teaching makes learning meaningful. She argued that while good teaching helps the learner to learn effectively, poor teaching will lead to poor learning and hence, poor achievement.

Many teachers adopt traditional method of teaching (lecture). Brooks and Brooks (1989) explained that in a traditional approach to teaching, linear model of knowledge building is encouraged. In this setting, focus is on whether or not students are aware of certain information, or can compute with certain algorithms. However, the writers observed that knowledge is not linear, nor is the process of learning. They emphasized that learning is a journey and not a destination, each point of view is a temporary intellectual stop along the path of ever-increasing knowledge.

Many instructional strategies and models have been adopted such as guided inquiry, problem solving, learning by doing and so on. In Nigeria, emphasis is

despite the much emphasis on advocated methods.

Current studies on how students learn (mathematics) have revealed new ideas and instructional approaches/models that have proved effective. One of such innovative instructional approach which educators have advocated recently is the constructivist instructional approach (Ogbonna, 2003).

Constructivism can be described as a theory that deals with the way people create meaning of the world through series of individual constructs. Von Glasersfeld (1989) simply stated that constructivism is a learning process which allows a student to experience an environment first-hand, thereby giving the student reliable knowledge. The student is required to act upon the environment to both acquire and test new knowledge.

Within constructivist framework, "knowledge" is no longer considered a neutral commodity that is transferred to everyone in the same way (Greeno, 2001). Instead, learning is conceptualized as an active constructive and cumulative process, in which students are engaged in high-level cognitive activities, developing new concepts and understandings based on their former knowledge or perceptions.

In mathematics and science education, it has been shown that effective learning environment is those that enable students to actively construct their own knowledge (De Jager, Greemers & Reezigt, 2002). Furthermore, in constructivist learning environment, provision is made for multiple representations of reality.

Some writers and researchers have proposed different models for instruction in their attempts to promote teaching and learning. In their bids to describe constructivist instructional models, these writers and researchers have come up with various phases of constructivist instructional models. Since constructivist instructional models has not been widely emphasized in Nigerian schools, the researcher in this study adopted a four phase constructivist instructional model i.e. Invitation, Exploration, Proposing explanation, Taking action (IEPT).

The Invitation, Exploration, Proposing explanation, Taking action (IEPT) as presented by Bybee, Buchward, Heil, Kucrbis, Matsumoto and McNerneney(1989) model focuses on student role of formulating, representing, clarifying, communicating, and reflecting on ideas that lead to an increase in learning. Learners learn by experimentation and not by being told what will happen and they are left to make their inferences, discoveries and conclusions. Here, the teacher plays the role of mediating, facilitating and enhancing learning. However, this study explored an instructional model grounded in constructivist framework with view to enhancing achievement in Mathematics. Therefore, the purpose of this study was to determine the effects of IEPT constructivist instructional model on students' achievement in Mathematics.

Research Question

The following research question guided the study:

What are the mean achievement scores and standard deviations of students taught Mathematics using IEPT constructivist instructional model and those taught using lecture method?

Hypothesis

There is no significant difference in the mean achievement scores of students taught mathematics using IEPT constructivist instructional model and those taught mathematics using lecture method.

Method

The study employed the specific pre-test post-test control design of quasi-experimental research. The design was considered appropriate for the study because intact classes were used instead of randomly drawn samples. The study made use of two groups – the experimental group and the control group. The experimental group was taught using IEPT constructivist instructional model while the control group was taught using lecture method.

One hundred and ninety out of three hundred and seventy six junior secondary two (JS2) students made up of 100 for experimental group and 90 for control from two selected secondary schools in Umuahia Education Zone of Abia State participated in the study. The JS2 students were used because they are in their foundation stage of their secondary school contact with the topic 'number and numeration'.

Two paralleled instruments and two lessons notes were used for the study. The instruments were the researcher's designed pretest and posttest on mathematics. These instruments consisted of 10 essay questions each developed from the contents taught in the lesson and these contents are: solving problems on direct and inverse proportion, finding ratio of two quantities in the same unit, using the idea of ratio in sharing quantities. The instruments were validated by two experts in Measurement and Evaluation and one in Mathematics Education using test blue print approach. The reliability indices of these instruments were established using Kendal's W Test. The pretest and posttest had a Kendal's coefficient of concordance of .707 and .875 respectively.

The regular mathematics teachers of selected schools for the study were coordinated to assist in the study. This was done for one week before the commencement of the study. The co-ordination exercise was based on: the purpose of the study, the content area to be taught, the use of the lesson plans, and the general conduct of the study. For the two regular mathematics teachers co-ordinated, one taught the treatment group (IEPT), the second teacher taught the control group (CG). The teachers were advised to observe the normal classroom procedures such as entry behavior, set induction, and so on. The teachers were also advised to use the same length of time (three weeks) to teach the content to the group.

In the experimental/treatment procedure, IEPT treatment condition which is a four phase constructivist instructional model was used. The phases are: (1) invitation – Recognizing the problem through observation and the decision to tackle such problem. (2)

Exploration/Discovery – In this stage, several attempts would be made to solve the problem (trial and error phase), but perseverance is needed to continue. (3) Proposing explanation and solution – when one arrives at the solution, then information would be communicated to others, that is, the explanation stage. (4)Taking action – This phase is the application stage where new knowledge is transferred to develop products and produce ideas.

At first, the students are involved in the understanding of the mathematical problem. The students try to identify the basic knowledge, relevant data and unknowns in the problems. The students also try to analyze, at times by making pictorial representation, forming equations. In fact, they try to recognize the problem through observation and then decide to tackle it by going to search in the long-term memory for a suitable plan or procedure for solution. If the plan or procedure devised is well articulated, solution could be completed quickly with few errors. Finally, new knowledge is transferred during application.

Before the onset of the experiment, the pretest on mathematics achievement (PREMAT) was administered by the coordinated regular mathematics teachers. This was to ascertain the level of achievement of the students. After the pretest, the regular coordinated mathematics teachers started the experiment in their respective schools. The researcher visited the school on regular bases for routine checks. This was to make sure that the participating mathematics teachers adhered strictly to the lesson plans written by the researcher. The experiment was conducted during the normal school periods following the normal time table of the school. The content areas were taught and covered within the second, third and fourth weeks. The post-test on achievement which is a parallel test to the pre-test was administered by the same teacher immediately after the three weeks of teaching. Data collected from the exercise were used to answer the research question and test the hypothesis stated for the study. The experiment lasted for four weeks and the students in the experimental and control groups were taught under the same experimental conditions.

The scoring of the students responses was on the minimum of 0 and maximum of 40 marks. Data analysis involved the use of mean and standard deviations. Analysis of covariance (ANCOVA) was also used. The instructional model was used as independent variable while

the pretest scores were used as covariates.

Results

The results of the study are presented in the tables below;

ResearchQuestion

What are the mean achievement scores and standard deviation scores of students taught Mathematics using IEPT constructivist model and those taught using conventional method?

Table 1: Mean Achievement Scores and Standard Deviations of Students in Mathematics Test.

Methods	Pre-Test		Post-Test		No of Students
	Mean	SD	Mean	SD	
Control Group (CMT)	10.4200	1.0126	23.4600	5.7045	100
Experimental Group (IEPT)	13.3111	4.6559	29.4222	7.4290	90

Table 1 shows the mean scores and standard deviations of the students in experimental and control groups pretest and posttest.

From table 1, it could be seen that the students in the experimental group had a mean score of 13.31 and standard deviation of 4.66 in pretest while in posttest, the students scored a mean achievement of 29.42 and a standard deviation of 7.43. For students in the control group, it was observed that they had a mean score of 10.42 and standard deviation of 1.01 in pre-test, while in post-test, the students scored a mean mark of 23.46 and a standard deviation of 5.70.

Hypothesis

There is no significant difference in the mean achievement scores of students taught Mathematics using IEPT constructivist instructional model and those taught using the conventional method. The hypothesis was tested at 0.05 probability level, using Analysis of Covariance (ANCOVA).

Table 2: ANCOVA Results for the Hypothesis (Achievement)

Source of variation	Sum of squares	DF	Mean	F	Sig. of F
Covariates	7776.920	1	7776.920	303642	.000
Pre-test	7776.920	1	7776.920	303.642	.000
Main Effects	482.544	1	483.544	18.880	.000
Method	482.544	1	483.544	18.880*	.000
Gender	114.837	1	114.837	4.276*	
2-Way Interaction	1.865	1	1.865	.074	.075
Method × Gender	1.865		1.865	.074**	.075
Explained	7897.217	2	3948.608	147.024	.000
Residual	7681.081	286	26.857		
Total	15578.298	288	54.091		

Table 2 shows ANCOVA results on achievement of students who were taught Mathematics using IEPT constructivist instructional model. The result shows that there is a significant difference between mean post Mathematics achievement scores of students in the experimental and control group. Method was significant in the achievement of students. The null hypothesis of no difference was rejected.

Discussion

Results showed that the mean achievement scores of the students in the experimental group were higher than that of the mean achievement scores of students in the control group. This was further confirmed by the result which revealed that method was a significant factor on students 'performance in Mathematics.

This finding supported the findings of other previous researchers such as (Aiyedum, 2000 & Ogbonna, 2003) where experimental treatment proved better than the control treatment. This equally agreed with other similar studies (Ogbonna, 2007) which confirmed that appropriate constructivist instructional approach leads to students' improvement performance in Mathematics. Thus, the researcher opines that IEPT holds great potential for Mathematics education of the present and future students and teachers of Mathematics. This model promotes students achievement in Mathematics through students creation of cognitive maps, linking of ideas, addressing misconceptions and reinforcing meaning.

Conclusion

The findings of the study have implications in the teaching and learning effectiveness at the secondary and upper primary levels. The use of IEPT constructivist instructional model enhanced significantly students' achievement in JS2 mathematics, thus, students taught with the conventional method achieved less. Therefore, every Mathematics teacher should be able to lead students to analyze the relationships among problems, predict how certain problems could be solved if certain variables were changed or removed. Analyzing, interpreting, predicting and synthesizing are mental activities that require students to make connections, delve deeply into texts and contexts and create new understanding.

Recommendations

The findings of this study and the implications to education have necessitated the following recommendations:

1. Since IEPT model appear relatively new and as such, it should be incorporated in the mathematics curriculum for the pre-service teachers programme. This will help the teachers to learn and use this model in the teaching of mathematic.
2. Workshops should be organized for in-service mathematics teachers to enable them learn how to use IEPT constructivist instructional model. This will help them to be able to incorporate the model in their teaching.
3. Again ministries of education, state secondary school education boards and professional bodies such as Mathematical Association of Nigeria (MAN), National Mathematical Centre Abuja and Curriculum Organization of Nigeria (CON) should be involved in promoting this model of teaching as innovation in the teaching of mathematics. This they could do by organizing conferences, seminars and workshops for the serving teachers on the teaching of mathematics using IEPT. These professional bodies should further sponsor researches on effects of this model on other mathematics concepts.
4. Since textbooks are the major source of information and knowledge for the teachers and students, authors and publishers of mathematics textbooks could incorporate the IEPT phases in their worked examples in order to offer students the opportunity of learning even unguided.

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