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The Effects of Modelling and Guided-Discovery On Secondary School Students' Performance in Mathematics in Ekiti State

AUTHOR(S): ABIODUN A. POPOOLA (PH.D)[1],
AND
BINUYO JOSHUA O[2]

Abstract

The study examined the effects of modelling and guided-discovery on secondary school students' performance in mathematics in Ekiti State. This study adopted a quasi – experimental pre-test and post-test three group design (two experimental groups and one control group). The population of the study comprised all 21,199 S.S.S. 2 students in all the public secondary schools in Ekiti State, Nigeria. The sample consisted of 169 S.S.S. 2 students (intact class size) drawn from 6 public secondary schools in Ekiti State, Nigeria. The sample was selected using multistage sampling technique. Performance Test in Mathematics (PTM) was used to measure performance of students in Mathematics. The face and content validity of the instruments were ensured by experts of Tests and Measurement and two Mathematics teachers. The reliability of the instrument was determined by finding the internal consistency of the instrument which yielded reliability co-efficient value of 0.91. The data collected through the instruments were analyzed using inferential statistics and all hypotheses were tested at 0.05 level of significance. The result revealed that the use of modelling, guided-discovery and conventional strategies enhanced performance of students in Mathematics, with guided-discovery strategy being the most effective strategy. The result also revealed that modelling and guided-discovery strategies are not gender biased. Based on the findings, it was recommended among others that the use of

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modelling and guided-discovery strategies should be encouraged so as to enhance better academic performance of students in Mathematics.

Keywords: Modelling, Guided-discovery, Performance, Mathematics,

About Author

Author(s): **ABIODUN A. POPOOLA (PH.D)**[1],

[1]EKITI STATE UNIVERSITY, ADO – EKITI, EKITI STATE, NIGERIA.
popabiodun_2005@yahoo.com[1],
*Corresponding author

AND

Co -Author(s): BINUYO JOSHUA O[2]

[2]EKITI STATE UNIVERSITY, ADO – EKITI, EKITI STATE, NIGERIA.
binuyoalaba@gmail.com[2].

Introduction

Mathematics is solving of problems that involve calculations. It is a subject seen by the society as the foundation of scientific and technological knowledge that is vital to the socio-economic development of a nation. Consequently, Mathematics is made a compulsory subject in primary and secondary schools in Ekiti State and Nigeria as a whole. In addition, Mathematics is so important that every child is expected to study it for six years in primary school, three years in Junior Secondary School and three years in Senior Secondary School. Moreover, students are expected to pass Mathematics before being promoted to the next class in Ekiti State or gaining admission into any higher institution of learning in Nigeria.

Students' poor performance in Mathematics over the years has been attributed to the fact that the subject is difficult. It has been observed that the performance of students in Mathematics has not been encouraging in Senior School Certificate Examinations (SSCE) as it was revealed from the result analysis gotten from Ekiti State Ministry of Education that less than 49 percent of students passed Mathematics between 2016 and 2019 at credit level (Ministry of Education, Statistics Division, 2020).

The performance of students in Mathematics especially in the certificate examinations in Senior Secondary Schools as opined by Popoola (2013) is a matter of great concern to researchers, teachers, parents, educators and administrators. She stressed further that stakeholders continue to shift blame on the teachers each time poor performance of students in Mathematics is recorded. The performance of students in Mathematics could be attributed to certain factors which include inadequate mastery of the subject matter by the teacher, inadequate instructional (both human and material) resources or inappropriate teaching methods by the teacher.

The studies of Popoola (2014) and Akanni (2015) at different times showed that Mathematics teachers in the classrooms are not making use of teaching skills acquired before and after certification. The deficiencies in Mathematics teaching according to Popoola (2013) range from; non-coverage of contents in schemes of work, non-giving and marking of assignments, non-supervision of instruction, non-organization of practical lessons, non-organization of extra lessons to cover lost grounds, non-proper handling of instructional materials to be used during lessons, non-assessment of learning outcomes regularly, non-application of improvisation knowledge in instruction to non-taking out of students to field experiences.

According to Akinsola (2010), the traditional approach to education where students receive direct instruction and then practice specific skills is not good enough for critical thinking. Therefore, there is need to search for alternative method of instruction in Mathematics that will be effective in helping learners to understand and retain what is learnt, improve their attitude and enhance their performance. Based on this, the study considered modelling and guided-discovery strategies as they affect students' performance in Mathematics.

The conventional instructional approach focuses completely on the intellectual and neglects the experiential learning (Salako, Eze, & Adu, 2013). In addition, empirical evidences have shown that the conventional instructional approach is not adequately effective for enhancing the achievement of students in the school subject because it lessens the students' participation in the learning process (Abimbola & Abidoye, 2014; Hossain & Tarmizi, 2013).

Modelling as a teaching technique involves using manipulative. Modelling embraces the use of visual aid, objects or pictures which highlight the main ideas and variables in a process or system to convey contextual instruction to the learners. It helps in concretising

abstract concepts during pedagogical processes. This system enhances both simulation and stimulation of mental thinking of the learners to contextualise knowledge and to retain the gained information for a long term duration (Campbell, 2006). The acquired knowledge of mathematical concepts can be made relevant to solve unfamiliar problems with which learners may be confronted within an authentic environment. It was therefore indicated that in using this approach, the learners' mathematical ideas are being brought to a higher cognitive level.

Guided discovery approach is an instructional approach in which a teacher provides clarifying learning materials for learners to study on their own under the guidance of a teacher (Akinbobola & Afolabi, 2010). Fatokun and Eniayeju (2014) and Udo (2010) found the effectiveness of guided discovery in facilitating the achievement of secondary students. In a related study, the effectiveness of guided discovery over conventional approach on students' mathematics achievement was found in the studies of Akanmu and Fajemidagba (2013) and Matthew and Kenneth (2013). Akanmu and Fajemidagba argued that the approach was effective in stimulating the high, medium and low achieving student to perform better in mathematics.

In view of the above, the researcher intends to investigate the effects of modelling and guided-discovery on secondary school students' performance in mathematics in Ekiti State

Purpose of the Study

The study examined the effects of expository and guided-discovery on secondary school students' performance in mathematics in Ekiti State. The study specifically examined:

1. the difference among the pre-test mean scores of students exposed to modelling, guided-discovery and conventional strategies;
2. the difference between the pre-test and post-test mean scores of students exposed to modelling, guided-discovery and conventional strategies; and
3. gender difference in the academic performance of students exposed to modelling and guided-discovery strategies

Research Hypotheses

The following research hypotheses were generated for this study

1. There is no significant difference in the pre-test mean score of students exposed to modelling, guided-discovery and conventional strategies.
2. There is no significant difference between the pre-test and post-test mean score of students exposed to modelling, guided-discovery and conventional strategies
3. There is no significant gender difference in the academic performance of students exposed to modelling strategy.
4. There is no significant gender difference in the academic performance of students exposed to guided-discovery strategy.

Methodology

This study adopted a quasi – experimental pre-test and post-test three group design (two experimental groups and one control group). The base line of the knowledge of students that were used for the study and homogeneity was established by pre-test while post-test was used after the treatment to measure students' academic performance. The pattern of the design is as shown below.

Experimental group 1 (E1) O_1 X_1 O_2

Experimental group 2 (E2) O_3 X_2 O_4

Control group (C) O_5 X_c O_6

Where:

O_1, O_3, O_5– (Observations before treatment)

O_2, O_4, O_6 – (Observations after treatment)

X_1 – Treatment (Modelling Strategy)

X_2 – Treatment (Guided-Discovery Strategy)

X_c – Treatment (Conventional)

The population of the study comprised all 21,199 S.S.S. 2 students in all the public secondary schools in Ekiti State, Nigeria. The sample consisted of 169 S.S.S. 2 students (intact class size) drawn from six public secondary schools in Ekiti State, Nigeria. The samples were selected using multistage sampling technique.

In stage one; one Local Government Area (LGA) was selected from the three Senatorial Districts in Ekiti State using simple random sampling technique. The next stage involved the use of stratified random sampling technique to select two public secondary schools from each of the three LGAs earlier selected. The third stage involved the use of cluster sampling technique to select an intact class from each of the six schools selected for this study. The fourth stage involved the use of purposive sampling technique to group the schools into different experimental and control groups.

Performance Test in Mathematics (PTM) was used to measure performance of students in Mathematics. It consisted of two sections, Sections A and B. Section A sought for the bio-data of the respondents which include the name of the school, identification number, school location and sex. Section B consisted of 30 objectives items with four options (made of 8 questions on Knowledge, 7 questions on Comprehension, five questions on Application, four questions on Analysis, three questions on Synthesis and three questions on Evaluation). The items covered all the topics to be taught for the six weeks. The PTM was used for both pre-test and post-test for data collection. The pre-test was designed to test the homogeneity of the three groups. The options of the questions of PTM used for pre-test was reshuffled for the post-test in order to prevent carry-over effect.

The face and content validity of the instruments were ensured by experts of Tests and Measurement and two Mathematics teachers who are WAEC examiners. The face and content validity was ensured by these professionals who assessed the wordings and ambiguity of the items of test as well as coverage. Based on their comments and suggestions, the items were modified accordingly.

The reliability of the instrument was determined by finding the internal consistency of the instrument. In doing this, a pilot study was carried out outside the sampled schools. The instrument was administered on 30 respondents. In order to ascertain reliability of the instrument, data collected were tested using Cronbach's alpha which yielded reliability co-efficient value of 0.91. The co-efficient value obtained was considered statistically high to make the instrument reliable.

The researcher took permission from principal of each sampled schools. The study will be carried out in three phases: pre-treatment stage, treatment stage and post-treatment stage which will spread through a period of 6 weeks. The data collected through the instruments were analyzed using inferential statistics. After treatment, the scores in pre-test and post-test in the three groups were collated and subjected to Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA) and t-test. The hypotheses were tested at 0.05 level of significance.

RESULTS

Hypothesis 1: There is no significant difference in the pre-test mean scores of students exposed to modelling, guided-discovery and conventional strategies.

Table 1: Analysis of Variance (ANOVA) for difference in pre-test mean score of students in experimental and control groups

Groups	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.188	2	1.594	0.769	0.503
Within Groups	344.269	166	2.074		
Total	347.457	168			

P > 0.05

The result presented in table 1 showed that F-cal value of 0.769 is not significant because the P value (0.503) > 0.05 at 0.05 level of significance. Hence, the null hypothesis is not rejected. This implies that there is no significant difference in the pre-test mean score of students exposed to modelling, guided-discovery and conventional strategies. The students in the groups are homogeneous at the commencement of the study.

Hypothesis 2: There is no significant difference between the pre-test and post-test mean scores of students exposed to modelling, guided-discovery and conventional strategies

Table 2: Analysis of Covariance (ANCOVA) for Pre – test and Post – test Mean Scores of Students under the Groups

Source	Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	10041.990[a]	3	3347.330	89.346*	.000
Intercept	650.458	1	650.458	17.361*	.000
Pre-test	98.990	2	49.495	1.321	.163
Groups	10021.312	2	5010.656	133.742*	.000
Error	6144.291	164	37.465		
Total	**166798.000**	**169**			
Corrected Total	**13196.282**	**168**			

a. R Squared = .788 (Adjusted R Squared = .781) * P < 0.05

The result presented in table 2 shows that there is a significant difference in the pre – test and post – test mean scores of students in the groups (modelling, guided-discovery and control groups) as P= 0.000<0.05. This result led to the rejection of the null hypothesis. By implication, there is significant difference between the pre-test and post-test mean score of students exposed to modelling, guided-discovery and control groups. In order to find out the most probable effective strategy, Multiple Classification Analysis (MCA) was carried out. The result is shown in Table 3.

Table 3: Multiple Classification Analysis (MCA) of students' performance in Mathematics by treatment

Grand Mean = 19.95					
Variable + Category	N	Unadjusted Dev'n	Eta^2	Adjusted for Independent + Covariate	Beta
Experimental (Modelling)	65	1.22	.81	1.15	.09

Experimental (Guided-discovery)	45	3.64		3.59	
Control	59	-4.87		-4.93	
Multiple R					.887
Multiple R^2					.788

The result in Table 3 shows the Multiple Classification Analysis (MCA) of students' performance in Mathematics by treatment. It reveals that, with a grand mean of 19.95, students exposed to guided-discovery had highest adjusted mean score of 23.59 (19.95+3.64) than their counterparts in modelling and the control group with modelling having 21.17 (19.95+1.22) and control group 15.08 (19.95+(-4.87)). This means that guided-discovery strategy was the most effective strategy of teaching Mathematics in Ekiti State, Nigeria. Followed by modelling strategy and the least was conventional strategy. The treatment explained about 81% (Eta^2 = 0.81) of the observed variance in students' performance in Mathematics. The three treatment strategies accounted for 78.8% (R^2 = 0.788) contribution to academic performance of the students in Mathematics.

Hypothesis 3: There is no significant gender difference in the academic performance of students exposed to modelling strategy

Table 4: t-test analysis for gender difference in the academic performance of students exposed to modelling strategy

Variations	N	Mean	SD	df	t_{cal}	P
Male	39	21.20	3.46	63	0.056	0.972
Female	26	21.15	3.52			

P>0.05

Table 4 shows that the t-cal value of 0.056 is not significant because the P value (0.972) > 0.05. This implies that null hypothesis is not rejected. Hence, there is no significant gender difference in the academic performance of students exposed to modelling strategy.

Hypothesis 4: There is no significant gender difference in the academic performance of students exposed to guided-discovery strategy.

Table 5: t-test analysis for gender difference in the academic performance of students exposed to guided-discovery strategy

Variations	N	Mean	SD	df	t_{cal}	P
Male	24	23.62	2.71	43	0.058	0.969
Female	21	23.57	2.99			

P>0.05

Table 5 shows that the t-cal value of 0.058 is not significant because the P value (0.969) > 0.05. This implies that null hypothesis is not rejected. Hence, there is no significant gender difference in the academic performance of students exposed to guided-discovery strategy.

Discussion

The finding of this study revealed that, the performance of students in both experimental and control groups in pre-test were low and do not differ statistically. This finding established the homogeneity of the three groups involved in the study prior to the experiment. In other words, it could be said that the knowledge baseline for the three groups

involved in the study are equal. Consequently, any significant difference recorded afterwards would not be ascribed to chance, but to the specific treatment applied.

The findings of this study revealed that there was significant difference in the pre-test and post-test mean scores of students exposed to modelling, guided-discovery and conventional strategies. There was a better improvement in the performance of students resulting from their exposure to modelling and guided-discovery strategies. Guided-discovery strategy was the most effective strategy of teaching Mathematics in Ekiti State, Nigeria closely followed by modelling strategy and the least was conventional strategy. This study agrees with the findings of Akanmu and Fajemidagba (2013) and Matthew and Kenneth (2013) who found that guided discovery method is effective in facilitating students' academic performance. They observed that guided discovery approach is capable of enhancing the achievement of secondary students because the learners are more likely to recall what they have discovered by themselves.

The findings from the hypothesis on gender difference between the experimental groups showed no significant difference. This means that, gender has nothing to do with students' response to the use of any of the instructional strategies i.e. Modelling and Guided-discovery. The findings agreed with the findings of Olofin (2019), Akanmu and Fajemidagba (2013) and Matthew and Kenneth (2013) who observed that gender has no effect on students' academic performance in Mathematics.

Conclusion

Based on the findings of this study, it could be concluded that, the three groups (modelling, guided-discovery and conventional strategies) were homogeneous at the commencement of the experiment. The use of modelling, guided-discovery and conventional strategies enhanced performance of students in Mathematics, with guided-discovery strategy being the most effective. Modelling and guided-discovery strategies are not gender biased.

Recommendations

Based on the findings of this study, the following recommendations were made.

1. The use of modelling and guided-discovery strategies should be encouraged so as to enhance better academic performance of students in Mathematics.
2. Mathematics teachers should be given adequate orientation through workshops and seminars to update their knowledge in the use of modelling and guided-discovery strategies in teaching.

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