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Investigating the Effects of Gamification on Student Motivation Learning Algebraic Concepts in Mathematics

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Abstract
This mixed-methods study investigated the effect of gamification on students' motivation in learning algebraic concepts in mathematics among Nigerian secondary school students. The study involved four schools with two classes each and a total of 320 students made up of forty (40) students in each class. The research employed an experimental design which was complemented by surveys, questionnaires, and classroom observations of students and teachers conducts and experiences. Elements like points, badges, leaderboards, and challenges were incorporated in the classroom teaching for the experimental group using gamification for learning algebraic concepts. Findings show that gamification can enhance students' motivation in algebra learning based on the following discovered facts: gamification increased or positively affected the motivation of students; gender does not influence the motivation of students; there was a significant difference in students' motivation between gamified and traditional classes. Recommendations include integrating gamified elements into mathematics curricula, teacher training on gamification strategies, and further research on long-term impacts and diverse learner needs. Results underscore gamification's potential for enriching mathematics education in Nigerian secondary schools.

Keywords: Algebraic concepts, Effects, Gamification, Investigating, Learning, Mathematics, Students Motivation

1. Introduction

Gamification according to Attah, Ogunlade & Otemuyiwa (2024) is a cutting-edge pedagogical approach to addressing student social behaviour, motivation, and academic performance in the classroom, particularly in subjects that are perceived to be difficult such as mathematics where there was a perceived failure. Gamification is a strategy for involving students by incorporating game elements into the learning process to improve specific abilities involving students, optimizing learning, supporting behavior change, and socializing (Lukman, Agustiani & Setiani, 2023). Gamification, the use of game mechanics in learning helps increase motivation, comprehension, and retention. The abstraction of concepts and the difficulty in linking them to real-life situations can generate disinterest, frustration and even anxiety in students. In this context, gamification has emerged as an innovative strategy that aims to transform the learning experience by integrating game elements into the educational process (Learning Lemur, 2025). "The main benefits supported by research include increased motivation and engagement; improved comprehension and retention of concepts; cognitive and social skills development; and mathematics anxiety reduction. One of the main challenges in teaching mathematics is to maintain students' interest, especially when they perceive the exercises as repetitive or difficult. Gamification transforms these tasks into interactive and stimulating experiences". Hamari, Koivisto, and Sarsa (2014) in Learning Lemur (2025) asserted that implementation of gamified strategies has been shown to significantly increase motivation and academic performance in various disciplines, including mathematics. "Games allow students to interact with mathematical concepts in a hands-on, visual way, facilitating deeper understanding. Instead of memorizing formulas without context, students can experiment with problems in dynamic scenarios".

2. Literature Review

This study on the effect of Gamification on students' motivation while learning Algebra is hinged on Deci & Ryan's (2000) Self-determination theory which emphasizes autonomy, competence and relatedness for motivation. Gamification elements like points and badges can support these needs in algebra learning and gamified algebra tasks might boost autonomy through choice and competence by achievements. Meta-analyses indicate gamification often boost motivation and engagement across educational contexts (Sailer et al., 2017). It has also been found that gamification can stimulate students' interest in learning, enhance their motivation, help them consolidate and understand relevant knowledge, and bring about good learning outcomes. Elements like instant feedback, progress tracking, and reward systems are noted as motivational factors in gamified learning environments (Dichev & Dicheva, 2017). Few researchers have made suggestions for rationalizing gamification in mathematics education. However, researchers have found that gamification plays a positive role in teaching and learning the relevant curriculum and can be used in different areas (Yan, 2023). There are potential challenges with gamification (Hanus & Fox, 2015; Dichev & Dicheva, 2017) and these include: overemphasis on rewards with possible undermining intrinsic motivation; design complexities as it needs alignment with learning objectives; and Contextual fit to Cultural, technological considerations. Dicheva (2017) additionally posited that creating a highly engaging, full-blown educational game is

difficult, time consuming and costly and typically targets only a single set of learning objectives as chosen by the game designer. Yet, she pointed out that the effective classroom adoption of games requires appropriate pedagogical integration and sometimes a certain technical infrastructure. Yan (2023) while analyzing the challenges of gamification, noted that these include the distraction of students and difficulty in designing lessons. And recommended that teachers need to create games based on the needs of their students, asserting that as organizers, they (teachers) also need to keep a tight rein on their students to prevent them from doing things that are not related to the content of the lesson. In its contribution, Learning Lemur (2025) asserted that to maximize the potential of gamification in math, educators and developers must carefully structure their approach and adopt some key strategies to ensure effective implementation. And these include: "Setting Clear Learning objectives; incorporating Interactive games for engagement; providing instant feedback and progress tracking. With advancements in technology, numerous tools are available that support gamification in math. These resources offer diverse ways to create a more dynamic learning experience, helping students grasp mathematical concepts more effectively. "Some of them are: Digital Learning Platforms, Classroom Gamification Kits, Virtual and Augmented Reality, and Customizable Gamification Plugins". Gil Ruiz (2024) then examined the impact of gamification on the development of critical thinking skills to counter misinformation, focusing specifically on students' roles as developers of educational software. "An educational Escape Room was implemented, and its influence on critical and digital competencies was scrutinized. The procedure comprised three stages: pretest measurement, formative intervention, and posttest evaluation. A comparative analysis of the scores for the questions highlights a pressing need to enhance media and digital literacy. The findings revealed a predominance of responses indicating improvements in source verification and factchecking. However, no significant differences were observed in the pre and post responses leading to the conclusion that the implementation of a technological training program does not significantly contribute to acquiring skills for identifying falsehoods and deceptions on the internet. In conclusion, the study underscores the necessity to develop effective strategies to address misinformation and recognizes gamification as a motivating educational tool".

Nautwima, Asa & Nendongo (2022) observed that in literature, there are a number of scholarly articles published between 2017 and 2021 that discuss the usage of gamification, participation, and encouragement throughout the preceding five years. This they noted is in accordance with the directive of Werbach and Hunter (2012) that underscores the need to investigate the game's mechanics, dynamics, and aspects in light of the constant development of technology. They asserted that Werbach and Hunter (2012) believe that gamification procedures in education provide significant benefits to students, although they come with certain challenges. However, they noted that there appears to be a paucity of evidence that addresses the effectiveness of gamification in the education system, not only in Namibia, but also in Africa as a whole, and generalizing the findings from other continents could lead to inaccurate conclusions due to the differences in settings, economic stability, and technology. Relying on the taxonomy of Miles (2017) on research gap, they noted that this implies an empirical gap. Thus, it is important to investigate the effects of Gamification on Student Motivation while Learning Algebraic Concepts in Mathematics

This research examined gamification's effect on student motivation in learning algebraic concepts among Nigerian secondary school students. And specifically sought to investigate:

- the effect of gamification on students' motivation in learning algebra concepts.
- the influence of gender on students' motivations in gamified algebra learning.
- the gamification elements students perceive as most motivating.
- the specific aspects of motivation individual elements are most useful.

The following research questions were therefore formed to guide the study, and these include:

1. What effect does gamification have on students' motivations learning algebra?
2. What influence does gender have on the motivation of students in gamified algebra learning?
3. Which gamification elements do students perceive as most motivating?
4. What aspects of motivation are the most useful elements?

The following hypotheses were then formulated to guide the research work which include:

1. There is no significant difference between Students' motivation in gamified and traditional settings.
2. There is no significant difference between gender influence on students' motivation in gamified algebra learning.
3. There is no significant difference between the perception of students on the most motivating gamified element.
4. There is no significant difference between the perception of students on the areas of motivation the elements are most useful.

3. Method

A mixed method was adopted with an experimental design. Four (4) Nigerian secondary schools were selected, two (2) classes per school with 40 students in each class. Participants included Secondary students whose ages range from13 to 16 in senior secondary classes-1, selected by purposive sampling. The expermental group were taught Algebra using gamification elements including points, badges, leaderboards and challenges, the control group by traditional teaching methods only. Classes or students were randomly assigned to treatment (gamification) and control (traditional methods) groups to minimize bias. Data Collection was done through Pre-test/Post-test to measure Algebra achievement; Surveys or questionnaires sought opinions on students' engagement, motivation, perceptions and experiences using Likert-scale; classroom observations examined interactions and engagement patterns between the teachers and the students; and Interviews on Teachers'

perceptions on gamification effectiveness. Analysis was carried out using Response Means, Standard Deviation, t-test and Chi-square. The following Algebra Topics were taught for eight(8) weeks during the first term that ran from early September to early December with topics for both groups but the gamified classes involved the following : week 1-2, linear equations and graphing (solving equations with point systems and leaderboards; week 3-4, involved variables and expressions (using puzzles for simplification, substitution) and solving quadratic equations (Gamified challenges for factoring, quadratic formula application and traditional methods for derivation); week 5, functions and relations (interactive tools exploring domain and range); week 6, systems of equations (Game-based solving methods for solving graphical, substitution, elimination problems); week 7, Inequalities (understanding solution, sets graphically and number line representations); and week 8, Patterns and Sequences (pattern recognition activities used for identifying arithmetic/geometric sequences.

4. Result

Research Question-1: What effect does gamification have on students' motivation to learn algebra?

Table-1: Effect of Gamification on students Motivation learning Algebra

	SA	A	N	D	SD
1. More confidence in solving problems.	65	90	05		4.38
2. Willingness to put in extra effort to succeed.	91	69			4.57
3. Increased my interest in learning algebra.	87	73			4.54
4. Longer Persistence solving challenging problems.	58	92	10		4.30
5. Autonomy/sense of control over learning Algebra.	74	75	07	04	4.37
6. Satisfaction with achieved rewards/badges.	83	77			4.52
7. More drive to solve algebra problems.	67	90	03		4.40
8. The rewards system moved me to improve.	78	82			4.49
9. Algebra became more enjoyable.	94	66			4.59
10. Willingness to tackle challenging problems.	86	72	02		4.53
11. The competitive aspect moved me to do better.	90	69	01		4.56
12. Helped me set and achieve algebra learning goals.	73	81	06		4.42
13. Sense of accomplishment with completed tasks.	89	71			4.56
14. Eagerness to participate in algebra class.	79	81			4.49

Findings-1: From Table-1, apart from seven items with very few neutral and disagree responses, all other items had a total of 160 experimental group respondents which is 100% of the total that either agreed or strongly agreed that gamification increased or massively affected the motivation levels of students while learning algebraic concepts in class. This was also complemented by the high response means recorded by all the 14 listed items that range from 4.30 to 4.59 which were all greater than the benchmark maximum average mean of 3.00. All the listed items were therefore accepted as factors that indicated gamification increased or positively affected the motivation of students while learning algebraic concepts.

Research Question-2: What influence does Gender have on the motivation of students in gamified algebra learning?
Table-2: Influence of Gender on motivation of students in gamified algebra learning.

Table-2: Influence of gender on motivation of students in gamified algebra learning

	Male		Female	
	SA	SD	SA	SD
1. More confidence in solving problems.	35,49	4.42	30,41, 05	4.33
2. Willingness to put in extra effort to succeed.	50,34	4.60	41,35	4.54
3. Increased my interest in learning algebra.	47,37	4.56	40,36	4.53
4. Longer Persistence solving challenging problems.	38,42, 04	4.40	20,50, 06	4.18
5. Autonomy/sense of control over learning Algebra.	44,40	4.52	30,35, 07,04	4.42
6. Satisfaction with achieved rewards/badges.	41,43	4.49	42,34	4.55
7. More drive to solve algebra problems.	37,44, 03	4.40	30,46	4.39
8. The rewards system moved me to improve.	40,44	4.48	38,38	4.50
9. Algebra became more enjoyable.	51,33	4.61	43,33	4.57
10. Willingness to tackle challenging problems.	46,38	4.55	40,34, 02	4.50
11. The competitive aspect moved me to do better.	45,39	4.54	45,30, 01	4.58
12. Helped me set and achieve algebra learning goals.	42,41, 01	4.49	31,40, 05	4.34
13. Sense of accomplishment with completed tasks.	44,40	4.52	45,31	4.59
14. Eagerness to participate in algebra class.	43,41	4.51	36,40	4.47

Findings-2: From Table-2 and just as it was reported in the general case where there were very few 'neutral and disagree' responses, 84 male students and 76 female students, 100% of the entire gender Populations either agreed or strongly agreed that gamification positively affected the motivation levels of students while learning algebraic concepts. However, the response means of the males range from 4.40 to 4.61 with a mean of 4.51 for all 14 listed items. That of the females range from 4.18 to 4.59 with an average of 4.45. With the average of the males inconsequentially higher by 0.06. This therefore indicates

that gender does not influence the motivation of students while learning algebraic concepts in a gamified class or setting.

Research Question-3: What gamification elements do students perceive as most motivating (Tick only one)?

Table-3: Students' Perceptions on the Most Motivating Element of Gamification

	Point	Badge	L.board	Challenge	Reward	Total
1. Motivated me most in learning	12	29	44	55	20	160
	7.5%	12.5%	27.5%	34.4%	18.1%	100%

Findings-3: From Table-3 where respondents were required to tick only one option, 55 respondents or 34.4% of the total indicated that challenges was the most motivating element of gamification ; 44 respondents or 27.5% of the total indicated Leader boards; 29 respondents or 18.1% of the total indicated Badges; 20 respondents or 12.5% of the total indicated Rewards; and 12 respondents or 7.5% of the total indicated Points.

Research Question-4: What aspects of motivation are the most useful elements?

Table-4: The aspects of motivation that showcased the usefulness of each element of gamification

	Point	Badge	L.board	Challenge	Reward	Total
1. Encouraging Engagement.	10	14	31	94	11	160
2. Promoting Learning	13	26	44	67	10	160
3. Fostering sence of Accomplishment	17	22	43	58	20	160
4. Fostering Competition	11	20	87	30	12	160
5. Encouraged Inprovement	10	31	65	44	10	160
6. Providing sence of prestige	12	33	61	44	10	160
7. Symbolizing Achievement	14	66	33	31	16	160
8. Providing sence of Recognition	20	57	31	34	18	160
9. Showcasing Expertise	19	53	35	35	18	160
10. Providing Tangible incentive	21	20	24	21	74	160
11. Motvating specific Behaviour	16	17	35	33	60	160
12. Offering sence of satisfaction	14	18	38	39	51	160
13. Providing Feedback	68	19	32	31	10	160
14. Tracking Progress	55	15	35	36	19	160
15. Encouraging Exploration	52	18	38	32	20	160
Total	351	429	632	629	359	2400

Findings-4: From Table-4, the aspects of motivation that showcased the usefulness of each element of gamification was not farfetched and included: Challenges and puzzle activities for encouraging engagement, promoting learning and fostering a sense of accomplishment; Leaderboards for Fostering competition, encouraging improvement and providing a sense of prestige; Badges for Symbolizing achievement, providing a sense of recognition, and showcasing expertise; Rewards for providing tangible incentives, promoting specific behaviors and offering a sense of satisfaction; and Points for Providing instant feedback, tracking progress, and encouraging exploration. Overall and based on the assessments from the Fifteen (15) listed areas/aspects of motivation, Leaderboards lead the way with 632 points (26.3%); followed by Challenge and puzzle with 629 points (26.2%); Badges with 429 points (17.9%); Rewards with 359 points (15%); and Points with 351 points or 14.6% of the total.

Hypothesis-1: There is no significant difference between Students' motivation in gamified and traditional settings.

Table-5: The difference in Students' Motivation: Gamified vs Traditional

Gamified:	Av.1= 4.48, Sd.1= 0.0868, df = 26, tcal = 63.14
Traditional:	Av.2= 2.27, Sd.2= 0.0971, df = 26, tcri = 2.06
tcal > tcrit, Decision: reject null hyp.	

Findings-5: From Table-5 and the hypothesis stated in null form and using the response means obtained from both the gamified (experimental) and traditional method (control) groups, with a combine sample size of 320 (160 apiece); from the 14 items listed to elicit response; the means and standard deviation were calculated and the obtained t-value (63.14) was compared to the critical (table) value of 2.06 at 0.05 significance level(two-tailed) with 26 degree of freedom. The calculated t-value was found to be greater than the critical table t-value. The null hypothesis was therefore rejected which shows that there is a significant difference in students' motivation between gamified and traditional methods with gamification affecting students' motivation positively.

Hypothesis-2: There is no significant difference between gender influence on students' motivation in gamified algebra learning.

Table-6: The difference between gender influence on students Motivation: gamified algebra class

Male:	Av.1= 4.51, Sd.1= 0.0640, df = 26, tcal = 1.52
Female:	Av.2= 4.45, Sd.2= 0.1326, df = 26, tcri = 2.06
tcrit > tcal, Decision: accept null hyp.	

Findings-6: From Table-6 with the hypothesis stated in null form and using the response means obtained from the gamified (experimental) group, with a sample size of 160 from the 14 items listed to elicit response; the means and standard deviation were calculated and the obtained t-value (1.52) was compared to the critical table value of 2.06 at 0.05 significance level(two-tailed) with 26 degree of freedom. The calculated t-value (1.52) was found to be less than the critical table t-value (2.06). The null hypothesis was therefore accepted that there is no significant difference between gender influence on students' motivations in gamified algebra learning.

Hypothesis-3: There is no significant difference between the perception of students on the most motivating element of gamification.

Table-7: The difference between students' perception on most motivating elements

D/freedom = 4	X'cal = 38.31
Alpha level = 0.05	X'tab = 9.488
X]cal > X'tab, Decision: reject null hyp.	

Findings-7: From Table-7 with the hypothesis stated in null form and using the response recorded from individual member of the gamified (experimental) group with a sample size of 160 who were expected to select only one option among the five (5) listed elements. Chi square was used to analyze by comparing the observed and the expected values under each Category from the 5 options. The obtained chi square value (38.31) was then compared to the critical table value (9.488) at 0.05 significance (alpha) level with 4 (5 -1) degree of freedom. And it (38.41) was found to be greater than the critical/table value (9.488). The null hypothesis was therefore rejected as there is a significant difference between the perception of students on the most motivating element of gamification.

Hypothesis-4: There is no significant difference between the perception of students on the areas of motivation the elements are most useful.

Table-8: The difference between students' perception on areas of most usefulness

D/freedom = 56	X'cal = 577.88
Alpha level = 0.05	X'tab = 33.84
X]cal > X'tab, Decision: reject null hyp.	

Findings-8: From Table-8 with the hypothesis stated in null form and using the response recorded from individual member of the gamified (experimental) group with a sample size of 160 who were expected to select only one option among the five (5) listed elements. Chi square was used to analyze by comparing the observed and the expected values under each Category from the 5 options. The obtained chi square value (577.88) was then compared to the critical table value (33.84) from (/2X' - /2df - 1) at 0.05 significance (alpha) level with 56: (5 -1)(15-1) degree of freedom. And the calculated chi square value (577.88) was found to be greater than the critical/table value (33.84). The null hypothesis was therefore rejected as there is a significant difference between the perception of students on the areas of motivation the elements are most useful.

5. Discussion of Findings

From the responses of majority of the respondents in the experimental group which was complemented by the high response means recorded by all the listed items which were also greater than the benchmark mean; there was strong indication that gamification increased or heavily affected the motivation of students while learning algebraic concepts. This is in line with the opinions of Learning Lemur (2025) that gamification helps increase motivation, comprehension, and retention. The ITA (2025) added that with games students and teachers feel fun and excited about the lesson.

Like the earlier case a large number and Percentage of both male and female respondents showed that gamification affected the motivation levels of students while learning algebraic concepts. This was also without dependence on gender differences in spite of the little differences in their individual response means. This therefore indicates that gender has no influence on the motivation of students while learning algebraic concepts in a gamified class or setting. This result is related to opinion expressed by Mangahigh (2025) that by meeting students in their natural digital habitat, mathematics learning can be made deeply engaging and highly productive.

From opinions expressed by individual respondents when required to tick only one option, indications showed that most respondents chose the following elements as the most motivating element of gamification. These in hierarchical order included: Challenges, Leader boards, Badges, Rewards and Points. This is in line with observations of Wouters et al (2013) in Learning Lemur (2025) that gamification helps to generate a more positive relationship with mathematics, allowing students to face challenges without fear of failure. And that Immediate feedback and reward systems reinforce individual progress, helping to build confidence and autonomy in learning.

On the aspects of motivation that showed the level of usefulness of each element of gamification and assessing them from all the listed areas/aspects of motivation, Leaderboards led the way followed by Challenges, Badges, Rewards and lastly Points. And this was based on the cumulative total points and general percentages recorded by the respondents' opinions. Critically, respondents' assertions were made based on the fact that Leaderboards fostered competition, encouraged improvement and provided a sense of prestige; Challenges encouraged engagement, promoted learning and fostered a sense of accomplishment; Badges Symbolized achievement, provided a sense of recognition, and showcased expertise; Rewards provided incentives, promoted some positive behaviours and offered a sense of satisfaction; and Points Provided instant feedback, tracked progress, and encouraged exploration. The views of Mangahigh (2025) that gamification is not just a supplementary technique; it is a transformative approach that aligns perfectly with the needs of the modern learner, provides a sound foothold and good foundational backing to it.

From all the items listed to elicit response; the calculated t-value was compared and found to be greater than the critical/table t-value. The null hypothesis was therefore rejected which meant that there is a significant difference in students' motivation between gamified and traditional methods with gamification having massive impacts on students' motivation. This also agrees with the assertions of Hamari et al (2014) in Learning Lemur (2025) that implementation of gamified strategies has been shown to significantly increase motivation and academic performance in various disciplines, including mathematics.

From the entire items listed to elicit response, the obtained t-value was compared to the critical/table value at the specified significance level(two-tailed) degree of freedom. The calculated t-value was found to be less than

the critical table t-value. The null hypothesis was therefore accepted/upheld that there is no significant difference between gender influence on students' motivations in gamified algebra learning. Male or Female, gamification according to Lukman et al (2023) is a strategy for involving students by incorporating game elements into the learning process to improve specific abilities, involving students, optimizing learning, supporting behavior change, and socializing. Learning Lemur (2025) emphatically asserts, it helps increase motivation, comprehension, and retention.

The obtained chi square value was compared to the critical table value at the specified significance (alpha) level and degree of freedom. And it was found to be greater than the critical/table value. The null hypothesis was therefore rejected as there was a significant difference between the perception of students on the most motivating element of gamification. This fact shows how diverse human beings can be in what motivates or propels them and the learning paces and styles. But despite the various levels of diversity, Guro & Corpuz (2025) opined that gamification as a learning strategy integrates game elements into educational activities to enhance student motivation, engagement, and academic performance. And when it comes to learning, being focused and immersed, Dahalan et al (2023) asserts that it can massively improve a student's experience. However, Mangahigh (2025) maintains that the data-driven approach (in their system) ensures that instructors know exactly where to focus their efforts to help each student improve.

Chi square was used to analyze by comparing the observed and the expected values under each Category from the listed options. The obtained chi square value was then compared to the critical table value at specified significance (alpha) level and degree of freedom. And the calculated chi square value was found to be greater than the critical/table value. The null hypothesis was therefore rejected as there is a significant difference between the perception of students on the areas of motivation the elements are most useful. This result brings to fore the diverse nature of humans, learning patterns of students and the different levels of challenges that pushes or motivates them in seeking solutions to difficult situations. This, however, does not dispute the fact according to Learning Lemur (2025) that gamification has proven to be an effective tool for improving the learning experience in various disciplines, and Its impact goes beyond making classes more entertaining. They added that it influences key aspects such as motivation, understanding of concepts, and the development of cognitive and social skills. However, Mangahigh (2025) maintains that customization and personalization are also ensured in their games as every student can follow a customized learning path. "Games are adapted to each student's learning pace and style, which maximizes their productivity and ensures that each student tackles mathematics challenges well-suited to their current level".

6. Conclusions

Based on the findings of this study, the following conclusions were reached or arrived at: gamification increased or positively affected the motivation of students learning algebraic concepts; gender does not influence the motivation of students; Students saw challenges as the most motivating element of gamification followed closely by Leader boards; Leaderboards lead the way followed by Challenges and puzzles in aspects of motivation that showcased the usefulness of each elements; there was a significant difference between students' motivation in gamified and traditional teaching methods; there was no significant difference between gender influence on students' motivations in gamified algebra learning; there was a significant difference between the perception of students on the most motivating element of gamification; and there was a significant difference between the perception of students on the areas of motivation the elements were most useful.

7. Recommendations

The following recommendations were made based on the conclusions arrived at in this study. And these included: Mathematics curricula should be made Flexible enough to accommodate gamification elements; appropriate measures should also be taken to introduce gamification and its elements into the curricular of other subjects and areas of learning; gamification strategies should be introduced into Teachers training programmes; and further research should be undertaken on long-term impacts of gamification and on diverse learner needs.

Games should be inroduced into classroom and Mathematics teachings but with emphasis on an appropriate teaching strategy.

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