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Comparative Effects of Three Instructional Methods on Mathematics Achievement of Senior Secondary School Students in Niger State

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Abstract

The purpose of the study is to find out the effects of three instructional methods (Guided Discovery, Multimedia & Conventional methods) on mathematics achievement of secondary school students in Niger State. Three research questions and three corresponding hypotheses were formulated to guide the study. The design adopted was quasi-experimental design. The sample of the study was 144 years two (SSII) students from three intact classes. Mathematics achievement test (MAT) was the instrument used for data collection. Test retest method of destemming releasing was adopted. A reliability coefficient of 0.87 was obtained for Mathematics achievement test, using Cronbach alpha. The data were analyzed using Analysis of Variance (ANOVA) and Analysis of Covariance (ANCOVA). The hypotheses were tested at 0.05 level of significance. The result of the study revealed that that guided discovery and multimedia methods were more effective than conventional method. No significant difference was however observed between mean achievement scores of students with respect to ability level. It was recommended among others that since guided discovery and multimedia methods were more effective, it should therefore be popularized and integrated in the teaching of mathematics in our secondary schools.

Keywords: Instructional methods, mathematics achievement, ability level

Introduction

Teaching is described as a problem solving activity involving both the teacher and the learner but the teacher serve as a guide and learners are actively involved using their mind and hands to develop knowledge, acquire skills and values. Teaching according to Carbone, Conway and Farr (2009) is a specialized form of bidirectional communication in which the students are active participants in the process of exposition. Learning on the other hand is the process of acquisition of new ideas knowledge, experiences, skills and values from teaching which ultimately lead to change in behavior on the part of the learner. It is measurable and permanent change in behavior of learner through experiences, instruction or study. In teaching and learning processes, instructional methods play a crucial role in the school setting.

Instructional methods on the other hand, are instructional ways used to guide the facilitation of learning in each phase of the instructional processes. It can be described as a systematic procedure employed by a teacher to lead the students through learning process. Research reports indicates that instructional method in our schools is still dominated by the conventional method which is no longer yielding expected results. This is in line with Shodehinde (2013) who reported that the traditional approach of passing instruction in schools must be replaced with techniques which allow students to learn needed skill in the context within which the skills are used in the real world. Ezenwa (2005)

noted that one of the main aim of research in science education is to provide data in order to answer the question "What curriculum and instructional methods are most appropriate for learners. Wushishi, Kure and Hassan (2013) noted that mathematics teaching in Nigeria is still dominated by traditional methods, particularly the lecture method. Hence traditional mathematics teaching is still the norm in Nigeria's schools. This traditional method is faulted on many factors, lemo (2014) reported that these includes; one-way communication, students ask few or no question and is teacher centered. This contributed to the low achievement of students in mathematics.

Indeed, low achievement of students in mathematics has of recent pose security challenges, however, present computer age couple with Covid-19 pandemic has made research in science education directed towards developing better instructional methods that are most appropriate for learners, to assist them learn science and perform well in a secured learning environment. Some of the methods among others that has the potential for effective teaching and learning includes multimedia method, Guided discovery method, concept mapping, just-in-time teaching (Jitt), mind mapping and inquiry method.

Multimedia instruction involved instructional messages that contain words and pictures. According to Alfred, Nwokolo, Abadu and Henda (2017), multimedia is a computer learning package which incorporates any three of text, audio, graphics and

animation. They examined the effect of multimedia instructional approach on achievement of cutie mechanics students in science and technical collages in Benue state. The study found that those taught with multimedia instructional approach had higher mean achievement test than their counterpart taught using lecture method. No significant difference exists between the post test mean scores of students with respect to ability level Ryan (2011), noted that multimedia has the potential and functionality to enhance achievement and retention of knowledge compared to lecture method. One major advantage of multimedia instruction is that people can learn more deeply and permanent from words and pictures than from words alone.

Guided discovery involves teaching and learning environment where students are allowed to establish their own findings, draw reasonable conclusion but the teacher originates what the students are to do. Guided discovery is an activity based learning, this help students to learn meaningfully by constructing mental models that allow for high performance. Hartfield, Davies, Hade, Kenley and Panko (2007) noted that active learning methods are different from traditional method of teaching on two points active role of students and collaboration among students are assured. Guiding students through activities especially outside the classroom teaching is crucial in improving students' achievement, provides students with opportunity to find out new knowledge, new rules, new approach of tackling problem, making learning self rewarding and motivating. Lemo and olakotan (2016) compared guided discovery and lecture method of instruction and reported the research outcome in favors of experimental group taught basic technology using guided discovery method.

Achievement in mathematics refers to a skill or level of performance in mathematics demonstrated by students, always measured by a score obtained in a test or examination. Research reports noted several factors can influence students' achievement in mathematics, these includes; interest, students' background, teaching method, teacher's competent and the complex nature of the subject. Issues on ability levels are in cohesive, ability levels implication as it affects achievement need more verification. A study carried out by Lowman (2006) suggested that teaching method and teaching aids used by a teacher to present knowledge have significant influence on students' achievement irrespective of ability level and gender. therefore It is crucial to examine if the use of guided discovery and multimedia instructional strategies can improve

students achievement in mathematics, irrespective of these levels of academic achievement.

Low achievement in mathematics by secondary school students in Niger State and Nigeria as a nation has attained an alarming stage. The West African Examination Council (WAEC) (2016), (2017), (2018) Chief Examiners' report has consistently indicated that mathematics score by average is still below fifty percent (50%). This ugly situation made students perform in other subjects like physics and chemistry. This consistent poor performance in mathematics affect all facet of national development in areas of low productivity, drop out of students in schools, unemployment, low attainment of tertiary institution, low pace in national development, hence all hands must be on deck, this work seeks to examine comparative effects of three instructional methods on mathematics achievement of secondary school students in Niger State.

The study therefore aims at investigating the effects of three instructional methods on mathematics achievement of senior secondary school students in Niger State, specifically the study intends to achieve the following objectives:

1. Examine the mean achievement score of students taught using guided discovery multimedia and conventional (lecture) methods.
2. Compare the mean achievement scores of low, medium and high-ability level students taught using guided discovery method.
3. Compare the mean achievement scores of low, Medium and high-ability level students taught using multimedia method.

In line with the purpose of the study, the following research questions guided the study

1. What are the difference in the mean achievement scores of students taught using guided discovery method, multimedia method and lecture method?
2. What are the difference in the mean achievement scores among low, Medium and high-ability level students taught mathematics using guided discovery method?
3. What are the difference in the mean achievement scores among low, medium and high-ability students taught mathematics using multimedia method?

The following null hypotheses guided the study

1. There is no significant difference in the mean achievement scores of students taught mathematics using guided, discovery, multimedia and lecture methods
2. There is no significant difference among the mean achievement scores of low, medium and high-ability level students taught mathematics using guided discovery method.
3. There is no significant difference among the mean achievement scores of low, medium and high-ability students taught mathematics using multimedia method.

Method

The study adopted the Quasi-Experimental design. Specifically, the pre-test-post-test non-equivalent control group design was adopted; there was no randomization of subjects because intact classes were used. Three instructional methods (Guided discovery, multimedia and lecture) were involved; they were randomly assigned to two experimental groups and a control group. The control group were taught using lecture method, experimental group one were taught using guided discovery method while experimental groups two were taught using multimedia method.

The population for the study comprised of fifty-three thousand three hundred and fifty-eight SSII students in Niger state (Niger state secondary education board). A sample of 144 subjects were used for the study, a multi-stage sampling method was employed. This is for fair represent station of the population. Niger state is divided into three political zones and a local government area was randomly selected from each zone. One secondary school was randomly selected in each of the three local government area, in each of the schools an SSII class was randomly selected, these made up the three intact classes used for the study.

A thirty items multiple choice Mathematic Achievement Test (MAT) was developed by the searchers and validated by three experts in science education (Mathematics education) and two experts in mathematics. The achievement test was administered on the control and the two experimental groups. Student that obtained an average of less than fifty percent (< 50%) in three consecutive terminal examinations were classified as low-ability level, those that obtained an average of fifty to sixty-nine percent (50% < 69%) were the

medium-ability level students while those with an average of seventy percent and above (> 70%) are high-ability level students. The research questions were answered using mean and standard deviation of the scores, while the null hypotheses were tested using ANOVA at 0.5 level of significance, using the Statistical Package for Social Sciences (SPSS) version 23.0. Scheffe post hoc test was however employed to determine direction of significant difference.

Results

Table 1: Mean gain scores for experiment and control groups on pretest and posttest

Group	N	X ₁	X ₂	Mean Given
Exp I	48	15.50	60.10	44.60
Exp II	50	15.36	58.96	43.60
Control	46	15.26	44.87	29.61

The result in table 1.0: indicates that experimental group one and two had a mean score of 44.60, and 43.60 respectively and control group had 29.61. The result revealed that those taught using guided discovery and multimedia methods gained higher than those taught by lecture method.

Table 2: Mean gain scores for low, medium and high ability level students on pretest and posttest

Group	N	Pretest (X ₁)	Posttest (X ₂)	Mean gain
High Ability	15	17.33	59.40	42.07
Medium Ability	23	17.00	59.04	42.04
Low Ability	10	17.20	59.27	42.07

The result in table 2 indicates high, medium and low ability students taught using guided discovery. The result shows mean gain of 42.07, 42.04 and 42.07 respectively. This revealed that the mean gain among the three ability level students is similar.

Table 3: Mean gains for low medium and high level students in pretest and posttest

Group	N	Pretest (X ₁)	Posttest (X ₂)	Mean gain
High Ability	16	16.75	58.81	42.06
Medium Ability	23	16.91	58.91	42.00
Low Ability	11	17.00	58.27	41.27

Result in table 3 shows that high, medium and low ability level students had a mean gain of 42.06, 42.00 and 41.27 respectively. This further revealed that the three ability level students had a similar mean gain.

To show whether the difference is significant, Analysis of variance (ANOVA) was performed these are presented below.

Table 4: Summary of Analysis of Variance (ANOVA) of achievement scores for experimental and control groups on pretest.

	Sum of Square	Df	Mean Square	F	Sig
Between group	1.360	2	0.689		
Within group	2242.390	141	15.903	0.043	0.958
Total	2243.750	143			

Table 4 show summary of analysis of variance of achievement scores for experimental and control group on pre test. The result revealed an F-calculated value of 0.043 and corresponding P- value of 0.958. Since 0.958 is greater than 0.05 ($P = 0.958$; $P > 0.05$). On the basis of this, H_{01} was rejected. This implies that the students in the three groups had similar entry level before the treatment. This

therefore suggest that there is no significant difference in the mean achievement scores of students taught mathematics using guided discovery, multimedia and lecture methods.

Table 5: Summary of Analysis of Variance (ANOVA) of achievement scores for experimental and control groups on posttest.

	Sum of Square	Df	Mean Square	F	Sig
Between group	6751.710	2	33.855		
Within group	4129.617	141	29.289	115.264	0.001
Total	10881.321	143			

Table 5 show summary of analysis of variance of achievement scores for experimental and control group on post test. The result shows P- value of 0.001 which less than 0.05 Alpha Value ($P = 0.001 < 0.05$). On the basis of this, H_{02} was retained. This therefore suggest that there is significant difference in the achievement scores of students taught mathematics using guided discovery, multimedia and lecture methods.

To dictate where the differences lies, Scheffe post hoc test was perform and the result shown in table 6 below.

Table 6: Scheffe post hoc test on the post test achievement scores.

(1)IRTM	2TRTM	Mean diff (1->)	St Error	Sign.	95% confidence in interval	
					Tower Bound	Upper Bound
EXP I	Exp2	1.1442	1.0936	.580	-1.561	3.850
	Ctrl	15.2346	1.1166	.000	12.472	17.997
EXP 2	EXP1	-1.1442	1.0936	.580	-3.850	1.561
	Ctrl	14.0904	1.1056	.000	11.355	16.826
Ctrl	Exp 1	-15.2346	1.1166	.000	-17.997	-2.4721
	Exp 2	-14.0904	1.1056	.000	-16.826	-11.355

Table 6 show summary Scheffe post hoc test. Analysis of the table shows that Experimental group I and Experimental group 2 had p- value = .580 > 0.05, this indicates there is no significant difference between Exp 1 and Exp II but exp I compared with control group had a P- value of $0.001 < 0.05$ which indicates a significant difference. On comparing Exp2 with control a p- value of $0.001 < 0.05$ was observed indicating a significant difference. This therefore suggest that the significant difference is in favour of exp I and Exp II. This implies that the students taught using guided discovery and multimedia methods had higher achievement.

Table 7: Summary of Analysis of Variance (ANOVA) of achievement scores for high medium and low

ability level students on pretest in experimental group one

	Sum of Square	Df	Mean Square	F	Sig
Between group	1.046	2	0.523		
Within group	410.979	45	9.132	.057	0.944
Total	411.979	47			

Table 7 show summary of analysis of variance of achievement scores for high, medium and low ability level of students taught using guided discovery method. An examination of the table result shows P- value of .944 which less than 0.05 Alpha Value ($P = 0.944 > 0.05$). On the basis of this, H_{02} was retained.

This therefore suggests that there are no significant differences on pretest scores among high, medium and low ability level students before the treatment.

Table 8: Summary of Analysis of Variance (ANOVA) of achievement scores for high medium and low ability level students taught using guided discovery method

	Sum of Square	Df	Mean Square	F	Sig
Between group	1.023	2	0.511		
Within group	2958.290	45	65.740	0.008	.992
Total	2959.313	47			

Table 8 show summary of analysis of variance of achievement scores for high, low and medium ability level students taught using discovery methods. The result shows p-value of 0.992 greater than 0.05 ($p=0.992$, $p>0.05$). On the basis of this, H_{02} was retained. This therefore suggest that there is no significant difference in the achievement scores for high, low and medium ability level students taught using discovery methods.

Table 9: Summary of Analysis of Variance (ANOVA) pre test achievement scores for high medium and low ability level students taught using guided multimedia method

	Sum of Square	Df	Mean Square	F	Sig
Between group	0.454	2	.227		
Within group	398.826	47	8.486	0.027	.974
Total	399.280	49			

Table 9 show summary of analysis of variance of achievement scores for high, medium and low ability level of student taught using multimedia method. An examination of the table result shows P- value of 0.974 which less than 0.05 Alpha Value ($P=0.974>0.05$). On the basis of this, H_{02} was retained. This therefore suggests that there are no significant differences on pretest scores among high, medium and low ability level students before the treatment. This therefore indicates that the students were at the same entry level before their treatment.

Table 10: Summary of Analysis of Variance (ANOVA) post test achievement scores for high medium and low ability level students taught using guided multimedia method

	Sum of Square	Df	Mean Square	F	Sig
Between group	3.175	2	1.587		
Within group	2802.445	47	59.626	0.027	.974
Total	2805.620	49			

Between group	3.175	2	1.587		
Within group	2802.445	47	59.626	0.027	.974
Total	2805.620	49			

Table 10 show summary of analysis of variance of achievement scores for high, medium and low ability level of student taught using multimedia method. An examination of the table result shows P- value of .974 which less than 0.05 Alpha Value ($P=0.974>0.05$). On the basis of this, H_{03} was retained. This therefore suggests that there are no significant differences on achievement scores among high, medium and low ability level students taught using multimedia method before the treatment.

Discussion

The effect of three instructional methods (Guided Discovery, Multimedia & Conventional methods) on mathematics achievement of secondary school students was investigated by hypotheses H_{01} , H_{02} , and H_{03} . The result presented in table 5 indicates significant difference in the achievement scores of students taught mathematics using guided discovery, multimedia and lecture methods. To dictate where the differences lies among the three group, a Scheffe post hoc test was perform and the finding was in favour of guided discovery and multimedia methods. This implies that students taught using guided discovery method and multimedia method perform better than those taught using conventional (lecture) method. In other words, experimental group one performs better than experimental group two, indicating that both guided discovery method and multimedia method are more effective than the lecture method. These better performances could be as a result of the treatment given to the two experimental groups. This however finding is in agreement with the findings of Ryan (2013) among other that guided discovery and multimedia methods could improve students' achievement if adopted by teachers at secondary schools in Niger State, Nigeria. It is based on this that, Shodehinde (2013) reported that the traditional approach of passing instruction in schools must be replaced with techniques which allow students to learn needed skill in the context within which the skills are used in the real world. In addition, lemo (2014) faulted conventional method, he reported that traditional method t includes; one way communication, students ask few or no question and is teacher centered. This contributed to the low achievement of students in mathematics.

The findings in table 8 and table 10 revealed that guided discovery and multimedia methods separately are in favour of high-ability level, medium-ability level and low-ability level students. It is for all the three ability levels and didn't indicate any bias in respect to ability levels. These concords to the findings of Alfred, Nwokolo, Adamu and Henda (2017), which suggested that the effect of students' ability level can be greatly neutralized with multimedia method. The finding is also in consonant with the finding of Ryan (2011), who noted that multimedia has the potential and functionality to enhance achievement and retention of knowledge compared to lecture method according to him, one major advantage of multimedia instruction is that people can learn more deeply and permanent from words and pictures than from words alone. In the case of Guided discovery method, its involves teaching and learning environment where students are allowed to establish their own findings, draw reasonable conclusion but the teacher originates what the students are to do. Guided discovery is ofcourse an activity based learning, this help students to learn meaningfully by constructing mental models that allow for high performance. It is on this note that Hartfield, Davies, Hade, Kenley and Panko (2007) noted that active learning (discovery methods) are different from traditional method of teaching on two points active role of students and collaboration among students are assured. Guiding students through activities especially outside the classroom teaching is crucial in improving students' achievement, provides students with opportunity to find out new knowledge, new rules, new approach of tackling problem, making learning self rewarding and motivating. The finding is therefore in conformity with the finding of Lemo and olakotan (2016) who compared guided discovery and lecture method of instruction and reported the research outcome in favors of experimental group taught basic technology using guided discovery method.

Conclusion

The results in this study revealed statistically that students taught mathematics achieved better when guided discovery and multimedia methods are used separately compared to those taught by lecture method. The results also confirm that guided discovery method and multimedia method are friendly in respect learning ability levels. In conclusion, guided discovery method and multimedia method are more effective and can improve students' achievement in mathematics in Niger State than lecture method.

Recommendations

1. Guided discovery method should be adopted by mathematics teachers in secondary schools.
2. Multimedia method is recommended for teaching of mathematics at secondary school level.

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