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EFFECT OF THREE ALGERAIC GAMES ON JUNIOR SECONDARY SCHOOL STUDENTS' RETENTION IN ALGEBRA IN ENUGU STATE

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Abstract: This study investigated the Effect of three Algebraic Games on Junior Secondary School Students' retention in algebra. Two research questions and three hypotheses guided the study. Non-equivalent control group quasi-experimental design was used for the study. The population of the study was 5,476 Junior Secondary School two (JSS II) students in the 31 government schools in Enugu Education Zone of Enugu State. A sample of 380 JSS II students drawn from two boys' secondary schools and two girls' secondary schools in Enugu education zone was employed for the study. Two JSS II classes were randomly assigned to experimental and control groups in each of the schools. The students were taught by their normal class mathematics teachers who served as research assistants. The instrument for data collection was Algebra Achievement Test (AAT). The instrument was constructed by the researcher, face validated by three experts, two from Mathematics Education, one from Measurement and Evaluation and content validated through table of specification. A trial test was carried out to verify the reliability of the instrument. Kuder Richardson 20 formula (K-R 20) was used to establish the reliability of AAT and the reliability coefficient was 0.73. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 alpha level. Major findings of the study revealed that the students taught algebra with three Algebraic Games retained knowledge gained more than those taught with Expository Method. There was no significant difference between male and female students taught algebra with three algebraic games. There was no significant interaction effect of teaching methods and students' gender on students' retention. The researcher recommended that Four Algebraic Games should be used by Mathematics teachers in teaching algebra, Mathematics teachers should be retrained through seminars, conferences, workshops and in-service training on how to apply the strategy for instructional improvement in algebra among others.

Keywords: Three Algeraic Games, Students' Retention, Algebra**,**

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Introduction

The word "game" is a common term used in some areas of life. Such areas include recreational centers (for fun or pleasure), field of sports (for competition and prediction), computer operation (to improve on one's typing skill), gambling (for commercial purpose), mathematics (to solve problems and or improve on/master a given topic), etc. Generally speaking, Hornby (2015) defined game as an activity or a sport with rules in which people or teams compete against each other. The above definition is in consonant with that of Ezeamaenyi (2014), who defined games as social activity with a set of rules in which the hallmark is to win. According to Ayotola in Onuoha (2016), game is explained as a contest in which people agree to abide by a set of rules in an attempt to win an objective. The above definitions can be summarized with three key words – activity, rules and competition or winning /losing. Game can be defined as an activity which has set of rules or order with the aim of winning or losing through competition.

In the content of mathematics, Obodo in Anibueze (2017) described mathematical games as activity in form of

puzzle, magic tricks, fallacies, paradoxes, or any other type of mathematics which provides amusement or curiosity and stimulates mathematical thinking, excitement and spirit of competition and co-operation. Irrespective of how beneficial algebraic games seem to be, science educators and researchers still have diverse opinions as regards its use in teaching Mathematics. Orim and Ekwueme (2011) stated that the use of games and activities can make mathematics enjoyable; they also indicated that practice, motivation, understanding and suppression of anxiety are some of the reasons behind the use of games in mathematics teaching and learning. Educational games do lead to improved learning (Dennis and Stewart in Abonyi, Maduagwuna and Ugama, 2014). However, some researchers alerted that the use of games can induce problems in teaching and learning. Mathematical games may seem to boost the students' achievement in a particular topic but they may depreciate the students' achievement in next lesson (Miller in Anibueze, 2017). Game may be a source of distraction on and waste of time, games could lead to students' addiction thereby causing physical or psychological problem, the goals of games do not necessarily always align with the learning goals of the classroom (Slideshare.com, 2013).

Expository method of teaching is the use of expert to explain a concept or give information to the student. Expository method of teaching enables the students learn new concepts and ideas better since all of the information they need are laid out before them (Study.com, 2012). On the other hand, expository method is a one-way communication, teacher-centred and boring method of teaching (Study.com, 2012). These gaps were bridged by this study. This work was based on the effect of three algebraic games on junior secondary school students' retention in algebra. The three Algebraic Games are mathematical learning interface where the brain, the heart and the hands work together to expand, factorise and simplify algebraic expressions. The rationale for using the three algebraic games is that each game is used to solve the problems in each of the three sub-topics that make up algebraic expressions in Junior Secondary School II. The three algebraic sub-topics encompass: (i) expansion of algebraic expressions of the form (a+b) (c+d): algebra tic-tacmatics game was used. This game normally involves two players at a time but if the materials for playing the game increase, the number of players will also increase. The materials for playing the game include: a Factor Board, a Game Board, forty Tokens of two different colours- one Token of each colour is used as a Factor Marker while the remaining 38 are used as Game Tokens. The game begins as player "A" places his factor marker and B's factor marker on any factor on the factor board. The product of these factors determines the placement of A's game token. For example, if player "A" places his factor marker on x-2 and player B's factor marker on x-3, then player "A" will place a game token on x^2-5x+6 because (x-2) (x-3) = x^2-5x+6. Player "B" takes his turn by moving his own factor marker to another factor on the factor Board (say, x+1) while A's factor marker remains in place. "B" expands (x-2) (x+1) and gets the result as x^2-x-2, then places his game token on x^2-x-2. The game continues with each player moving only his/he factor marker and placing a game token on the corresponding product on the game board until a winner is decided - when a player succeeds in placing four game tokens in a row, either vertically or horizontally. (ii) factorization of algebraic expressions: algebra factorisation card game was used. The materials for playing this game are: a Game board, Cardboard paper in at least three colours - the first for the algebraic expressions to be factorised (Game Board), the second for the first player's Solution Card and the third for the second player's Solution Card, two rulers-one for each player, and a pair of scissors. The game board consists of 25 algebraic expressions to be factorised. Each of the algebraic expressions is in a box. Beneath each box containing an algebraic expression to be factorised is an empty box for receiving the solution (factorised algebraic expression). Pieces of cardboard of the same sizes as these empty boxes are made in two different colours, different from the colour of the large cardboard on which these

boxes are marked. To start the game, each of the players works out the answers mentally or on paper, writes the solutions on pieces of cardboard provided for the purpose and puts them in the boxes beneath the corresponding questions. The player that first fills five boxes with correct answers, vertically or horizontally wins the game. (iii) simplification of algebraic expressions- algebra simplification card game was used . The game can be played by two or more students and there should be a moderator (the teacher) to verify answers. The materials for playing the game are: a Game Board – containing twenty unsimplified fractional algebraic expressions, 20 Play Cards numbered 1 – 20, a Record Board and a Coin. To commence the game, the twenty play cards of same colour are shuffled and shared equally between the two players. The play goes serially beginning from the first card on top of each player's cards. The first player picks a card from the top and plays on the problem corresponding to the number on his card. He then solves the problem on the game board, if he gets it correct, he scores two marks. However, if he gets it wrong, he scores zero and his opponent solves it. If he gets it right, he scores a bonus of one mark. The second player takes his turn and the game continues in this order. The maximum time for each player is one minute. A round is completed when the last player finishes his card. The winner is the player whose cumulative score is higher. The combination of these three algebraic games is aimed at enhancing the students' retention in the four sub-topics in algebra in junior secondary school curriculum.

It is pertinent to consider the retention ability of the students when evaluating learning strategies. Retention is the act or process of holding what has been absorbed or assimilated (Onoh and Albert, 2017). According to Nneji (2014), retention is defined as the act of absorbing, holding or continuing to hold or have facts or things learned. Many a times, students complain that they understand mathematics during mathematics class, but immediately after the lesson, the whole thing goes off their memory as if they never learnt them. The reason for this is that they only heard the teacher said and copied something on the board while they imitated him/her by copying same into their notes without any active participatory action. The passive practice of mere seeing and copying that dominate the expository method of teaching does not encourage the retention of what has been learnt. Stone, Zubby and Bill in Onoh and Albert (2017) asserted that failure to provide enough applications to real life activities and social usage cum poor teaching techniques are strong limiting factors to students' retention in mathematics. Nneji (2014) in his study to ascertain the effect of computer game on students' retention in mathematics inferred that computer game enhances more retention than expository strategy in mathematics. Three years later, Onoh and Albert (2017) investigated on the effect of computer game on students' retention in trigonometry and concluded that computer game promoted higher retention than expository method.Iyoke (2015) conducted a research on the Effect of Two Mathematical Games on Secondary School Students achievement, interest and retention in algebra. The result of the study revealed that: (i) Algebra Expansion Game and Algebra Tic-tac-Time have improved students' achievement, interest and retention. (i) Use of games in mathematical instruction depicted gender balance. There was no significant difference in the mean achievement retention scores of male and female students in the experimental group. (i) The interaction effect of teaching method and gender was not significant on students' retention. This is why the current study investigated the effect of four algebraic games on students' retention in algebra. Okafor (2011) carried out a study on the Effectiveness of Abacus and Diene's Block on Junior Secondary School Students' achievement and retention in mathematics. The major findings from the study revealed that there was a significant difference between the mean retention scores of male, female and co-educational secondary school students. Onoh and Albert (2017) studied on the Effect of Computer Game in students' retention in trigonometry. Major finding depicted that: (i) Students taught trigonometry with computer games retained higher

than those taught with expository method. (ii) Male and female students taught trigonometry with computer game retained equally. (iii) There was no significant interaction effect between methods and gender on the students' retention in trigonometry. Wushishi, Danjuma and Usman (2013) investigated the Effect of Two Modes of Concept Mapping Instructional Strategies on secondary school students' retention level in mathematics in Niger State. The results obtained showed that there was no significant difference in the retention level of the experimental and control groups. Also both spider and Hierarchy modes of concept mapping instructional strategies were not gender bias at retention level. This implies that, there was no significant interaction between gender and methods on the students' retention.

Purpose of the Study

The general purpose of this study was to find out the effect of three algebraic games on junior secondary school students' retention in algebra in Enugu Education Zone of Enugu State. Specifically, the study sought to:

1. Find out the mean achievement retention scores of students taught algebra using three algebraic games and those taught using expository method.
2. Determine the mean achievement retention scores of male and female students taught algebra using three algebraic games.

Research Questions

The following research questions guided the study:

1. What are the mean achievement retention scores of the students taught algebra with three algebraic games and their counterparts taught algebra with expository method?
2. What are the mean achievement retention scores of male and female students taught algebra in experimental groups?

Hypotheses

The study was guided with the following research hypotheses which were tested at 0.05 level of significance.

Ho_1: There is no significant difference between the mean achievement retention scores of students in the experimental group and their counterparts in the control group as measured by Algebra Retention Test (ART).

Ho_2: There is no significant difference between the mean achievement retention scores of male and female students in the experimental group as measured by Algebra Retention Test (ART)

Ho_3: The interaction effect of method and gender on students' mean achievement retention scores is not significant as measured by Algebra Retention Test (ART).

Method

Non-equivalent control group quasi-experimental design was used for this study. The population of the study was 5,476 Junior Secondary School two (JSS II) students in the 31 government schools in Enugu Education Zone of Enugu State. A sample of 380 JSS II students drawn from two boys' secondary schools and two girls' secondary schools in Enugu education zone was employed for the study. Two JSS II classes were randomly assigned to experimental and control groups in each of the schools. The students were taught by their normal class mathematics teachers who served as research assistants. The instrument for data collection was Algebra Achievement Test (AAT). The instrument was constructed by the researcher, face validated by three experts, two from Mathematics Education, one from Measurement and Evaluation and content validated through table of specification. A trial test was carried out to verify the reliability of the instrument. Kuder Richardson 20 formula (K-R 20) was used to establish the reliability of AAT and the reliability coefficient was 0.73. AAT was administered to all the subjects of the study as pretest. Thereafter, the treatment was administered for two weeks. The experimental groups in each of the schools were taught algebra using three algebraic games while expository method was used for the control groups. After concluding the treatment, AAT was re-arranged and administered to all the subjects as posttest. After two weeks of administering the posttest, AAT was re-arranged and administered again to all subjects as

retention test. The study lasted for six weeks. All the tests administered were scored by the researcher using the marking scheme prepared for the purpose. Mean and standard deviation were used to answer the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 alpha level.

Results

Research Question 1:

What are the mean achievement retention scores of students in experimental group and their counterparts in control group?

Table 1: Mean Achievement Retention Scores and Standard Deviation of Experimental and Control Groups in AAT

		Post-AAT		Re-AAT		
Groups	**N**	**Mean**	**S**	**Mean**	**S**	**Mean Gain**
Experimental	192	39.82	12.80	63.61	10.32	**23.79**
Control	188	42.90	14.55	48.73	12.62	**5.83**

From the result in Table 1, the mean achievement retention scores of the posttest in experimental and control groups are almost equal while the mean achievement retention scores of the experimental group are higher than that of the control group in the retest.

Research Question 2:

What are the mean achievement retention scores of male and female students taught algebra in experimental group?

Table 2: Mean Achievement Retention Scores and Standard Deviation of Male and Female Students in Experimental Group

		Post-AAT		Re-AAT		
Groups	**N**	**Mean**	**S**	**Mean**	**S**	**Mean Gain**
Males	97	38.39	13.43	63.55	10.30	**25.16**
Females	95	41.28	12.02	63.67	10.39	**22.39**

From the result in Table 2, the mean achievement retention scores of male and female students in experimental group are almost equal in both the posttest and retest.

Hypotheses 1

There is no significant difference in the mean achievement retention scores of the students in experimental group and their counterparts in control group.

Hypotheses 2

There is no significant difference in the mean achievement retention scores of male and female students taught algebra in experimental group.

Hypotheses 3

The interaction effect of the three algebraic games and gender on students' mean achievement retention scores is not significant.

Table 3: Test Between Subject Effects for Retention

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	21344.251[a]	4	5336.063	40.197	.000	
Intercept	72871.303	1	72871.303	548.939	.000	
Covariate (Posttest)	318.326	1	318.326	2.398	.122	
Group	17268.471	1	17268.471	130.083	.000	S
Gender	4.615	1	4.615	.035	.852	NS
Group * Gender	9.986	1	9.986	.075	.784	NS
Error	49780.999	375	132.749			
Total	1273469.000	380				
Corrected Total	71125.250	379				

Key: S = Significant; NS = Non Significant

The data in Table 3 tested the hypotheses 1, 2 and 3.

In hypothesis one, the F-calculated of 130.083 has an associated probability of 0.000 which is less than 0.05. The null hypothesis of no significant difference is rejected. This means that there is significant difference in mean achievement retention scores of students taught algebra in experimental group and control group. The direction of the difference is in favour of experimental group which recorded higher retention index as shown in Table 1.

In hypotheses two and three, the F-calculated of 0.35 and 0.075 have associated probabilities of 0.852 and 0.784 which are greater than 0.05. This means that there is no significant difference in the mean achievement retention scores of male and female students taught algebra in experimental group and there is no interaction effect of group and gender on students' mean achievement retention scores. Hence the null hypotheses are not rejected.

The results of this study revealed the following:

1. The students taught algebra with three algebraic games retain knowledge more than those taught with expository method.
2. The use of three algebraic games in teaching and learning of algebra indicated gender parity in students' retention.
3. The interaction effect of teaching method and gender on students' retention was not statistically significant.

Discussion of Findings

The finding for research question one in Table 1 showed that the mean achievement retention scores of students taught algebra with three algebraic games are greater than that of the students taught algebra with expository method. This was confirmed by the finding of hypothesis one in Table 3 which showed that there is a significant difference between the mean achievement retention scores of students taught algebra with three algebraic games and those taught algebra with expository method. The direction of the significant difference is in favour of the experimental group. This led to the rejection of the null hypothesis. This agrees that when students are taught with mathematical games, their retention ability is enhanced.

This finding may have been obtained because mathematical games provide opportunity for real life activities which stimulate students' retention. Zubby and Bill in Onoh and Albert (2017) asserted that failure to provide enough applications to real life activities and social usage cum poor teaching techniques are strong limiting factors to students' retention in Mathematics. This finding agrees with that of Onoh and Albert who concluded that computer game promoted higher retention than

expository method. The finding for research question two in Table 2 revealed that the mean achievement retention scores of male and female students who studied algebra with the three algebraic games are close to each other. The findings for hypotheses two and three in Table 3 showed that there is no significant difference in the mean achievement retention scores of male and female students taught algebra in experimental group and that there is no significant interaction effect of method and gender on students' mean achievement retention scores. This implies that there is no significant difference in the mean achievement retention scores of male and female students taught algebra with the three algebraic games and the interaction effects of the three Algebraic Games and gender on students' mean achievement retention scores are not significant. The null hypotheses were accepted. This gives an insight that when a suitable approach is used in teaching process, students will retain knowledge more and maintain gender parity in their level of retention.

The findings disagree with Okafor (2011) who asserted that there was a significant difference between the mean retention scores of male, female and co-educational secondary school students. Notwithstanding, the findings agree with Onoh and Albert (2017) whose findings showed that: (i) students taught trigonometry with computer game retained higher than those taught with expository (ii) male and female students taught trigonometry with computer game retained equally (iii) there was no significant interaction effect between method and gender on the students' retention in trigonometry. Therefore use of three Algebraic Games in teaching algebra is considered appropriate method to bridge the gap between male and female students' retention ability.

Conclusion

Considering the findings of this study, it was concluded that three algebraic games promoted higher retention than expository method.

Recommendations

Consequent upon the findings of this study, the following recommendations were made by the researcher.

1. Three Algebraic Games (algebra Tic-tacmatics game, algebra factorisation card game and algebra simplification card game) should be used by Mathematics teachers in teaching algebra.
2. Mathematics teachers should be retrained through seminars, conferences, workshops and in-service training on how to apply the strategy for instructional improvement in algebra.
3. Mathematics teachers should be motivated and encouraged by both the school management and the government to regularly make use of varied approaches for effective teaching and learning process.
4. Government, through relevant agencies should develop enriched Mathematics laboratories to create avenue for activity learning. **References**

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