

Effects of Heuristic Teaching Approach on Academic Achievement of Senior Secondary School Mathematics Students in Girei Local Government Area of Adamawa State, Nigeria

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Abstract

This study was conducted to find out the effect of Heuristic Teaching Approach on academic achievement of Senior Secondary School Mathematics students in Adamawa State, Nigeria. A total of 100 SSII students was drawn from five (5) senior secondary schools using stratified random sampling technique with fifty (50) males and fifty (50) females. The instrument used for the study was a self-designed questionnaire with reliability coefficient of 0.84. Three research questions were raised and three hypotheses were formulated and tested using t-test statistical tool at 0.05 level of significance. The findings of the study revealed that students exposed to Heuristic Teaching Approach achieved higher than those taught with Conventional Approach. Also the male students achieved higher than the female students with a significant mean difference. Based on the findings, it was recommended among others that Heuristics teaching approach should be used in teaching mathematics and that mathematics teachers should be well trained on the use of Heuristic Teaching Approach so as to enhance students' academic achievement in mathematics.

Key words: academic achievement, heuristic teaching approach, mathematics, gender

Introduction

Mathematics is a subject that is found useful in most fields of life. Hence it is made compulsory to both primary and secondary school students in Nigeria today. According to Salman (2003), it is a subject that enables a learner to have adequate understanding and interpretation of concepts in science and technology. It is referred to as the bedrock of science, which brings about technology (Azuka, 2003).

The importance of mathematics cannot be over emphasised, unfortunately available evidence has shown that Nigerian students' achievement in this subject is not encouraging. For instance, Sanni and Ocheba (2002) made this report and this was confirmed by Uloko and Usman (2007). Efforts to find solution to these problems made some researchers to examine some factors, which were considered to influence mathematics achievement. These include poor method of teaching and gender difference (Harbour, 2001 and Ozofofor, 2001).

According to Harbour (2001), this low achievement is caused by teachers' non utilization of appropriate teaching methods. This assertion had been ascertained by Obodo (1997), who opined that the method of teaching mathematics in Nigeria is teacher centred, students are not fully involved in teaching -learning process. This method did not yield expected results. In the quest to search for a method which makes students more participatory in the teaching and learning process, the introduction of heuristic teaching approach becomes imperative as stressed by previous researchers (Tiong, Hedberg, and Lioe (2005))

The term heuristic was coined from a Greek word, which means 'I find'. Here the student is put in the place of a discoverer. The method involves finding out by the student, instead of merely explaining everything to the students by the teacher. Heuristic method of teaching is aimed at removing the shortcomings attributed to lecture method or other conventional methods used by the teachers. It is a method by which students learn to reason for themselves.

This method has been found very useful in the teaching of mathematics (Břehovský, *et al* (2013)). Staunch supporters of this method are of the opinion that every student should be made a discoverer and inventor. The mathematics teacher's job is not to solve the problems for the students, but to enable the student to solve problems by themselves after listening to teacher's leading questions or hints that will give a clue to solving the problems in the class.

As a practical example of the use of heuristic method, if we take the problem of the students' discovery of the characteristics of a parallelogram. The mathematics teacher only give the students many parallelogram already drawn on sheets of paper and ask them to find out the qualities of the different elements of a parallelogram. Naturally the students will start judging and measuring the elements of different parallelograms, their findings about equality of its opposite sides and equality of the sum of its adjacent angles, will perfectly agree. Thus their respective observations will enable them to generalise about some of the characteristics of a parallelogram. Furthermore, students can be encouraged to draw the diagonals of the parallelograms and find out after actual measurements that diagonals bisect each other in every parallelogram. Hence, students can convincingly list all the properties of parallelogram without cramming them.

Heuristics method has a lot of advantages, for instance, students becomes an active participants in the teaching and learning process, they also take pride in their achievement after discovering basic facts in mathematics by their efforts. This in turn give them happiness and mental satisfaction, thus encouraging them towards further achievement.

Statement of the Problem

Despite the efforts of Nigerian government towards improving the teaching and learning of mathematics in secondary schools, students interest in the subject remain poor, though other teaching methods have been applied by teachers for the purpose of improving students interest and retention in mathematics, yet little or no reasonable improvements have been recorded.

Heuristics approach is alien to some mathematics teachers, thus students have not been able to develop necessary skills that could have helped them to tackle mathematics problems with or without teachers supervision. This has given rise to the problem of low achievement in mathematics among students. Female students dread mathematics more than the male students during internal and public examinations. This study seek to determine whether the use Heuristic Teaching Approach might bring some improvement in students interest and achievement in mathematics more than other teaching approaches being used by mathematics teachers in secondary schools.

Purpose of the Study

The main purpose of this study is to determine the effect of Heuristic Teaching Approach on academic achievement of senior secondary school mathematics students in Adamawa State, Nigeria. The specific purposes of this study are to:

- (i) Determine the effect of Heuristic Teaching Approach on students' achievement in mathematics;
- (ii) Determine the effect of Heuristic Teaching Approach on the pre-test and post –test achievements of the experimental group based on gender
- (iii) Examine the effect of Heuristic Teaching Approach on the post-test achievements of the experimental and control groups based on gender.

Research Questions

- (i) What is the effect of Heuristic Teaching Approach on students'

achievement scores in mathematics?

- (ii) What is the effect of Heuristic Teaching Approach on the pre-test and post-test achievements scores of the experimental group based on gender?
- (iii) What is the effect of Heuristic Teaching Approach on the post-test achievement of the experimental and control group based on gender?

Hypotheses

The following hypotheses were formulated and tested at 0.05 level of significance:

HO₁: There is no significant difference between the mean achievement scores of students taught mathematics using Heuristic teaching approach and those taught with conventional teaching approach.

HO₂: There is no significant difference between the mean scores of the experimental group in the Mathematics Achievement Test based on gender

HO₃: There is no significant difference between the mean scores of the post-test Achievements of experimental and control groups in Mathematics Achievement Test based on gender

Methodology

This study was a quasi-experimental design. This design was adopted because it was difficult to randomise all the subjects used for the study. The researcher used intact classes.

The population comprised of all the SS II students in Girei Local Government Area of Adamawa State. Four schools were sampled out of the senior secondary schools in the local government area. The four schools were randomized and assigned experimental and control groups respectively. The experimental groups were taught with Heuristic teaching approach while the control groups were taught with the traditional approach. The experimental group comprised of 50 male and female students while the control group also comprised of 50 male and female students, making a total of 100 students used for the study.

The instrument used to collect data was Mathematics Achievement Test (MAT) which was constructed by the researcher. MAT contained 25 multiple choice items, each item contained one correct answer and three distractors. Copies of the 25-item multiple choice questions were given to three experts for face and content validation, in the Department of Science Education, Modibbo Adama University of Technology, Yola, they are specialist in measurement and evaluation and are also mathematics educationist. The validation exercise was conducted by assessing the instrument in terms of suitability of the items for the objectives of the lessons prepared for teaching during the experiment, the validators also ensured that the items measured the six objectives in the cognitive domain of Bloom's taxonomy. They vetted the keys in the multiple objectives test used for the study. The (MAT) was marked over 100, indicating that the total marks possible for each student was 100%.

The items were trial tested on thirty students in a school different from those used for the study. The reliability of multiple choice items was computed using Kuder-Richardson K-R21 formula, the value obtained was 0.84 which is an indication that the instrument is reliable.

Two regular mathematics teachers were trained by the researcher one week before the commencement of the study. The training exercise was based on the purpose of the study, the topic being taught, the use of the lesson plans, the use of the MAT instrument and the general conduct of the study. These mathematics teachers were trained to teach both the experimental and control groups. Specifically, for the experimental groups, the teachers concerned were asked to use Heuristic Teaching Approach to teach the students while in the control groups, the teachers were advised to use the traditional method they are used to. The researcher ensured that the extraneous variables such as teacher variable, students’ interaction and pre-test sensitization were controlled throughout the experiment period.

RESULTS

The results of the study were presented according to the research questions and hypotheses formulated for the study.

Research Question I

What is the effect of HTA on students’ achievement scores in mathematics?

Table 1: Mean Achievement Scores and Standard Deviation of Subjects in the Experimental and Control groups in Pre-test and Post-test (MAT)

Teaching Method	Type of Test	n	\bar{X}	σ
Heuristic Teaching approach	Pre-test	50	44.68	11.09
	Post-test	50	81.12	15.10
Conventional	Pre-test	50	40.25	10.35
	Post-test	50	58.72	13.16

The result in table 1, indicates that the experimental group had a mean achievement score of 44.68 and a standard deviation of 11.09 in pre-test while control group had a mean and standard deviation of 40.25 and 10.35 respectively in pre-test. Similarly, in post-test, mean achievement score and standard deviation of experimental group are 81.12 and 15.10 respectively while mean achievement score and standard deviation of control group are 58.72 and 13.16 respectively. The mean difference between Pre-test and Post-test for experimental and control groups are 36.44 and 18.47 respectively. This implies that students taught mathematics using Heuristic Teaching Approach improved tremendously in mathematics achievement test than those taught with Conventional Teaching Approach. To confirm this result, it was tested in hypothesis 1

Hypothesis 1

There is no significant difference between the mean achievement scores of students taught mathematics using Heuristic Teaching Approach and those taught with Conventional Teaching Approach.

Table 2: Comparison of the Experimental and Control Groups using Post-test Scores

Group	n	\bar{X}	σ	df	t-cal	t-crit	Remark
Experimental	50	81.12	15.10	98	7.91	1.98	S
Control Group	50	58.72	13.16				

In Table 2, the result of the analysis of the post-test scores of both groups (control and experimental) shows that there is a significant difference between the two groups. In other words, there is a difference in the performance of students in both groups after they were exposed to different treatments. The null hypothesis is therefore rejected. The implication of this finding is that the Heuristic Teaching Approach enable students in the experimental group to perform better than the students in the control group. This findings is in consonance with those of Novotná, *et al.* (2013) in whose experiment the group that was exposed to Heuristic Teaching Approach performed better than the control group.

Research Question 2

What is the effect of HTA on the pre-test and post-test achievements scores of the experimental group based on gender?

Table 3: Comparison of Post-Test Achievement Scores of Experimental Group with Respect to Gender

Group	Sex	Type of Test	n	\bar{X}	σ
Experimental	Male	Pre-test	25	43.64	12.48
		Post-test	25	77.89	11.42
Experimental	Female	Pre-test	25	31.38	9.74
		Post-test	25	66.45	16.67

Table 3 shows that the mean achievement scores of male students taught with Heuristic Teaching Approach was 77.89 and their standard deviation was 11.42 while their female counterpart had 66.45 as mean and the standard deviation was 16.67. This implies that Heuristic teaching approach has higher impact on the male students more than female students. Hypothesis 2 was therefore tested to confirm this.

Hypothesis 2

There is no significant difference between the mean scores of the experimental group in the Mathematics Achievement Test based on gender.

Table 4: A Comparison of the Experimental Group Achievement Scores from Pre-test to Post-test Based on Gender

Group	Sex	Type of Test	n	\bar{X}	σ	df	t-cal	t-crit	Remark
Experimental	Male	Pre-test	25	43.64	12.48	48	10.12	2.01	S
		Post-test	25	77.89	11.42				
Experimental	Female	Pre-test	25	31.38	9.74	48	9.08	2.01	S

Post-test 25 66.45 16.67

Table 4 revealed that male in the experimental group achieved significantly better from pre-test to post-test in the Mathematics Achievement Test since t-calculated value 10.12 is higher than t- critical value of 2.01 at 0.05 level of significance . Similarly, the females in the experimental group achieved significantly better from pre-test to post-test in the Mathematics Achievement Test since the t-calculated value 9.08 is greater than t-critical of 2.01 at 0.05 level of significance.

Research Question 3

What is the effect of HTA on the post-test achievements of the experimental and control groups in MAT based on gender

Table 5: Mean Achievement and Standard Deviation Scores of Experimental and Control Group in Pre-test and Post-test.

Group	Sex	Type of Test	n	\bar{X}	σ
Experimental	Male	Post-test	25	77.89	11.42
Control	Male	Post-test	25	60.88	10.12
Experimental	Female	Post-test	25	66.45	16.67
Control	Female	Post-test	25	48.15	15.96

Table 5 shows that both male and female students performed better than their counterparts in the control group. The mean of male students is however higher than that of the female students in the experimental group. To confirm this result, hypothesis 3 was then tested.

Hypothesis 3

There is no significant difference between the mean scores of the post-test achievement experimental and control groups in MAT based on gender

Table 6: A Comparison of the Achievement of Males and Females in the Experimental Group and Control Groups Using Post-test Scores

Group	Sex	Test	n	\bar{X}	σ	df	t-cal	t-crit	Remark
Experimental	Male	Post-test	25	77.89	10.84	48	5.74	2.01	S
Control	Male	Post-test	25	60.88	10.12				
Experimental	Female	Post-test	25	69.73	10.34	48	5.67	2.01	S
Control	Female	Post-test	25	48.15	15.96				

Table 6 revealed that in the Mathematics Achievement post-test, males in the experimental group achieved significantly better than males in the control group (t- calculated value 5.74 > t-table 2.01 value at 0.05 level of significance) and females in the experimental group also achieved significantly better than females in the control group (t- calculated value 5.67 > t-table value 2.01 at 0.05 level of significance). This meant that Heuristic teaching approach helped both male and female students in the experimental group.

Discussions

The result in Table 1 show that students taught with Heuristic teaching approach had a higher mean achievement score of 81.12 than their counterparts taught with conventional approach (with 58.72 mean achievement score). This was further confirmed by the results in Table 2 which revealed that Heuristic teaching approach is a significant factor in the achievement of students in the mathematics achievement.

The reason for the higher achievement by the Heuristics Teaching Approach group could be that the students acquires a real understanding and clear notion of the subject, this gives them a complete mastery of what they have learnt. Heuristic Teaching Approach is certainly a psychologically sound method, as it aims at utilising the active, original, creative and constructive tendencies of the learner. Furthermore, the students thinks by themselves and do not merely listen for information. This therefore agreed with the view of Mayer (2003) and Novotnal et al (2013). The higher achievement of experimental group in this study also shows that Heuristics teaching approach is very effective for use in teaching. This concurred with Harbour (2001) who opined that the low achievement of secondary school students in mathematics could be attributed to non-utilisation of appropriate teaching approach by mathematics teachers.

Furthermore, the experimental group was taught with an approach that involve students' active participation and require a student to learn by doing. This corroborated the report of Obodo (1997) and WAEC (1998) which stated that mathematics teaching method should be students' centred and concepts to be taught should not be taught dogmatically.

Table 3 and Table 4 show that the Heuristic teaching approach benefited boys in the experimental groups as they achieved significantly better than girls in the experimental group and the control group in their mathematics achievement test. This confirms the report of Odili (2006) that boys outperform girls in mathematical tasks. It also confirms Adeleke (2007) who found out that boys achieve significantly better than girls in mathematics when placed in the same group to learn mathematics using conceptual and procedural learning strategies.

Tables 5 and 6 revealed that the difference in the achievements of male and female is significant. This is in line with the findings of Ezeugo and Agwagah (2000) that males achieved higher than females in mathematics. Furthermore, the findings of this study is consonance with Kolawole (2007) who discovered that boys are better than girls in their academic performance in mathematics. This means that the issue of gender differences in mathematics achievement and overall performance still exists.

Recommendations

1. Heuristic teaching approach should be adopted by mathematics teachers and should be emphasized more strongly by inspectors from the Ministry of Education.
2. Nigerian mathematics text book authors should be encouraged by the government to review their books in line with Heuristic Teaching Approach, so that the books will be students' friendly.
3. Workshops should be organised for teachers on the effective use of heuristic approach of teaching mathematics in secondary schools.
4. Mathematics teachers should be given refresher courses in the implementation and use of Heuristics teaching approach in all secondary schools.

Conclusion

Based on the findings of this study, it can be noted that achievement in mathematics by the students depends on the approach of the instruction used by the teacher, it is indeed important for mathematics teachers to improve their methods of instruction. This is especially true for secondary school mathematics teachers since with the present-day method of teaching mathematics and the criteria of judgement of students' progress, the students form misleading notions about their intelligence which makes the crammers excel and the intelligent ones suffer. The very sight of the examination paper upsets and puzzles students .

There is no downplaying the fact that the approach of mathematics teachers to teaching affects the approach of students in answering public examination questions.

Given the central place of Mathematics in the curriculum and the present day woeful performance of students in external examinations, there is an urgent need for improved methods of teaching that would enable all students irrespective of their background to understand mathematics and apply it to solve daily problems. The use of Heuristic teaching approach in teaching mathematics is timely.

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