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INFLUENCE OF A VARIATION THEORY TEACHING STRATEGY ON MALE AND FEMALE PUPILS' ALGEBRAIC MOTIVATION, UNDERSTANDING AND PERFORMANCE

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ABSTRACT
This study investigated influence of Partitive Variation Teaching Strategy (PVTS) on male and female Basic Five Pupils' algebraic motivation, understanding and performance in Benue state, Nigeria. The quasi experimental, pretest-posttest design was adopted for the research. Two schools were systematically selected in Zone B education zone of the state. There were 113 pupils (54 male, 59 female) in the two schools. Three research questions and three hypotheses guided the study. The experimental procedure took 6 weeks from training to completion. The pupils were taught using carefully prepared lesson plans based on the Partitive Variation Teaching Strategy (PVTS). There were three instruments used for the study: The Algebra Motivation Questionnaire (AMQ), algebra performance test (APT) which was an objective test and the Algebra Understanding Test, which was theory. The data collected were analysed using SPSS for Windows analytical software. Means and standard deviations were used to answer the research questions. Means and standard deviations were used to answer the research question while multivariate analysis of covariance (MANCOVA) as well as analysis of covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance. Findings revealed that there was no statistically significant difference where $F(2, 110) = 1.47$ and $p = 0.24 > 0.05$ in the mean motivation rating of the respondents in the experimental group in terms of gender. Also, there was no statistically significant influence, where $F(1,110) = 0.08$ and $p = 0.78 > 0.05$ on the understanding ability and $F(1, 110) = 0.33$ and $p = 0.57 > 0.05$ for performance between male and female pupils. It was concluded that the partitive variation teaching strategy was not gender biased and therefore should be used for the effective teaching and learning of algebra at the basic level of education.

Keywords: Partitive variation, motivation, understanding, performance, algebra, Basic Five

INTRODUCTION
Algebra is said to be an Arabic contraption of 'Al-jabr'al-muqabulah' which refers to the process of transferring or subtracting one or similar quantity from one side of an equation to another (Sidhu, 2006). Alfred

North Whitehead, a famous mathematician saw Algebra as the intellectual instrument which has been created for rendering clear the quantitative aspect of the world. The use of principles and generalisations in mathematics makes the knowledge of algebra fundamental for success. In Nigeria, basic algebra is taught under the theme of algebraic processes and is first offered at the Basic 4 level. In basic algebra, concepts of the variable, expressions, equality, are necessary but the literature has established that students often have misconceptions about them. These misconceptions have been linked to the difficulties that students experience as they transit from arithmetic to algebra. Other researchers describe the ensuing state as "a cognitive gap", or a "cognitive obstacle" existing in the transition process. These difficulties translate into students committing various errors (Ladele, 2013), losing interest and running short on motivation.

It is believed that motivation is an individual's internal status toward something. It has power to enhance the strength of the relationship between the input and the output of human behavior. Motivation refers to the reasons for directing behavior towards a particular goal, engaging in a certain activity, or increasing energy and effort to achieve the goal. The factors that will influence the extents of an individual's motivation include the types and intensity of needs and psychological process (Liu and Lin, 2010). Learning facts can be a crucial backdrop to learning for understanding, but learning facts is not learning for understanding. Being able to explain the solution and its processes to a problem is seen to depict understanding (Beals & Garelick, 2015). According to National Academy of Sciences (2019), the model for modern study of mathematics is supported by research on human learning and is organized around the goal of fostering learning with deep conceptual and by extension, procedural understanding or, more simply, learning with understanding. Learning with understanding is strongly advocated by leading mathematics and science educators and researchers for both male and female students (issues relating to gender), and also is reflected in the national goals and standards, including achievement, for mathematics and science curricula effective for teaching both male and female learners. Managing the issues relating to understanding and performance in mathematics among male and female pupils has led to a wide range of

research. Studies have identified factors responsible for the high rates of failure to include among others, students' negative attitude to the subject, lack of qualified teachers, inadequacy of teachers, lack of necessary learning skills, specialized language of the subject and inadequate and unsuitable textbooks. Also, it has been established that there is a significant relationship between teachers' method of teaching, teachers' attitude and students' achievement in mathematics (Avong, 2013; Daso, 2013).

The Variation Theory is a theory of learning and experience that explains how a learner might come to see, understand, or experience a given phenomenon in a certain way and why two students sitting in the same class might come to understand a concept differently (Bussey, Orgill & Crippen; 2012). The main assumption of the variation theory, is that a person's conceptions and experiences of a given phenomenon are accessible through language. Thus, variation theory looks to capture this experience through the re-telling of experience. The major thrusts of the variation are: Contrast or Awareness, Separation or discernment, Generalization and Fusion or Simultaneity. Students who are focused on a particular aspect or feature of a phenomenon may not notice other features of the phenomenon, even though those features may be important. Contrast seeks to distinguish different and unlike things. Separation is an awareness of part-whole relationship awakened by a systematic refined contrast obtained by purposely varying or not varying certain aspects aiming to differentiate the invariant parts from a whole (Bussey, Orgill & Crippen; 2012; The Learning Theory Project Team, 2011).

The first form of procedural variation: varying a problem. This form of variation aims to consolidate a concept by extending the original problem by varying the conditions, changing the results and making generalization. Variation Teaching Strategy (PVTS) in this study. The following detailed example, based on teaching division involving decimal numbers, will illustrate the idea of how students' conceptual understanding and higher order thinking skills can be enhanced by changing one condition of the original problem, as may be demonstrated as follows:

$a^2 + 25a + 24 = (a + 1)(a + 24)$
$a^2 + 14a + 24 = (a + 2)(a + 12)$
$a^2 + 11a + 24 = (a + 3)(a + 8)$
$a^2 + 10a + 24 = (a + 4)(a + 6)$.

In this set of equations, the teacher wants the pupils to work on the aspect that the 'b' coefficient is always the sum of two factors of the constant, assuming the coefficient of 'a^2' is always 1.

Gender has been used in many studies as a moderating variable as discussed at a later part of this work. It is used as a measure of how male and female learners respond to school work based on various indices that may be cognitive, psychological, environmental, societal and/or physiological. It may be used to consider the differences in performance or achievement in Mathematics learning. The gender gap continues to affect students through an impact on students' engagement with mathematics. It is on this backdrop that the influence of the partitive variation teaching strategy become expedient in the teaching of algebra at the basic level of education.

The following research questions guided the study:

i. What is the influence of PVTS on male and female pupils' mean algebraic motivation ratings?
ii. What is the influence of PVTS on male and female pupils' mean algebraic understanding scores?
iii. What is the influence of PVTS on male and female pupils' mean algebraic performance scores?

Three corresponding null hypotheses were formulated and tested at 0.05 level of significance:

i. There is no significant influence of PVTS on male and female pupils' mean algebraic motivation ratings.
ii. There is no significant influence of PVTS on male and female pupils' mean algebraic understanding scores.
iii. There is no significant influence of PVTS on male and female pupils' mean algebraic performance scores.

MATERIALS AND METHODS

The quasi experimental, pretest-posttest, non-equivalent group design was adopted for the study. This design is seen as suitable due to the

inability to manipulate and randomize the respondents who were primary school pupils studying in Basic Five. Denga (2017) posited that quasi-experimental studies are conducted under conditions that do not permit control, manipulation of variables or random selection. Random assignment can be achieved but the intact groups coupled with administrative constraints (random selection may lead to a disruption of school organization and classes) do not allow randomization, control or manipulation. It is an investigation of the effectiveness of a teaching method where random selection of subjects is not possible being a good example, in this study, the Partitive Variation Teaching Strategy. The area of study is Benue Education Zone B, also called Benue North West Senatorial Zone. The population comprised 20,895 pupils from 1,804 primary schools in Zone B education zone of Benue state (SUBEB, Makurdi, 2019). The sample for this study was 113 pupils (54 male and 59 female). This sample was obtained from two intact classes from different local government areas within the Education Zone.

Procedure Methodology

The study made use of 3 instruments: The Algebra Motivation Questionnaire (AMQ), which was a 30-item questionnaire rated from strongly disagreed to strongly agreed; Algebra Performance Test (APT), which was a 20-item test set by the researcher. The Algebra Understanding Test (AUT) contained three theory questions. There were specially designed lesson plans for the research in each sub-topic treated based on Partitive Variation Teaching Strategy. Some lesson plans were for a period of 1 hour, while others lasted for 30 minutes.

Statistical Analysis

The means and standard deviations of the variables studied were used to answer the research questions. The Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

RESULTS

The data is presented according to the objectives of the study. This is done by placing data for a research questions first and followed immediately by the corresponding hypothesis.

Research question one: What is the influence of PVTS on male and female pupils' mean algebraic motivation ratings?

Table 1: Descriptive statistics for motivation in terms of gender for the groups in the pretest and posttest

	Group	Gender	Mean	Std. Dev.	N
Posttest	1	Male	3.20	0.23	32
		Female	3.31	0.19	39
	2	Male	3.30	0.21	22
		Female	3.19	0.15	20
Pretest	1	Male	2.77	0.26	32
		Female	2.84	0.30	39
	2	Male	2.85	0.25	22
		Female	2.88	0.23	20

The results in Table 1 show the means and standard deviations of male and female pupils in terms of their motivation ratings. Both descriptive statistics depict a homogenous distribution of the data collected from the students in the two groups.

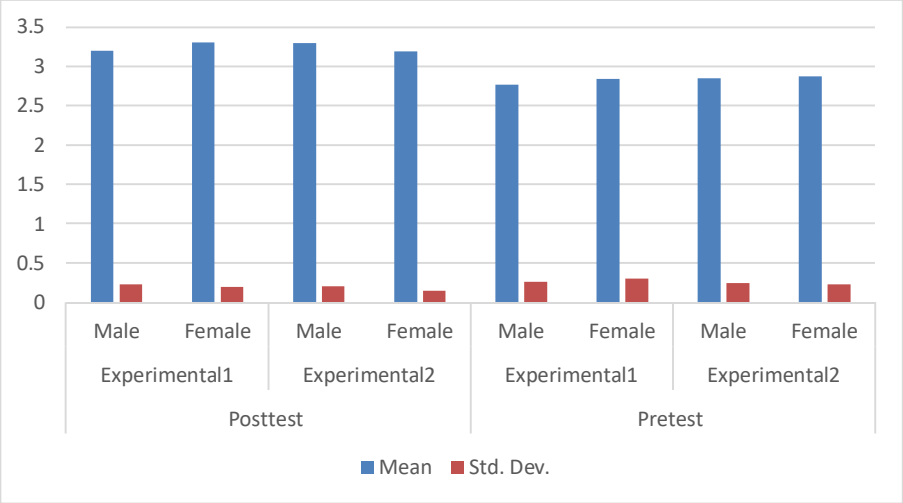

Figure 1: Bar chart for motivation in terms of gender for the 2 groups in the pretest and posttest

The means in blue and standard deviations in red, illustrate the ratings of pupils in the experimental group with respect to the pretest and posttest in terms of motivation.

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Table 2: Summary descriptive statistics for motivation in the 2 groups in terms of gender

Group	N	Pretest Mean	S.D.	Posttest Mean	S.D.	Mean Gain
Male	54	2.81	0.255	3.25	0.22	0.44
Female	59	2.86	0.265	3.25	0.17	0.39
Mean difference		**0.05**		**0.00**		**0.05**

Data in *Table 2* shows that male pupils had a mean of 2.81 and standard deviation of 0.26 in the pretest and 3.25 with a standard deviation of 0.22 in the posttest, which gave a mean gain of 0.44. The female pupils on the other hand had a mean of 2.86, with a standard deviation of 0.27 in the pretest, and a mean of 3.25, with a standard deviation of 0.17, which gave a mean gain of 0.39. The mean differences between the male and female pupils stood at 0.05 in the pretest in favour of the female pupils, and 0.00 in the posttest and 0.05 in their mean gains, in favour of the male pupils with respect to motivation ratings. Thus, it appears there is a little more motivation on the part of the male due to the use of the PVTS than on the female pupils.

Hypothesis one: There is no significant influence of PVTS on male and female pupils' mean algebraic motivation ratings.

Table 3: Summary of multivariate tests for motivation ratings for pupils in the experimental according to gender

Effect		Value	F	Hypothesis df	Error df	Sig.
Gender	Pillai's Trace	0.03	1.47	2	110	0.24
	Wilks' Lambda	**0.97**	**1.47**	**2**	**110**	0.24
	Hotelling's Trace	0.03	1.47	2	110	0.24
	Roy's Largest Root	0.03	1.47	2	110	0.24

The results in *Table 3* shows that there was no statistically significant difference where $F\ (2, 110) = 1.47$ and $P = 0.24 > 0.05$ in the mean motivation rating of the respondents in the experimental group in terms of gender. The stated hypothesis is therefore not rejected, which asserts that gender has no significant effect on the algebra motivation ratings of Basic 5 pupils in the study area.

Research question two: What is the influence of PVTS on male and female pupils' mean algebraic understanding?

Table 4: Descriptive statistics for experimental group in algebraic understanding based on gender

Group	N	Pretest Mean	S.D.	Posttest Mean	S.D.	Mean Gain
Male	54	6.06	3.32	9.13	4.11	3.07
Female	59	5.59	1.86	8.81	3.45	3.22
Mean difference		**0.47**		**0.32**		**0.15**

The descriptive statistics in *Table 4* reveal that male pupils had a mean of 6.06 and standard deviation of 3.32 in the pretest and 9.13 with a standard deviation of 4.11 in the posttest, which gave a mean gain of 3.07. The female pupils on the other hand had a mean of 5.59, with a standard deviation of 1.86 in the pretest, and a mean of 8.81, with a standard deviation of 3.45, which gave a mean gain of 3.22. The mean differences between the male and female pupils stood at 0.47 in the pretest, 0.32 in the posttest inn favour of the boys. However, female pupils appear to have had a better mean gain than the boys with 0.15 in the mean gain difference, in their favour with respect to the concept of understanding.

Hypothesis two: There is no significant influence of PVTS on male and female pupils' mean algebraic understanding.

Table 5: ANCOVA summary tests of between-subjects (male vs female) effects in algebraic understanding in the experimental group with posttest as the dependent variable

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	780.03	2	390.02	53.12	0.00
Intercept	192.43	1	192.43	26.20	0.00
Pretest	777.21	1	777.21	105.83	0.00
Gender	0.58	1	0.58	0.08	0.78
Error	807.82	110	7.34		
Total	10669.00	113			
Corrected Total	1587.85	112			

Results in *Table 5* show that PVTS has no statistically significant influence, where $F(1,110) = 0.08$ and $P = 0.78 > 0.05$ on the understanding ability between male and female pupils in the teaching and learning of

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algebra, which led to the non-rejection of null hypothesis. This means that there is no difference in understanding scores of male and female pulpils in the experimental group.

Research question three: What is the influence of PVTS on male and female pupils' mean algebraic performance?

Table 6: Descriptive statistics for the performance of boys and girls in the experimental group

Group	N	Pretest Mean	S.D.	Posttest Mean	S.D.	Mean Gain
Male	54	10.52	5.48	18.81	8.61	8.29
Female	59	10.03	4.30	17.63	7.60	7.60
Mean difference		**0.49**		**1.18**		**0.69**

The performance of male pupils increased from 10.52 in the pretest to 18.81 in the posttest as shown in *Table 6.* Also, the table reveal that the performance of girls increased from 10.03 to 17.63 in the pretest and posttest respectively. This shows that while the boys had a mean gain of 8.29, the girls had a mean gain of 7.60. This gave a mean difference of 0.49 in the pretest and 1.18 in the posttest results, and 0.69 as the difference in the mean gain of the two groups (male and female) in favour of the boys. The data thus suggests that the boys may have performed better than the girls.

Hypothesis three: There is no significant influence of PVTS on male and female pupils' mean algebraic performance.

Table 7: ANCOVA summary tests of between-subjects (male and female) Effects in the

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3090.98	2	1545.49	40.28	0.00
Intercept	1080.76	1	1080.76	28.17	0.00
Pretest	3051.20	1	3051.20	79.52	0.00
Gender	12.61	1	12.61	0.33	0.57
Error	4220.74	110	38.37		
Total	44720.00	113			
Corrected Total	7311.71	112			

APT for pupils in the experimental with posttest as the dependent variable.

The data in *Table 7* reveals that PVTS has no statistically significant influence on the mean performance between male and female pupils while using posttest result as the dependent variable, where F (1, 110) = 0.33 and P = 0.57> 0.05. Thus, the null hypothesis is not rejected, this means that boys and girls performed at par when exposed to the partitive variation teaching strategy.

DISCUSSION

The findings of the study by Ifelunni, Ugwu, Aneke, Ibiam, Ngwoke, Ezema, Charles, Oraelosi, & Ede (2019) on motivation as a determinant of academic achievement of primary school pupils in Mathematics in South-East, Nigeria, revealed, among others that there is a significant correlation between intrinsic motivation and primary school pupil's academic achievement in Mathematics in South-East, Nigeria results. Also, Andamon and Tan (2018) investigated the conceptual understanding, attitude and performance in mathematics of grade 7 students. This study sought to; describe the students' demographic profile, in terms of gender. Students' performance in mathematics did not relate significantly to respondents' gender, and conceptual understanding in mathematics which agreed with the current study. In addition, Yakubu (2017) carried out a study to determine the effect of inclusion instructional strategy on motivation and achievement of Middle Basic pupils with mathematics learning challenge in Benue state. The study also considered gender as moderating variable. The findings corroborate the present study in that, there was no significant difference between male and female pupils in terms of mean motivation rating scores.

In contrast, Awofala (2016) studied mathematical proficiency as related to gender and performance in mathematics among 400 Nigerian senior secondary school students from 10 elitist senior secondary schools in Lagos State. Gender made statistically significant contributions to the variance in senior secondary school students' performance in mathematics. However, Saleh and Rahman (2016) worked on students' achievement in algebra, considering the effect of gender and types of schools. The findings showed that there were statistically significant

main effects for gender and types of schools towards students' achievement in algebra.

Furthermore, effect of integrated curriculum delivery strategy on secondary school students' achievement and retention in Algebra in Benue state was experimented by Anyor and Iji (2014). The study is in agreement with the present study because it averred that the teaching strategy was nondiscriminatory with respect to gender of the students in achievement and retention. But, Gasco, Goni and Villarroel (2014) examined the gender differences in motivation in the area of mathematics in 8th and 9th grade, that is, in the transition from Middle School to Junior High School; the findings showed statistically significant differences in 8th grade in self-efficacy, where boys scored higher.

Finally, Sengul and Erdogan (2014) carried out their study that evaluated 6th grade students' performance related to algebraic problems prepared at declarative, procedural (as is the case with the variation theory) and conditional knowledge levels, and to investigate the levels of achievement by gender variable. No differences were found between declarative and procedural knowledge achievement of students by gender factor. However, conditional knowledge achievement of female students was significantly higher than that of the male students.

CONCLUSION

Going by the findings, the study concluded that pupils in the study area significantly showed improved motivation ratings and hence did better in their posttest scores in the understanding and performance test. We further, concluded that the partitive variation teaching strategy may be useful for better algebra teaching and learning outcomes in Basic Five pupils' algebra in Benue state, Nigeria, which may be replicated nationally and internationally.

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