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# TEACHER QUALIFICATIONS, STUDENTS' MULTI-VARIANT AND TEACHING STRATEGIES VARIABLES AS DETERMINANTS OF MATHEMATICS STUDENTS' COGNITIVE ACHIEVEMENT

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## ABSTRACT

The study investigated the extent to which some multi-variant variables such as self-efficacy, mathematics anxiety, students' perception, self-concept, and teaching techniques determined the cognitive achievement of senior secondary school mathematics students. A non-randomized pre-test, a post-test control group with a 3x3x2x2 factorial arrangement on the quasi-experimental design was adopted. The participants for the study involved 140 senior secondary two mathematics students and a multistage sampling technique was adopted. Two researcher-made instruments were used for data collection. These were the Mathematics Achievement Test (MAT) and School Multivariate Variable Questionnaire (SMVQ). MAT consists of 50 multiple-choice items while SMVQ was divided into four sections namely self-efficacy, mathematics anxiety scale, self-concept perceptions, and student's ability in mathematics. The internal consistencies of 0.88, 0.86, 0.92, 0.85, and 0.88 respectively were achieved using the Kuder-Richardson formula 21, and Cronbach Alpha was used to gather data for the study. Analysis of Covariance (ANCOVA) was used to analyse the data collected. The results revealed that teaching, teaching technique with an index of the relationship of 0.44 (0.52) has the most facilitating effect in the enhancement of students' cognitive achievement in the concept of Algebra in mathematics. This is seconded by teachers' qualification with an index of the relationship of 0.14 (0.40<sup>2</sup>), while the multi-variant variable with an index of the relationship of 0.0014 (0.04<sup>2</sup>) has the least facilitative effects. The result also indicated that there is no significant interaction effect of teaching strategies (discussion and guided discovery) is equally good for the students.

## KEY WORDS:

Achievement, Mathematics, Teacher Qualifications, Teaching Strategy.



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## Introduction

Mathematics is a science of numbers that deals with logic, accurate thinking, and reasoning. Mathematics is a basic tool in the development of any science-based knowledge such as technology, industry and even for sound analytical reasoning in daily living in a modern society that is why mathematics is described as the queen of all science. The characteristics of most mathematics concepts have resulted into making it difficult and abstract subject to learners.

Guided Discovery Strategy allows the students to discover and classify concepts by themselves. The teachers supply students with material with which experiments are performed and data collected are analysed. Guided discovery makes the teacher to avoid direct instruction and attempts to lead the students through questions and activities to discover, discussed appreciate and vandalize new knowledge. The challenge in teaching is to create experiences that involve the students and support his own thinking, explanation, evaluation, communication and application of the scientific model needed to make sense of experiences. Jonnassen (2004) explains that in the guided discovery approach which is an example of constructivist learning is an approach of enquire.

According to Akinbobola (2006) the following guidelines are requires for effectives teaching and learning of mathematics using guided discovery techniques.

- Guided discovery can be used when mathematics lessons are moderately structured so that the teacher can give some guidance if need be.
- Guided discovery is used when pre-activity discussion precedes actual discovery lesson. It will help students to understand the expected outcomes of their activities
- Guided discovery technique cannot be used effectively with large class; when the technique is to be used, students should be divided into smaller groups for effective supervision and guidance
- Guided discovery technique should be used consistently because it is applicable to all levels of students.
- The post-activity discussion should be part of the discovery lesson so that questions based on students' activities can be discussed by the whole class.
- Guided Discovery focuses on independent learnings creativity, critical thinking and problem-solving. Guided discovery is based on the fact that skills and knowledge acquisition are not by passive receiving and rote learning but involve active participation of the learners through knowledge construction hands-on and minds-on activities (Akinbobola & Ado, 2007). According to Iyang (1993)
- Guided discovery approach is activity-based science teaching that allows students to explore their environment and discover nature.

In an attempt to reach a high level of effectiveness in teaching. Learning process, a strong and passionate orientation had been lately continually adverted towards the use of discussion method.

According to Akinsola (2000) the method involves the raising of issues on both sides (teacher and students) seeking solutions based upon the participant analysis for engaging in the discussion and the teacher is expected to be clearer at guiding the students without necessarily dominating the discussion. Students gain knowledge on their own through active participation and involvement in the lesson, Jegede (2003) opined that discussion method develops positive interpersonal relationship because the pupils interact with the teacher and with their colleagues on the basis of their mutual desire to gain knowledge from one another. It provide students with a sense of confidence through frequency exchange of ideas between the pupils and the teachers

The supply of quality mathematics teachers is critically important, not only at the secondary school level, but also at other levels of the education system of a nation. Hurlock (2007) referring to some other works, reported different findings relative to the academic performance of students taught by teachers having advanced degrees in mathematics. They found out that neither mathematics teachers with bachelor's degree in education nor mathematics teachers who possessed degree in mathematics without teaching qualifications could increase the academic achievement of their students who were in the upper grades of schools. These authors argued that

advanced academic training is important for mathematics teachers. He noted that a study conducted to determine the relationship between the professional qualification of teachers and the academic performance of their students at secondary level in mathematics resulted in the fact that the mathematics students taught by the untrained teachers with Bachelor of Science (BSC) qualification performed poorly than those students taught by trained teachers with professional qualifications such as B.Ed and M.Ed mathematics.

Mathematics students' multi-variant variable refers to those variables such as students self-efficacy, students perceptions, test anxiety and self-concept according to Adedayo (2009) self-efficacy is the belief one has in his or her capacity to successfully undertake or execute a particular programme of action. Mathematics self-efficacy of College undergraduate is more predictive of their mathematics interest and choice of mathematics related courses rather than their prior mathematics achievement

Students' perceptions of how well they are able to perform in mathematics have an important influence on their responses to learning of mathematics. Also, the degree to which such student like mathematics or any other school subject and find them interesting is also related to their willingness to become effectively engaged in learning mathematics. Mathematics test anxiety is a measure of students' responses in interesting situations. Scales have been designed to measure such test anxiety. Anxiety can be grouped into two main division. They are high-anxious or those who are cool and calm. People have for themselves and their attributes. It is a desirable educational goal that acts as a mediating variable facilitating the attainment of designed outcomes such as academic achievement. Self-concept is the relatively stable picture people have for themselves and their attributes. It is a desirable educational goal that acts as a mediating viable facilitating the attainment of desired outcomes such as academic achievement. Self-concept deals with a persons' belief or idea about his ability or feeling towards the items on the self-concept scale

Gender is the state of being masculine or feminine. The division into male or female. It has been observed by many people that male students perform better than female students in mathematics. It is generally inherent in our society that certain occupations are meant for men and some basically for woman, while men go for profession like medicine, pharmacy, engineering, banking etc most women opt for simple like teaching, catering, music etc. the perception leads to the belief that men are stronger and more capable than women in certain subject most especially science related subject. Although a few number of women go for sciences the observation over the years is that this number is small compared with that of men scientists' liberation and education.

Popoola (2000) found that by the early school years, the two sexes to be employing different cognitive style girls show more routine and non-creative responses in the imaginative activity. The problem of poor achievement of students in mathematics is of great concern to mathematics educators. This has been attributed to a number of factors among which is the lack of instructional materials, poor attitude of students for mathematics learning, school environment. However evidence of the availability of these factors as well as other factors need to be obtained. Some major predictors of academic achievement are teaching methods, mathematics anxiety and self-concept self-efficacy, perception of student's ability in mathematics and gender difference. These are causative factors in the learners.

The purpose of the study is to investigate the interaction of teaching strategies, student's multi-variant variables such as self-efficacy mathematics anxiety, students' perception and self-concept in mathematics and gender difference on students cognitive achievement in mathematics. In order to successfully do this, two hypothesis were tested for acceptance or otherwise in this investigation (i) There is no significant interaction effect of teaching methods, student's multi-variant variables and gender on students' cognitive achievement in mathematics (ii) There is no significant interaction effect of variables and gender in students cognitive.

## Materials and Method

The research design adopted for this study was a non-randomized pre-test-post test control group with a 3x3x2x2 factorial design quasi-experimental. The population for the study consisted of all the 1426 senior secondary two (SS2) mathematics students in Ondo West Local Government Area of Ondo State, Nigeria. A

total of five hundred and fifty-six (556) mathematics students took part in the study, this was made up of two hundred and ninety (290) male students and two hundred and sixty six (266) female students. The multistage random sampling technique were used. The first stage involved the use of purposive sampling technique. The criteria include

- i. Schools that are co-educational
- ii. Schools that have at least 100 students in SSII
- iii. Schools that have at least one professional mathematics teacher and one counselor
- iv. Six schools met the above criteria the second stage involves the use of simple random sampling technique.

Two schools among those that met the above criteria were randomly selected and assigned to treatment and control groups equally had experimental class was randomly selected in each school. Two types of instruments were developed by the researchers and used to collect data for the study. These are mathematics achievement Test (MAT) and School Multivariant Variable Questionnaire (SMVQ). MAT consists of section A and B section A consists of information on bio-data of the respondents and the academic qualification of his or her Mathematics teacher. The MAT consisted of 50 multiple-choice items on SSII Mathematics topics. Each item had four options with only one correct answer. The post-test contained the source questions in the pre-test arranged in different order. Each correct answer was scored two marks.

The SMVQ was a 20 item questionnaire measured on a 4 rating scale of strongly Agree (A) Agreed (S) Disagree (D) (A and B). Part A contained the personal data of the respondents, which consisted of name of school, gender and the school location. Part B consisted of four sections including self-efficacy, mathematics Anxiety scale, self-concept perception of students ability in mathematics. The students multivariant variable questionnaire (SMVQ) was scored using a score range of four (4) for strongly Agree (SA) to one (1) for strongly Disagree (SD) for positive items, and the scoring was reversal for the negative items. The instrument SMVQ and MAT were validated by two secondary school mathematics teachers, two experts in the test, measurement and Evaluation and a school counsellor. The average difficulty and discrimination indices of MAT were 52.96 and 0.48 respectively. The instruments were trial tested with 40 students who were not part of the main study. The data collected from MAT were analysed using Kuder-Richard's son formula 21 and the result showed an internal consistency of 0.74. The data collected from SMVQ was analysed using Cronbach, Alpha and the result indicated an internal consistency of 0.94.

Teacher quality variables and students multi variant variables were controlled by using the mathematics teachers in each group. The research assistants were trained for one week and they were also given detailed instructions. In order to account for possible pre-existing differences in overall ability between the experimental and control groups, pre-test was administered to the two groups (experimental and control group) and the result was used as covariant measures. Immediately after administration of SMVQ post-test was administered to the experimental and control groups. The data collected were analysed using Analysis of Covariance (ANCOVA) using pre-test scores as covariance and multiple classification analysis.

## Results and Discussion

Hypothesis: There is no significant interaction effect of teaching strategies, students multivariant variable and teachers' qualifications and gender on students cognitive achievement in mathematics the analysis is as shown in Table 1. As shown in Table 1 teaching strategies ( $f_2 = 527.41$ ) students multivariant variable  $F_2 = 104.85$ ), teachers' qualification ( $F_2 = 100.56$ ) and gender ( $F_1 = 521$ ) have significant effect on students cognitive achievement in Mathematics since the calculated value are greater than the critical F-values at  $p < 0.05$  consequent upon the existence of a significant difference in the main effects. Multiple classification Analysis (MCA) was considered to determine which of the factors was most influential as determine the index of relationship and also shown in Table 2.

**Table 1:** 3x3x2x2 factorial Analysis of Covariance (ANCOVA) of post test scores of Mathematics students as determined by teaching strategies, student multivariant variable, teacher qualification and gender using pretest scores as covariant.

Sources of Variation	Sum of Squares	Df	Mean Square	F-Cal	F-Critical	Decision at p<0.05
Pretest	17217.65	1	17217.65	1620.76	3.89	*
Main Effect	14850.58	6	2550.17	240.26	2.14	*
TS	12404.13	2	5646.51	527.41	3.04	*
SMV	2131.78	2	1010.33	104.85	3.04	*
GEN	55.80	1	55.80	5.21	3.89	*
TQ	1070.48	1	1070.48	100.56	3.89	*
2-way Interactions	256.74	13	27.20	2.56	1.77	*
TS X SMV	260.61	4	56.57	6.30	2.41	*
TSX GEN	4.82	2	2.86	0.17	3.04	NS
TSX TQ	41.42	2	13.04	1.23	3.78	NS
SMV X TQ	27.18	2	13.04	1.23	3.04	NS
GEN X TQ	3.22	1	3.21	0.20	3.78	NS
B-way Interactions	121.11	12	10.02	1.03	1.80	NS
TSX SMV X GEN	63.82	4	17.62	1.66	2.41	NS
TSXSMV X TQ	23.82	4	6.12	0.47	3.64	NS
TSXGEN X TQ	19.21	2	10.05	0.85	3.04	NS
SMV X GEN X TQ	7.26	2	4.07	0.30	1.04	NS
4-Way Interaction						
TS X SMV X GEN X TQ	13.07	3	4.62	0.34	2.65	NS
Explained	13703.70	35	883.31	92.85	1.48	
Residual						
Total						

\* = significant at p<0.05 alpha level, NS = Not significant where TS = Teaching strategies, SMV = Students multivariant variables, GEN = Gender TQ = Teachers Qualifications.

**Table 2:** multiple classification Analysis (MCA) of post test scores of students as determines by teaching strategies, students multivariant variables, gender and teacher qualification

Grand Mean = 69.0 <sup>1</sup>	N	Unadjusted Adjusted for Independent Variables and Covarankes			
Variable + Category		Dev'n	Eta	Dev'n	Beta
Teaching Strategies			0.52		0.50

Guided Discovery	93	8.60		7.22	
Discussion on	92	-0.12		0.21	
Lecture	90	-8.12		-7.82	
Students' Multivariant Variable			0.55		0.30
Self Efficacy	1000	8.50		4.13	
Mathematics Anxiety Scale	96	-2.06		-1.23	
Self Concept	70	-10.40		-5.18	
Perception of Student stability	70	-10.40		-5.18	
Gender			0.02		0.03
Male	130	0.32			
Female	126	0.33			
Teacher Qualification			0.07		0.08
BSC Mathematics	124	-2.00		-2.13	
Multiple R = 0.96					
Multiple Rsquard = 0.92					

Table 2 shows that teaching strategies has an index of relationship of 0.25 (0.50<sup>2</sup>) with those of students multivariant variable teachers qualifications and gender 0.70 (0.30<sup>2</sup>), 0.009 (0.03<sup>2</sup>) and 0.0064 (0.008<sup>2</sup>) respectively, this means that teaching strategies has the most facilitating effect in the enhancement of students cognitive achievement in mathematics with a multiple regression squared index of 0.90 it shows that, 90% of the total variance in the cognitive achievement of students in mathematics is attributed to joint influence of teaching strategies, student multivariant variable, teacher qualification and gender. The analysis in Table 2 also shows that the interaction effect was not significant at  $p < 0.05$  the calculated f-value of 0.90 is therefore, the null hypothesis stating a non-significant interaction effect of teaching strategy, students multivariant variables teacher qualifications and gender on each other is the same at all levels of the other factors. This means that the teaching strategies (guided discovery and discussion) are equally good for both male and female mathematics students. Also, the teaching can be used effectively for students with self efficacy, self concept and students with good perception ability.

This study indicated that there is a high positive relationship between each of student multi variant, variables in secondary schools' mathematics. The respective correlation coefficients of variable are significant at 0.05 alpha levels.

This study is concurred with Bandura's social cognitive theory (Spence, 2004) who asserted multi-variant variables as they affect the secondary school student's academic achievement in mathematics. The experimental group had higher score in the mean achievement test than the control group. Therefore, teaching strategies were significant factor on student's achievement in mathematics. The findings collaborate with the submission of Ajayi (2012) that problem of students can be solved or at least minimized significantly by using guided discovery or discussion methods. The findings of the study also agrees with the position of Tarto (2000) who believed that the experience of teachers has a significant influence on students' performance in mathematics. The result also is in agreement with the finding of...that, there is no significant interaction between treatment and gender on students' performance in mathematics

## Conclusion

This study established significant relationship between each of the students multivariant variable, teaching strategies teacher qualification, gender and students' academic performance in the secondary school

mathematics. It was also concluded that students taught by experienced teachers and non-experienced teachers regardless of the gender of students. On the basis of the findings of this research it is recommended that.

1. Authorities and school counsellors who are involve in allocating students to classes are advised to take cognizance of these variables such as self-efficacy mathematics anxiety, students' perception in mathematics while allocating classes to the mathematics teachers, because of their effects on the performance of the students
2. Qualified and experience mathematics teachers should be employed to teach in secondary schools
3. It should be noted that the students' gender is not a determinant of the students' achievement. Hence, female students should not be discriminate against in studying mathematics
4. Guided discovery and discussion method should be integrated into Nigerian senior secondary school mathematics curriculum.



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