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Sex Differentials in Students' Achievement and Interest in Geometry Using Games and Simulations Technique

Emmanuel E. Achor[1,*], Benjamin I. Imoko[1] and John T Ajai[2]

[1]Benue State University, Makurdi-NIGERIA; [2]NKST Secondary School, Makurdi- NIGERIA

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Abstract – This study investigated the effect of games and simulations on the gender related differences in mathematics achievement and interest of students in geometry. The sample group consisted of 287 senior secondary school (SSS I) students comprising 158 boys and 129 girls from six out of the 46 secondary schools in Gwer-West LGA of Benue state, Nigeria. The study adopted a pre-test and post-test quasi-experimental design, where intact classes were assigned to experimental and control groups. Data generated using Geometry Achievement Test (GAT) and Geometry Interest Inventory (GII) were analyzed using descriptive statistics to answer research questions and Analysis of Covariance (ANCOVA) to test the hypotheses. Findings reveal that male and female students taught using games, and simulations did not differ significantly both in achievement and in interest. It was recommended among others that mathematics teacher should always use relevant games and simulations in teaching mathematics concepts but paying equal attention to the learning needs of both male and female students, and that school administrators should be encouraged to provide local games that could facilitate meaningful learning of mathematics.

Key words: Games and simulations, achievement, interest, geometry, gender.

Introduction

Many people these days hate to see figures. More often than not it is translated into their inability to handle figures effectively. This becomes more serious when the figure to be handled is not about buying and selling but about abstract areas like geometry in mathematics. Geometry is a branch of mathematics that deals with the measure and properties of points, lines, curves and surfaces. Geometry forms the building blocks of engineering and technical graphics. Further, the conic section of geometry which is purely locus is of great importance

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* Corresponding author: Emmanuel E. Achor, PhD,
Department of Curriculum and Teaching, Benue State University, Makurdi-Nıgeria.
E-mail: nuelachor@yahoo.com

to astronomy, mechanics and technology (Aleksandrov, Kolmogorov & Lav-rent'ev as cited in Achor, Imoko & Uloko, 2009). More disturbing is the fact that there could be sex or gender differences in students' ability to understand lessons on geometry.

Gender is a socially ascribed attribute, which differentiates feminine from masculine. A number of studies have verified the influence of gender on mathematics achievement of students. This had led to series of divergent views on the influence of gender on the mathematics achievement and interest of students.

Many research findings in Nigeria have shown that boys perform better than the girls in mathematics generally despite the fact that they are put under the same classroom situation (Agwagah, 1993; Alio & Harbor-Peters, 2000; Etukudo, 2002; Ezeugo & Agwagah, 2000; Jahun & Momoh, 2001). To the contrary, Agwagah (1993) had reported that female students perform significantly better than their male counterparts. Etukudo (2002) shares similar view. Mean while other research findings have debunked the idea of sexual differentiation in ability. This school of thought said that there is no disparity in the performance of both boys and girls (Gbodi & Laleye, 2006; Olagunju, 2001). These conflicting views necessitate the present study with a view to lending support to the actual situation in Nigeria.

There is no gain saying that gender disparity exists in mathematics achievement, but Etukudo (2002) emphasized that this is in the face of weak methods. The search for a good instructional delivery process that could balance the gender inequality in mathematics cannot, therefore, be over-emphasized. There is therefore the need to find out if games and simulation as instructional strategy is capable of eradicating this gender related differences in mathematics achievements among students. Thus, the aims of this study are:

1. to ascertain whether there is gender disparity in the achievement of male and female students in geometry when taught using games and simulations.

2. to ascertain if there is gender disparity in the interest of male and female students in geometry when taught using games and simulations.

Research hypotheses

The following research questions hypotheses (H_O) guided the study:

Ho_1: There is no significant difference between the achievement scores of male and female students taught Geometry using games and simulations method.

Ho_2 Group does not significantly interact with gender to influence students' achievement in Geometry

Ho_3: There is no significant difference between the interest of male and female students taught Geometry using games and simulations method.

Ho_4 Group does not significantly interact with gender to influence students' interest in Geometry.

Research Method

The study adopted quasi-experimental setting of non-equivalent (pre-test and post-test) and control group design. The reason for the adoption of this design was hinged on the fact that intact classes were randomly assigned to experimental and control groups respectively, since it was not possible to have complete randomization of subjects.

The sample consisted of 158 male and 129 female senior secondary school one (SSS I) students in six secondary schools in Gwer-West local government area of Benue State, Nigeria. Simple random sampling technique of hat and draw was used to select 6 schools from the 46 secondary schools with a total of 1,434 students in SSI, as at the time of the study.

In each of the selected schools, simple random sampling technique of hat and draw was used to assign intact classes to experimental and control groups. The experimental group had 74 boys and 65 girls while the control group had 84 boys and 64 girls.

The instruments used to collect data for this study were the Geometry Achievement Test (GAT) and Geometry Interest Inventory (GII). GAT is the researcher – made instrument that consisted of 20 items prepared based on SS 1 mathematics curriculum on geometry (circle mensuration). The items of GAT were developed using lower and higher order questions. The lower order questions covered knowledge and comprehension of the cognitive domain while questions involving higher thinking processes covered application and analysis. The 20 items were multiple-choice objective questions with four options (A, B, C, and D). GAT was scored out of 100% meaning each item correctly answered is 5 marks.

The GII is the researchers'-made 20 items questionnaire that was used to help students express their feelings towards mathematics generally and geometry in particular. It consisted of two sections. Section A sought general information about respondents, while section B bothered on their interest in Geometry. Each of the items is a 5-point Likert – type-rating scale with 5 response options. The options are: Strongly agree (SA), Agree (A), Undecided (U), Disagree (D), Strongly disagree (SD) rated 5, 4, 3, 2 and1 for all positive statements and 1, 2, 3, 4 and 5 in that order for all negative statements.

Both instruments were validated by experts in mathematics education and in test and measurement. The validated GAT and GII were trial tested in a pilot study and psychometric indices were computed. The Kuder-Richardson (KR-20) was used to estimate the internal consistency (reliability) of 0.8 for GAT while Cronbach Alpha (α) was used to estimate the internal consistency (reliability) of 0.9 for GII. These reliability coefficients showed that the instruments are reliable and could therefore be used for the main study (Maduabum, 2004).

The students were taught by research assistants who were trained by the researchers for one week before the commencement of the experiment. The teaching lasted for 4 weeks. Pre-GAT and pre-GII were administered before the treatment while post-GAT and post–GII were administered after the treatment. Students in the experimental group were taught using games and simulations instructional package (GSIP). The rules and mechanics of the game were explained to the students after which they competed against one another (see appendix A for the rules of the game). The game itself was adopted from the resource materials of the National Mathematical Centre, Abuja Nigeria. However, the rules and techniques of the games were developed by the researchers and was trial tested severally by using it for competition in the games to ensure that it is useable. The to develop different rules and techniques for the games is informed by the need to reflect the peculiarities of geometry and level of students involved.

The teachers play supervisory role while the study was on. Pre-test was used to ascertain the level of students' interest and achievement in geometry before the treatment. The Post-test was used to determine the extent of students' interest and achievement in geometry after the experiment which lasted for four weeks. The control group students were taught using lecture method only and were similarly subjected to pre and post tests. Pre-test and post-test items were same in content but different in organization, that is, the numbering reshuffled. Both the teaching units and test administration took place simultaneously in all the six schools. The researchers monitored by going round the schools for supervision. To ensure uniformity in instructions, the participating students' exercise books were checked at regular intervals by the researchers.

Results

Data for testing research hypotheses 1 and 2 are presented in Tables 1.

Ho_1: There is no significant difference between the achievement scores of male and female students taught Geometry using games and simulations method.

Ho_2 Group does not significantly interact with gender to influence students' achievement in Geometry.

Table 1: 2-Way ANCOVA on the achievement scores of students in Geometry Achievement Test (GAT)

Source of Variation	Sum of Squares	df	Mean Squares	F	Sig.	Decision at P< .05
Corrected Model	45222.821[a]	4	11305.705	154.951	.000	S
Intercept	14142.672	1	14142.672	193.833	.000	S
Pre-GAT	13617.187	1	13617.187	186.631	.000	S
Sex	190.109	1	190.109	2.606	.108	NS
Group	31160.109	1	31160.109	427.066	.000	S
Sex * group	480.664	1	480.664	6.588	.011	S
Error	20575.639	282	72.963			
Total	697246.000	287				
Corrected Total	65798.460	286				

Table 1 reveals that there is no significant difference between the mean scores of male and female students taught geometry using games and simulations, F (1,282) = 2.61, P > .05. This means that male and female students taught geometry using games and simulations did not perform differently. Thus, hypothesis 1 of no significant difference in the male and female students' achievement is therefore upheld. Table 1 also reveals that method of teaching has significant effect on the groups, F (1,282) = 427.07, P< .05. This also suggests that there is significant difference in the achievement of students in the experimental and control groups. In testing for hypothesis 2, Table 1 equally reveals that group interacted significantly with method to influence students' achievement, F (1,282) = 6.59, P< .05. Thus contrary to hypothesis 2, sex interacted significantly with group to influence students' achievement in Geometry.

Again, data for testing hypotheses 3 and 4 are contained in Table 2

Ho$_3$: There is no significant difference between the interest of male and female students taught Geometry using games and simulations method.

Ho$_4$ Group does not significantly interact with gender to influence students' interest in Geometry.

Table 2: 2-way ANCOVA on the interest rating of students in Geometry Interest Inventory (GII)

Source of Variation	Sum of Squares	df	Mean Squares	F	Sig.	Decision at P< .05
Corrected Model	34406.355[a]	4	8601.589	179.615	.000	S
Intercept	19608.646	1	19608.646	409.460	.000	S
Pre-GII	14831.046	1	14831.046	309.696	.000	S
Sex	768.085	1	768.085	16.039	.000	S
Group	20604.701	1	20604.701	430.259	.000	S
Sex * group	131.259	1	131.259	2.741	.099	NS
Error	13456.823	282	47.889			
Total	1068005.000	287				
Corrected Total	47863.178	286				

Results of Table 2 reveals that after adjusting for Pre-GII scores, there is a significant difference in interest between male and female students taught geometry using games and simulations, F (1,282) = 16.04 P < .05. This means that male and female students' interest mean rating differ significantly. Thus, the hypothesis 3 of no significant difference in the mean interest rating of male and female students taught using games and simulations technique is therefore rejected. For hypothesis 4, gender does not significantly interact with group to influence students' mean interest rating, F (1,282) = 2.74, P > .05. Method of teaching however has significant effect on the groups, F (1,282) = 430.26, P < .05. This suggests that there is significant difference in the mean interest rating of students in the experimental and control groups.

Discussion and implications of the findings

One of the findings of this study is that female students in the experimental group gained in achievement more than their male counterparts did. However, hypothesis testing revealed that this difference in the mean achievement scores of male and female students exposed to games and simulations instruction is not significant. This finding is in conflict with those of Amali, Ojogbane and Akume (2004), Alio and Harbor-Peters (2000), Ezeugo and Agwagah (2000) as well as Jahun and Momoh (2001). However, it corroborates the findings of Gbodi and Laleye (2006) and Olagunju (2001), that there is no significant gender difference in the performance of students in experimental group.

The study also agrees with the assertions that gender difference may exist but a good method should be capable of neutralizing the difference (Etukudo, 2002). Hence, in the pre-test there existed some gender difference between the sexes in both the experimental and control group. The difference that existed within the experimental group reduced drastically after treatment. Nevertheless, rather than reduce the difference, the control group that did not experience games and simulations instructions, has increased gender difference.

Similarly, though the finding reveal that female students gained interest more than the male students did, the difference in the mean interest rating of male and female students exposed to games and simulations instruction is however not significant. This finding of significant difference in the interest of male and female is in conflict with the findings of Imoko and Agwagah (2006). The study reveals as well that interest gained by both male and female students in the experimental group surpassed that of their respective counterparts in the control group. This study therefore asserts that interest is not a function of gender but method.

This present study has implications for future teaching and learning of mathematics. It is one thing to teach mathematics using a facilitative method; it is another thing to teach with method that is interesting, participatory and concretized with rules and procedures that are well documented. It may be appropriate to say that the use of games and simulations appeal to students who are concrete operators and those who shy away from participating actively in mathematics lessons for whatever reason.

Conclusion and Recommendations

The results in this study provide empirical evidence that achievement in geometry depend on the method of instruction adopted and are not influenced by gender. However, interest of male and female students taught geometry using games and simulations differ significantly but group did not interact significantly with gender to influence students' interest.

Based on the findings of the study, the following recommendations are made:

- Mathematics teacher should welcome and accept the use of games and simulations in the teaching and learning of mathematics in schools. This can be done by constantly exposing the students to various games and simulations situations that are related to mathematics concepts taught in the classroom.
- School administrators should provide local games such as lido, playing cards, whot, etc to facilitate meaningful learning in their schools. This will enable the teachers to have access to them for better delivery of their lessons.
- Colleges of education should ensure that teacher trainees are provided with enough opportunities to master the principles behind the use of games and simulations and how to develop them. This will ensure the training of pre-service mathematics teachers to use games and simulations technique.

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APPENDIX

GAMES AND SIMULATIONS INSTRUCTIONAL PACKAGE (GSIP)

Title: Mathematical Palace Game

Class level: SS I

Topic: Circle Mensuration

Purpose of the game: The game will enable students to recall and apply formulae correctly in solving problems on circle mensuration.

Objective of the game: The objective of the game is to get to the mathematical palace by answering all questions correctly

Materials:

i. Game board from cardboard sheets
ii. Pack of cards with questions on circle mensuration
iii. A die and eight game tokens of four colours and two tokens for each colour.
iv. Pack of teaching card for reference and solution sheets
v. Summary sheet of basic concepts of the topic

Number of players: 2 to 4 players. There should be a judge to monitor the game.

Procedure: At the start of the game, each player should be given the summary sheet to study. Any of the players can start the game by throwing the dice and other players will play in a clockwise direction. But to qualify his entering any of his game tokens on the game board, a player must get a six and the second throw will determine where to place his game token. He has to follow the instruction on that number square. For example, "pick a question and solve"

Correct response will move the game token forward to the number shown on the arrow. Wrong answer implies that the player will move his game token backward as directed on the game board. In this case, he has to perform the instruction on the number square as part of penalty. If the number moves forward to the former position otherwise, he will remain in that number square. He could then refer to the teaching cards for correction

If a player falls in a square where he has to recite a formula in mathematics, he has to do so loudly. If he gets it correct, he can move forward, otherwise he will remain there. A player should spend a maximum of one minute on a question. A winner will be decided by the first player to get all his game tokens to the "mathematics palace" numbered fifty on the game board.

Strategies: The interest of every player is to get to the "mathematics palace" first. Since each player has two game tokens; he has to move the one that will reward him more at any particular throw of the die. As much as possible, a player should avoid penalties that will move him backwards. Another defensive strategy is that if your game token meets another player's game token, then that token should be taken back by two steps.

Follow-up activities: At the end of the game, the teacher should give students more problems to solve on the topic covered in the game to ensure mastery of the key concepts in the topics.

*****The game itself can be made available based on request*****