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Motivational Impact of Four Algebraic Games on Students' Interest in Algebraic Expressions

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Abstract
Numerous studies have been conducted on mathematical games, but none have examined the best ways to mix different games to pique students' interest in algebraic expressions. The primary focus of this study was on how four algebraic games affected students' motivation and interest in algebraic expressions. The design for this study was a nonequivalent control group quasi-experiment. This gave room for a random partitioning of the students into experimental and control groups for proper treatment. For a comprehensive data collection in this study, a 380-sample size of junior secondary school students was purposively selected from two girls' secondary schools and two boys' secondary schools. The population from where the sample was obtained is 5,476 Junior Secondary School II students from 31 government schools in Enugu Education Zone. The normal mathematics instructors who worked with the students were research assistants. The inquiry was led by three hypotheses and two research questions. For analysis purposes, the study made use of the Algebra Interest Scale (AIS) for its data collection, while a reliability coefficient of 0.77 was determined by Cronbach's Alpha. A 0.05 alpha level was obtained using Analysis of Covariance (ANCOVA) to test the hypotheses. The results of the study showed that the students who used the four algebraic games were more engaged, owing to their increased interest level, than those in the expository approach group. This proves that they were motivated to solve many algebra problems without coercion with the use of the four algebraic games. It was also obvious that the male and female students who used the four algebraic games showed gender parity in their interest ratings. Given that the findings favored the four algebraic games, the researcher recommended that mathematics teachers should undergo in-service training, conferences, seminars, and workshops, to be well-equipped for the effective use of these games in their classrooms.

Keywords: Algebraic Expressions, Algebra Interest Spark, Four Algebraic Games, Students' Gender

Introduction

Teachers and students are acquainted with games because they play them either directly or indirectly as part of their official or casual activities. Games are used in many areas of life, such as leisure (for enjoyment or fun), sports (for competition and prediction), computer use (to improve one's typing skills), gambling (for profit), and mathematics (to solve problems and/or improve on/master a given topic), according to Ochulor (2022). Games are interesting, rule-based activities that strike a balance between ability and chance, with winning serving as a motivating factor, according to Russo et al. (2018). Games, from Onuoha's (2016) perspective, are contests where players agree to abide by rules to win. We can deduce four key terms from the above definitions, such as engagement, enthusiasm, specified rules, and goal-oriented. Therefore, a game may be seen as an engaging activity in a light-hearted setting with win-or-lose rules. In agreement with the aforementioned, Okigbo and Agu (2010) define mathematical games as any kind of mathematical activity that piques curiosity or amusement and fosters mathematical thinking, excitement, and the spirit of competition and cooperation. This includes puzzles, magic tricks, fallacies, paradoxes, and other mathematical activities. The teachers' approaches have proven that students continue to show low interest in learning algebra and mathematical content. Based on some studies carried out in Nigeria, students' lack of interest in mathematics, particularly algebra, is traceable to the conventional teacher-centered teaching strategies that do not spark their interest (Emmanuel, 2024; Ojonugwa et al., 2020; Ibrahim & Musa, 2023). Nonetheless, it has been revealed that the use of game-based teaching techniques significantly improves students' engagement and performance in algebra (Ezeuwgu et al., 2016; Udeh et al., 2019). Remarkably, available studies show that generic mathematics games fail to concentrate on a specific mathematical domain, like algebra or algebraic expressions; as a result, they do not affect students' interest, thereby decreasing their performance (Okigbo & Agu, 2010; Asanre et al., 2021). This investigation into the motivational impact of the four algebraic games on junior secondary school students' interest in algebraic expressions aims at bridging the above gap by designing the four games with a concentration on a single mathematics domain, such as algebra, to ascertain a quantifiable effect on the students' interest. The games are not generic but purposefully designed to spark students' interest in algebraic expressions, closing the gap between abstract mathematics and real-world models, given that algebra is a vital skill needed in numerous areas of mathematics (Boaler, 2016). This also resonates with Kilpatrick et al. (2001), who submitted that students' mathematical development depends on their ability to engage in algebraic reasoning.

Despite their apparent benefits, experts and science teachers disagree on the most effective ways to include algebraic games in math lessons. Roche et al. (2021) found that students demonstrate increased motivation, enthusiasm, and effective involvement in mathematics when they are engaged in mathematical games. In their study, Orim and Ekwueme (2011) emphasize that incorporating games and activities can make math more engaging. Remarkably, some scholars affirm that the use of educational games improves students' attitude and academic achievement in math and other subjects (Azuka & Awogbemi, 2012, p. 10). McLaren et al. (2017, p. 49) supported this as they asserted that children who play online games show significant engagement and enthusiasm. On the contrary, some scholars have cautioned about the potential for games to complicate teaching and learning. Math games may actually make students perform worse in the next class, even if they seem to improve their performance on a certain subject (Anibueze, 2017). Games may have the potential to be distracting and affect the learning process as a whole, claim Smith and Clark (2019). Determining which aspects of games are most effective for a certain kind of student engaging in each activity is crucial when employing games (Dichev & Dicheva, 2017).

In our mathematics classes, teachers adopt the expository method, which is teacher-dominated, to help students understand the content systematically and interactively. The expository technique is a conventional method involving instruction through lecture, explanations, and giving examples, with little or no student involvement. Agreeing with the above, Eggen and Kauchak (1994) define the expository approach as a teacher-dominated approach that expressly communicates information but yields poor cognitive engagement, non-active learning, and impersonalized instruction. Chintya and Efendi (2021) maintained that a well-organized delivery and good presentation of the expository approach significantly enhance the mathematical outcomes of students. However, Kayode (2014) highlights that the expository techniques may affect student engagement and hinder conceptual understanding except the instructor dutifully promotes it. This is an indication that, though the expository method can encourage students to understand the subject, it fails to promote active learning and the accompanying critical thinking.

Adeleke (2008) asserts that algebra is the mathematical subject in which pupils struggle the most. Additionally, Onuoha (2016) states that algebra is among the mathematical ideas that secondary school pupils struggle with the most. This so because algebra has historically given students their first in-depth exposure to the abstraction and symbolism that give mathematics its potent qualities (Susac et al., 2014). Most conferences, workshops, and seminars aimed at improving secondary school mathematics instruction and learning address this problem. The National Teachers Institute (2010) states that if children play with real items in a meaningful and practical way, they may become a little more sensitive to learning numbers. Additionally, Kurrummeh and Achor (2008) found that a variety of factors contribute to students' poor performance in mathematics, including the manner the content is presented to them, their lack of interest, and the abstract character of mathematical ideas. Since people are more likely to do well in any activity when they are actively involved in it, interest is an essential component of learning. Many educators and government officials have voiced their concerns over students' low math proficiency, and in his initial remarks at the National Mathematical Centre in Abuja in 2018, former CEO and Director Professor Stephen Onah noted that only a negligible percentage of candidates passed mathematics and English in previous international tests (Onah, 2018). Lack of attention, poor memory, and inappropriate teaching strategies have all been linked to low maths performance among students (Obodo, 2014). Although there was no significant relationship between the students' gender and the teaching approach (POTTOG strategy), Nneji (2017) found that students who were taught the game had a considerably greater interest in mathematics than those who were not. Furthermore, Takor (2015) examined the impact of mathematical manipulatives on the interest in algebra of Upper Basic One pupils in Benue State's Kwande Local Government Area. According to the study's findings, pupils who received algebra instruction using mathematical manipulatives showed more interest in the topic than those who received instruction through the expository technique. In the experimental group, there was no gender difference between the male and female students. Onuoha (2016) examined how a game-based teaching approach affected the engagement and academic achievement of elementary school algebra pupils. According to the research, students' interest in algebra and academic achievement are significantly impacted when mathematics is taught using game-based instructional methodologies. Furthermore, there was a significant difference in the mean interest ratings between male and female students in the experimental group. The study also discovered that the association between learning style and gender had a major impact on students' interest in algebra.

The WAEC (2014) Chief Examiner's report found that a greater proportion of candidates lost full marks because of computational errors in factorization and solving quadratic equations. According to Obodo (2004), it has also been shown that certain mathematics instructors are so deficient in the tools and methods required to teach particular topics that they would choose not to do so if given the chance. Considering that many math professors find it difficult to teach factorization in algebra, this is not impossible. This is because it seems to be abstract, which leads to arithmetic mistakes since kids don't have the physical resources to verify the information. As part of the mathematical improvement project (MIP), the National Mathematical Centre used an innovative teaching technique (game-based teaching) to increase students' math competency (Solarin, 2013). These activities are intended to enhance students' logical thinking and problem-solving skills while also kindling their interest and passion for mathematics. Oluremi (2012), Michelle (2012), and Ngoma (2013) assert that mathematical games are very successful in stimulating students' interest in the subject and enhancing their performance. Although some research demonstrates a predilection for mathematical games and others show the opposite, no study has examined the motivating impact of four algebraic games on students' interest in algebraic expressions.

Students' Perception of Algebraic Expressions

According to Tekin-Sitrava (2017), algebra is a generalised kind of arithmetic that makes use of letters, signs, and symbols. The rationale for the above is as follows: (i) Cate purchases three tins of Peak milk and six boxes of biscuits from a supermarket. The provisions may be combined as $6x + 3y$ if x and y stand for one carton of cookies and one tin of Peak milk, respectively. The equation $6x + 3y = 620$ may be expressed algebraically if the six cookie boxes and three cans of Peak milk mentioned above are sold for 620. 6x and 3y are algebraic terms, $6x+3y$ is an algebraic expression, and $6x+3y=620$ is an algebraic equation, according to the equation above. A letter or symbol with a positive or negative sign makes up an algebraic word. The algebraic expressions x, -2x, 9x, 2y, 5, and -3 are a few examples. The coefficient of an algebraic term is the number that either multiplies or divides a letter or symbol to create the algebraic term. The coefficients of the aforementioned algebraic expressions are 1, -2, 9, 2, and -3 for each of the aforementioned sentences. Arithmetic sign(s)/operators of addition, subtraction, multiplication, and division are linked with algebraic words to form an algebraic statement. (i) 4x+8y, (ii) 7a+3b, (iii) 4p3p+r, and (iv) 9a+ 2b79c are a few examples. There are two types of algebraic expressions: (i) Similar terms: $7x + 8x + 3x$ (ii) The algebraic expression for the unlike terms is 3x+5y8z. It is possible to delete the bracket that surrounds an algebraic expression. As an example, $3(4x5y) = 12x+15y$. This technique is known as bracket removal. When an equality sign separates two sets of algebraic expressions, the equation is said to be algebraic. A mathematical statement in which the terms or expressions on the left side are equal to those on the right side is called an equation. As you can see, each of the aforementioned variables has a maximum power of 1. As a result, an equation that has a variable or unknown with a maximum power of one is said to be simple or linear. To solve a linear equation, keep in mind the following steps: (i) Each side must have the same value added to it; (ii) each side must have the same value deducted from it; (iii) each side must have the same value multiplied by it; (iv) Each side must be divided by the same amount, and (v) To make algebraic statements or equations simpler, like terms must be grouped.

Algebraic expressions have additional features. (1) Substitution: To determine the numerical values of the provided algebraic terms or expressions, replace the unknown variables in the equation with numbers (Arigbabu et al., 2016). For instance, if a = 5 and b = 5, students may determine the value of x in ax+b. (2) Expansion: removing the bracket by multiplying. For instance, extend (i) 4(7x+3y). (i) 4(7x3y) = 28x + 12y (removing bracket) is the solution. Simplifying algebraic formulas essentially involves the following steps: (a) + + + = + (ii) + + - = - (if the negative-sign number is greater than the positive-sign number, but otherwise +) (iii) - + + = + (if the negative-sign number is less than the positive-sign number, but otherwise +). (3) Factorisation is the process of determining an algebraic expression's factors. Expansion is the opposite of factorisation. Factorise (i) $16y^2+10x$, for instance. The answer is $2(8y^2+5x)$. (4) Simplifying algebraic equations by taking them down to their most basic forms. Simplify (i) x/3+ 7 and (ii) 4un4/12n3, for instance. (i) x/3 + 7 = (x+21)/3; (ii) $4un^4/12n^3 = un/3$ is the solution. When simplifying algebraic equations, the lowest common multiple of the denominators should be used. The four algebraic games may encourage students to answer a range of problems without compulsion if they are exposed to algebraic substitution, expansion, factorisation, and simplification.

Rationale for the Four Algebraic Games and how they are used to boost students' Interest in Mathematics

In order to encourage students to solve problems in four main areas of algebraic expressions, the Four Algebraic Games were created to focus on: (i) expanding algebraic expressions of the form a(b+c); (ii) expanding algebraic expressions of the form (a+b) (c+d); (iii) factorising algebraic expressions; and (iv) simplifying algebraic expressions.

Algebra Evaluation Dart Game: Expanding algebraic statements of the kind a(b+c) is the aim of this game. The gaming board or dartboard (Fig. 1) was constructed from round quarter plywood, which measured 60 cm in diameter by 188.6 cm in circumference. To show the darting zones (sectoral gaps) and the non-darting area (non-scoring zone), the inner concentric circle was darkened. For the students' own version of the game board, a cardboard may be used. The eight darting zones include eight algebraic formulae of the kind a(b+c). Since "a" is the constant term outside the bracket in these formulas, the brackets must be eliminated by multiplying the terms within. The letter "b," which appears in the first sentence in the bracket, is followed by the letter "c." Two players at a time were intended to be accommodated by the eight darting zones. The scoring and non-scoring zones comprise the dartboard (Fig. 1). The algebraic formulae on the Dartboard are also darted using a 15 cm long pointer (Fig. 2) that is included with the game. Finally, the students' scores are shown on the Record Board after each play (Fig. 3). This game involves two to four players and a judge (the instructor). The game's required supplies are a dartboard with eight algebraic expressions of the kind a(b+c), a pointer for playing on the algebraic expressions on the dart zones, and a record board for writing down the solutions after the problems in the dart zones have been resolved. The players take turns throwing the pointer at the Dartboard and expand the affected algebraic equations. At the end of the fixed round's allocated time, the player with the greatest score on the Record Board is deemed the winner.

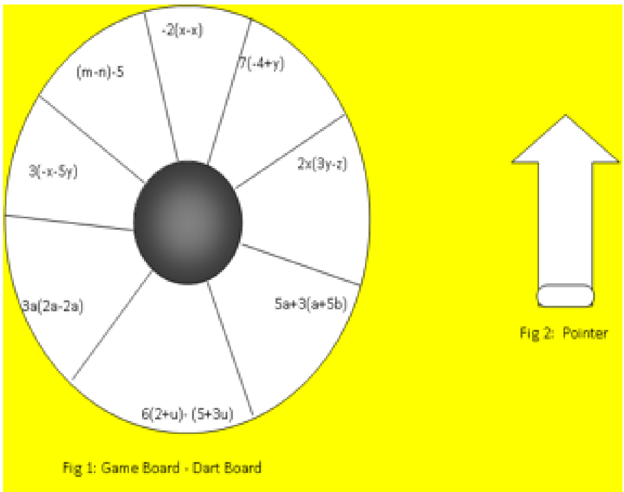

Figure 1: Algebra Evaluation Dart Game (Yellow, White, Black)

Fig 3: Record Board (White)		
Players	**Score at each throw**	**Cumulative scores**
Ist		
2nd		

(2) **Algebra Tic-tacmatics Game**. This may be used to extend algebraic formulas that include (a+b) (c+d). Using rectangular quarter plywood measuring 50 cm by 100 cm, the game board (Fig. 4) was designed to incorporate 45 algebraic equations (in play zones) with solutions in the form (a+b) (c+d), where a, b, c, and d are independent terms. Numerous play zones have been introduced to encourage many play turns and provide room for different horizontal, vertical, and diagonal lines—the key scoring directions in the game. The tools required to play the game include a Factor Board (Fig. 7), which holds all factors or roots of the equations on the Game Board, and a Game Board (Fig. 4), which houses all play zones and provides the solutions. Forty tokens of two different colours are needed for the game (Fig. 5: yellow, Fig. 6: purple). The players divide the tokens between them. Each player uses a token as a factor marker and 19 tokens as game tokens out of the 20 tokens allotted to him or her. To begin the game, Player A places both his and B's factor markers on the factor board of his choice. The product of these factors determines where A's game token will be placed (Fig. 5). Because (x-4) (x+3) = x^2-x-12, player "A" will put a game token on x^2-x-12, for example, if he sets his factor marker on x-4 and player B's on x+3. Player "B" shifts his factor marker to a different factor on the factor board while A's factor marker remains in place. After extending (x-4) (x-1) to x^2-5x+4, "B" places his game token on x^2-5x+4. A winner is announced when a player correctly arranges four game tokens in a row, either diagonally, vertically, or horizontally. Each player moves just their factor marker and places a game token on the relevant product on the game board as the game progresses.

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$X^2-7x+12$	X^2-5x+6	X^2-2x	X^2+2x-3	X^2+4x+3
X^2-8x+6	X^2-6x+9	X^2-3x+2	X^2+x-2	X^2+3x+2
X^2-5x+4	X^2-3x	X^2-4	X^2	X^2+4x+4
X^2-6x+8	X^2-4x+3	X^2-x-2	X^2+3x-4	X^2+5x+4
X^2-3x-4	X^2-x-6	X^2+2x-8	X^2+2x	X^2+6x+8
X^2-4	X^2-2x+3	X^2+x-6	X^2+x	X^2+5x+6
X^2-x-12	X^2+x-12	X^2-x	X^2+4x	$X^2+7x+12$
X^2-2x-8	X^2-9	X^2-2x+1	X^2+3x	X^2+6x+9
X^2-4x+4	X^2-1	X^2+2x+1	$X^2+8x+16$	X^2-16

Figure 4: Diagram of Algebra Tic-tacmatics Game

Game Token

Fig 5

Game token

Fig 6

X+4	X+3	X+2	X+1	X-1	X	X-2	X-3	X-4

Fig 7: Factor Board (Green)

(3) **Algebra Factorization Card Game (Fig. 8)** is used to factor algebraic expressions. The materials for playing this game are 5cm by 10cm Cardboard papers in three colors - the first for the algebraic expressions to be factorized (in the Game Board- 50cm by 50cm (Fig. 9), the second for the first player (5 cm by 10 cm Solution Cards (Fig. 10), and the third for the second player's (Solution Cards (Fig. 11). The answer cards of the first player (Fig. 10) are red, while those of the second player (Fig. 11) are green. The game board contains twenty-five algebraic expressions that need factorisation. A rectangular box encloses each algebraic expression. Under each box containing an algebraic expression that has to be factorised is an empty box for the solution (factorised algebraic expression). The first player figures out the answer to each question, either mentally or on paper, then writes it down on the solution cards and puts it in the box under the algebra problem it corresponds to. This activity is turn-based. The first player to complete any five boxes with the correct answers, either horizontally, vertically, or diagonally, wins the game.

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$6x^2$-4x	ms-ns	$21x^2$+15xy	18rs+30pqr	15a+25b
2ab+3bc	2xy-2yz	ab^2c-2abd	15xyz-9x2y	$8y^2$+12y
$12c^3d^2+3c^2d^3$	$6x^2y^3+4x^3y^2$	X^2+2x-24	X^2+x+2x+2	$3yx^2-2y^2x^2$
3abc-21bdc	2ax+bx	Xyz-$5y^2z$	56pq-42ps	15xyz-$9x^2y$
6ky+4xy	$7a^2b$-49bc	$6a^2b-8ab^2$	X^2-8x+15	$4x2y^3$+4xy

Figure 8: Diagram of Algebra Factorization Card Game

Fig 9: Game Board (Tan)

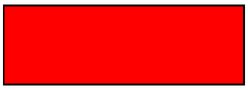

Fig 10: Solution Card (Red)

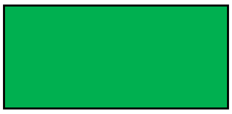

Fig 11: Solution Card (Green)

(4) **Algebra Simplification Card Game**. This game's objective is to simplify algebraic expressions in a 40 cm × 50 cm quarter plywood game board, 20 non-simplified fractional algebraic expressions (the students' task for the game) are set out in distinct play zones (Fig. 12). Additionally, there are a Record Board (Fig. 14) where the scores are recorded and 20 (5 cm by 10 cm) Play Cards with numbers 1–20 on them, where the students will answer the problems and play in the proper play zone. To begin the game, the participants shuffle and equally divide the red play/game cards (Fig. 13). Each player gets two points for correctly identifying the corresponding problem on the game board after selecting a card. If it is incorrect, the opponent has a chance to figure it out and score. You get one extra point for responding to your opponent's question. You have 30 seconds to answer the question posed by your opponent. A round ends when the last player has played up all of their cards, and each player has a one-minute time restriction. The winner is determined by the cumulative score, which aims to boost students' interest in algebraic simplifications.

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Fig 12: Game Board (Light Blue)			
$\frac{2u}{3} - \frac{u}{6}$	$\frac{5n}{6} - \frac{3x}{8}$	$\frac{2x}{9} + \frac{3x}{4}$	$\frac{x}{5} + \frac{5x}{8}$
$\frac{x+2}{2} - \frac{x-1}{3}$	$\frac{1}{x} + \frac{1}{4}$	$\frac{x-11}{2} + \frac{x-3}{5}$	$\frac{9a3b}{6b}$
$\frac{9x}{3a}$	$\frac{15a+10b}{5}$	$\frac{1}{2}y$	$\frac{3x}{5} + \frac{4x}{15}$
$\frac{18xyz}{8xy}$	$\frac{4}{9a} X \frac{3b}{16}$	$\frac{3abc}{7dc} X \frac{28cd}{9ac}$	$\frac{8z}{12z}$
$\frac{9}{5} + \frac{a}{6}$	$\frac{2b}{5} - \frac{3b}{25}$	$\frac{1}{2} + \frac{3}{y}$	$\frac{3}{xy} \div \frac{6}{yz}$
Figure 12: Diagram of Algebra Simplification Card Game			

1

Fig 13: Game Card (Rose)

Players	Score at each throw	Cumulative sum at the end of the round
1st player		
2nd player		

Fig 14: Record Board (lavender)

Purpose of the Study

Finding the motivating effects of four algebraic games on students' interest in algebraic expressions in the Enugu Education Zone of Enugu State was the main goal of this research. The study's specific objectives were to:

(i) determine the mean interest scores of students who learnt algebra via four algebraic games against those who learnt it using the expository method;

(ii) (ii) determine the mean interest scores of students who learnt algebra through four algebraic games, who were male and female.

Research Questions

(i) How much interest did students who were taught algebra via the four algebraic games have compared to those who were taught algebra using the expository method?

(ii) (ii) How much interest did male and female students who were taught algebra through the four algebraic games have?

Hypotheses

At the 0.05 threshold of significance, the following hypotheses were examined: As determined by the Algebra Interest Scale (AIS),

(i) there is no significant difference between the mean interest scores of students in the experimental group and their counterparts in the control group;

(ii) there is no significant difference between the mean interest scores of male and female students in the experimental group; and

(iii) there is no significant interaction effect of method and gender on students' mean interest scores.

Methodology

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This research used a quasi-experiment design with a non-equivalent control group. In this survey, 5,476 junior secondary school students made up the population. The students attend the 31 state-owned schools in Enugu State's Enugu Education Zone. Participants in this research were 380 junior secondary school students from 4 schools in the Enugu education zone. In each school, the students were randomised to either the experimental or control groups. During the clinical investigation, the students learnt algebraic expressions from research assistants, who also serve as their regular classroom lecturers. The Algebra Interest Scale (AIS) was the tool used to gather data for the research. In both the pretest and posttest, the students' interest in algebra was assessed using the AIS items. The AIS was scored by the researcher using a four-point Likert scale. The instrument was created by the researcher and face-validated by three specialists in measurement and evaluation, as well as mathematics instruction. Additionally, the validity and reliability of the instrument's content were ascertained. A pilot study was carried out to demonstrate the instrument's internal consistency. Cronbach's Alpha was used to determine the AIS's reliability, and the instrument's reliability coefficient came out to be 0.77. All research participants took AIS as a pretest before beginning a two-week course of therapy. While the control groups got their algebraic expressions lessons using the expository technique, all of the experimental groups' participants were taught algebra using four algebraic games. Two weeks later, the AIS was rearranged and given to every student again as a posttest. The duration of the therapy was six weeks. The mean and standard deviation were used to summarise the data, and Analysis of Covariance (ANCOVA) at the 0.05 alpha level was the statistical method utilised to analyse the data. According to Dehghan Nayeri et al. (2023), ANCOVA is a good statistical technique for research using a pre-test and post-test design.

Results

The findings from this study were analyzed in this section.

Table 1: Mean Interest Scores and Standard Deviation of Students in Experimental and Control Groups in AIS

		Pre-test		Post-test		
Groups	N	Mean	SD	Mean	SD	Mean Gain
Experimental	192	48.85	9.85	57.29	8.77	8.44
Control	188	43.30	13.74	47.91	10.19	4.61

According to Table 1, the experimental group's mean interest ratings on the pre-test were somewhat higher than those of the control group, but in the post-test, the experimental group's mean interest scores were higher than those of the control group.

Table 2: Mean Interest Scores and Standard Deviation of Male and Female Students in the Experimental Group

		Pre-test		Post-test		
Groups	N	Mean	SD	Mean	SD	Mean Gain
Males	97	47.68	9.55	55.95	8.43	8.27
Females	95	50.05	10.05	58.66	8.94	8.61

Table 2 shows that the mean interest scores of male and female students in the experimental group are almost equal in the pre-test and post-test.

Table 3: Interest's Test of Between-Subject Effects

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Dec.
Corrected Model	8773.454[a]	4	2193.363	24.424	.000	
Intercept	61476.666	1	61476.666	684.561	.000	
Covariate (Pre-interest)	57.359	1	57.359	.639	.425	
Group	7647.873	1	7647.873	85.161	.000	S
Gender	239.676	1	239.676	2.669	.103	NS
Group * Gender	103.367	1	103.367	1.151	.284	NS
Error	33676.693	375	89.805			
Total	1095924.000	380				
Corrected Total	42450.147	379				

The F-calculated has a probability of 0.000 for hypothesis 1, which is less than 0.05, according to Table 3. As a result, the null hypothesis was rejected. This suggests that there is a substantial difference in the mean interest scores between the experimental and control groups of algebra students. This is consistent with Table 2, which indicates that the experimental group's mean post-test interest score was greater. The F-calculated corresponding probability for hypotheses 2 and 3 in Table 3 are 0.103 and 0.284, respectively, and both are more than 0.05. As a result, the two hypotheses were either accepted or not. Consequently, there is no significant difference in the mean interest scores of the male and female students in the experimental group. Additionally, when the four algebraic games are used to teach the students, there are no discernible interaction effects between the students' gender and mean interest scores.

Discussion

According to the results of the first study question, which are shown in Table 1, students who were taught algebra using the four algebraic games had higher mean interest scores than those who were taught algebra through the expository technique. The outcome of hypothesis 1 in Table 3, which indicates that there was a statistically significant difference between the two groups, favouring the experimental group, and that the null hypothesis was rejected, further supports this conclusion. This demonstrates that students' interest in algebra was increased when the four algebraic games were included in the lesson, as they were motivated to solve many algebra problems without coercion with the use of the four algebraic games. This effect is in tandem with what Takor et al. (2015) found in their study, which showed that students who received algebra lessons with mathematics manipulatives had an increased interest in mathematics compared to those who received the same lesson with the expository approach.

The arousal and engaging features of the four algebraic games used by the students strongly suggest a boost in their interest. Earlier on, some scholars found that mathematical games greatly spark students' interest and mathematics achievement (Oluremi, 2012; Michelle, 2012; Ngoma, 2013).

In Table 2, the male and female student users of the four algebraic games had almost the same mean interest level as depicted by the descriptive statistics. Male and female students in the experimental group did not change significantly in their mean interest ratings, and there was no significant interaction effect between gender and instructional style, according to the related results from hypotheses 2 and 3 in Table 3. Consequent upon these, the null hypothesis was accepted. The results are indicators that these four algebraic games help male and female students to maintain parity in their interest ratings, agreeing with the saying that when teaching approaches are engaged, there is the likelihood of even engagement by all genders. The findings align with those of Nneji (2017), who found that the use of Power Tic-tactoe Game revealed gender equality in interest and that students' gender does not significantly interact with instructional strategies, and the conclusions that male and female students taught mathematics with the support of the game-based approaches resulted in significantly differentiated interest levels (Onuoha, 2016; Anibueze, 2017).

Conclusion

The research found that the four algebra games were more successful than expository teaching techniques. This is a tangible and useful sign that students are successfully engaged in learning mathematics via game-based education. It also proves that students were motivated to solve many algebra problems without coercion, with the use of the four algebraic games. This motivational impact made through the four algebraic games is obviously lacking in the math classrooms, as only the conventional approach of mere exposition of the subject matter by the instructor who stands as a preacher or news caster dishes out the lesson without interactive participation by the students, which sparks their interest, dominates our mathematics classrooms. Additionally, the findings demonstrated gender parity in the four algebraic games used, suggesting that this method encourages equal interest from the male and female students. These confirm that using the four algebraic games in maths classes increases students' interest and, more significantly, preserves gender parity.

Recommendations

The researcher provided these recommendations based on the study's findings.

1. To increase students' interest and engagement, math teachers can include the four algebraic games—Algebra Evaluation Dart Game, Algebra Tic-tac-matics Games, Algebra Factorisation Card Game, and Algebra Simplification Card Game—into their algebra lessons.
2. The school administrators should provide in-service mathematics teachers with the opportunities to regularly engage in training and retraining through workshops, conferences, and seminars to implement this game-based learning in their classrooms.
3. It is advisable for the school administrators and the government authorities who supervise the schools to inspire mathematics teachers to adopt the innovative and engaging strategies that enhance effective learning experiences.
4. Government investments should also target the construction and equipment of standard mathematics laboratories in different schools to encourage the implementation of game-based learning and other interactive instructional aids.

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