Effects of Game-Based Instructional Strategy on Senior Secondary Students' Interest and Achievement in Probability in Pankshin Local Government Area of Plateau State, Nigeria

***Sarki Din Sarki., Lydia Kwari., Bwirdimma Dugul Gotep., Mary Dickson Dikop., Iliya Gushi., Gakbish John Gagara., Golji Godfrey Gopep., Yilleng Augustine Mwagitdang., Atang I. Toma., Awuya Michael Ali**

Department of Mathematics, Federal University of Education Pankshin, Plateau State, Nigeria

***Correspondence Author**

DOI: https://dx.doi.org/10.47772/IJRISS.2025.903SEDU0252

Received: 19 April 2025; Accepted: 23 April 2025; Published: 04 June 2025

ABSTRACT

This study investigated the effects of game-based learning (GBL) instructional strategy on students' interest and achievement in probability among senior secondary II students in Pankshin Local Government Area pf Plateau State, Nigeria. The study followed the quasi-experimental research design which enhanced the grouping the sampled population of 294 respondents into an experiment group (comprising of 152), which was taught using GBL strategy and a control group (made up of 242), which was taught using the conventional method. Probability interest inventory test was administered on the groups where students' interest in the experimental group was found to significantly increase due to treatment. A pre-test and post-test evaluations were administered on the groups to compare achievement scores of respondents. Results suggested that respondents in the experimental group demonstrated superior problem-solving skills, appeared to indicate more interest in learning probability and scored higher marks due to GBL. This suggests that GBL has a positive effect on learning outcomes. In light of the findings, the study considers it instructive for educators to integrate game-based activities in instructional design to enhance students' learning outcomes, and that efforts should be made to encourage the use of GBL strategy through the provision of relevant resources for learning and incentives for teachers.

INTRODUCTION

Mathematics has been identified as an important part of learning (Chen, P., Hwang, G., Yeh, S., Chen, Chen, & Chien, 2022). Reasons for students' struggles in mathematics are well reported (Chen et al., 2022; Cicchino, 2015; Bai et al. 2020; Johnson, 2023; Conmy, 2023). Associating instructional delivery in mathematics with games could raise pedagogical curiosity (Karakoç, Eryılmaz, Özpolat & Yıldırım, 2020). Characteristically, games articulate the air of exploration, resilience, entertainment and reward. Depending on the type, games emphasis the fundamentals of team work and collaboration (Karakoç, et. al., 2020) and this is irrespective of age (Muniroh,2023), gender, and status. Games are presenting new frontiers to pedagogy and affording learning opportunities for improving students' interest in the mathematics (Hamzah & Rosli, 2017; Cheng, Chi & Lee, 2018; Leung, Lee, & Lo, 2020; Conmy, 2023). The traditional methods of teaching, which often rely heavily on lectures and textbook exercises, may not be sufficient to capture students' interest or promote deep learning. Buttressing further, Kamarudin, Ain, and Malek, (2019) posited that the level of students' interest in teaching and learning is always low when the traditional (conventional) methods are employed. Teaching methods are undoubtedly foundational in instructional delivery. It is therefore, instructive that innovation must meet with mastery in instructional delivery (Wang, Chen, Hwang, Guan, & Wang, 2022; Gao, & Sun, 2020). Teachers must adopt ingenious and innovative teaching techniques and strategies that foster engagement, arouses interest and facilitate achievement among students. Real learning, according to Engin, Seven, & Turhan, (2004) in Karakoç, et. al., (2020), takes place when one does not only enjoy a learning activity, but would express the enjoyment explicitly. It is common sight to observe games of choice arousing visible surges of emotions that are deep actions that are enthusiastically physical. This may explain why Karakoç, et. al. (2020) re-echoed earlier studies' (Chang et al. 2012; Çavus et al. 2011; Giannakos 2013; Mayo 2009; Meluso et al. 2012; Musselman 2014; Yang and Chang 2013) enthusiasm that the effectiveness of games in instructional delivery suggests that it is instructive to match basic game features with teaching concepts to achieve desired educational objectives.

Probability is a fundamental concept in mathematics that plays a crucial role in fields such as statistics, sciences, and economics (Cheng et al., 2018). However, students often struggle to grasp the concept due to its abstract and theoretical nature. Traditional methods of teaching probability, such as lectures and textbook readings, may not be effective in engaging students and fostering a deep understanding of the topic.

Several explanations are noted to be responsible for students' underperformance in probability. Chernoff (2014) for instance identified lack of basic mathematics skills, inappropriate teaching method, lack of interest, and anxiety as major reasons why students find it difficult to grasp the fundamental ideas of probability. In another submission, Vivian (2015) reported that students' weak background in rational numbers constitute the major reason for their weak achievement in probability. Yet still, Bantero (2016) argued that the preference of a larger majority of students to indulge in memorisation of formulae rather than committing to grasping the fundamentals of probability is the most important challenge. Additionally, the study identified wrong instructional approach, language barrier learners' natural setting and the probability content articulation on one hand and the instructional setting on the other hand. These studies are unanimous that students' negative perception and poor achievement in probability is a result of the cumulation of students' negative disposition to mathematics and the inappropriate deployment of teaching materials by teachers are contributory to students' increasing difficulties.

Game-based learning (GBL) strategy is any instructional strategy that uses elements of games for content delivery (Talan, Doğan, & Batdı, 2020). Gamification conceptualises the incorporation of gaming mechanics into a learning activity without mortgaging the foundational structure of learning experience (Nadolny, Alaswad, Culver, & Wang, 2017). GBL are classified into digital games (Clark, Tanner-Smith, & Killingsworth, 2016), mobile games (Wang et al., 2022, p. 2), nondigital games (Naik, 2014), serious educational games (Lamb, Annetta, Firestone, & Etopio, 2018) and simulations (Lamb et al., 2018). GBL in an ingenious instructional strategy (Ahmad & Iksan, 2021) that is receiving increasing research attention in recent years (Zou, 2020).

Conventional or traditional teaching approach is described as teacher centred where learners simply listen, copy notes, and are tsked with classwork, assignments and tests. Notably, these activities are the only levels of learning interactions between the teacher and the students. Dotun (2015) reported that the conventional methods of teaching mathematics are no longer adequate to meet the needs of modern mathematics. In view of the foregoing, it is imperative that educators deliberately adopt innovative teaching strategies that foster both interest and achievement in probability. One promising approach is the use of GBL.

Interest plays a significant role in the achievement of learners. Schunk (2020) reports that there are two components to students' interest: situational and individual interest. He observed that situational interest refers to a temporal attention that a student gives to a subject due to external stimuli, which could be a classroom activity, while individual interest is a long-term, personal engagement with a subject. In the context of probability, situational interest can be sparked through activities that allow students to actively explore probabilistic concepts, such as using games to stimulate mathematical thinking and generate excitement and the spirit of competition where learners are challenged by a contest that produces a winner and a loser. Thus, they become motivated by the prospect of a reward. Probability deals with the use of games in teaching and learning environment. It uses competitive exercises, either putting the students against each other or getting them to challenge themselves in other to motivate them to learn better. Studies have indicated that GBL is not only a motivating educational idea, but also a didactic concept that if effectively implemented could be an alternative with better outcomes than conventional methods (Gee 2018; Prensky 2019).

Basically, achievement in mathematics, and other fields of endeavours, is often influenced by the level of motivation and engagement with the subject. Research has been consistent that students who are more interested in a subject of study tend to perform better in tests, assignments, and other assessments (Huang & Lee, 2022). However, achievement is not solely dependent on interest, it also involves students' ability to grasp and navigate through the complexities of learning concepts. Studies have identified several factors as key contributors to achievement in probability (Talan, Doğan, & Batdı, 2020; Nadolny, Alaswad, Culver, & Wang, 2017; Clark, Tanner-Smith, & Killingsworth, 2016; Wang et al., 2022; Naik, 2014; Lamb et al., 2018; Ahmad & Iksan, 2021; Zou, 2020).

Interest and achievement in probability are deeply interconnected and essential for students' success (Joseph, 2016; Vivian et al., 2015; Jamilah, 2017; Joseph, 2016; Hornby, 2018; Ebele & Sam, 2015). Students who are engaged and motivated are more likely to excel in a learning engagement, while those who lack interest often struggle to achieve at high levels. Given the challenges students face with achievement in probability, it is crucial for educators to adopt strategies that enhance both interest and achievement. It is against the backdrop that the researcher intends to investigate the effect of GBL on Senior secondary school two (SS II) students' interest and achievement in probability.

Statement of the problem

Despite global efforts to improve teaching and learning outcomes of probability, numerous challenges persist in delivering effective teaching of probability. The issue of falling interest and achievement among students has lingered. The impact of this on students' achievement in probability, and other areas of mathematics, has been substantial and very disturbing. Students' poor achievement has been traced to various factors, including inappropriate pedagogical methods. Game-based learning in education is an approach to learning in which aspects of games are inherent in the learning activities that are used to teach students about a variety of topics. They are competitive and encourage students to interact with each other by using entertainment as a learning tool. Therefore, the problem of this study is to investigate the effect of GBL on students' interest and achievement in probability.

Aims and objectives of the study

The aim of this study was to determine the effect of GBL on students' interest and achievement in probability among SS II students in in Pankshin Local Government Area of Plateau State, Nigeria. Specifically, the study sought to:

1. Determine the extent to which the use of GBL would influence SS II students' problem-solving skills in probability.

2. Determine the extent to which the use of GBL would influence SS II students' interest in learning probability.

3. Determine the extent to which the use of GBL would influence SS II students' achievement in learning probability.

Research questions

The following research questions guided the present study:

1. What is the mean interest scores of students taught probability using GBL approach and those taught with conventional teaching method?

2. What is the difference in mean achievement scores of students taught probability using game-based approach and those taught with conventional teaching method?

3. What is the difference in mean problem-solving skills of students taught probability using game-based and those taught with conventional teaching method?

Research Hypotheses

The following hypotheses, tested at 0.05 level of significance, guided the study.

Ho_1: GLB does not influence any significant difference in the mean interest scores of students in probability.

Ho_2: GLB does not influence any significant difference in the mean achievement scores of students in probability.

Ho_3: GLB does not influence any significant difference in the mean problem-solving skills of students in probability.

Significance of the study

This study is significant as it contributes to the growing body of research on the effectiveness of GBL in enhancing students' interest and achievement in probability. The findings of this study can inform educators and policymakers about the benefits of incorporating games into the teaching of probability.

The positive engagement role of GBL on students' learning outcome can profoundly encourage teachers to incorporate games in their teaching strategy in probability and other topics in mathematics.

By fostering interest and engagement through the incorporation of GBL, students may develop a deeper understanding of probability, leading to improved confidence and increased academic performance.

Scope of the Study

This study was carried out on SS II students in four of the 24 Government Secondary Schools in PLGA of Plateau State, Nigeria. The study was on the concept of probability as contained in the SS II mathematics curriculum in Nigeria. SS II students have spent several years in the school environment and are relatively aware of factors impeding their interest and achievement in probability.

Theoretical/conceptual framework

The Engagement Theory developed by Kurt Lewin in the 1940s and later expanded by Philp and Henson in 2000 in the context of education. The theory is concerned about the for students to be actively engaged in the learning process, especially within collaborative and interactive environments. The principles and components of Engagement Theory are discussed below.

Principles of Engagement:

Active Learning: Students must be fully engaged in the learning process to think through with acquired data. To could be only achieved when students interact with the material, their peers or mates, and the teacher.

Collaborative Learning: Learning is more effective when students work together, as engagement increases through social interaction, discussion, and group problem-solving.

Authentic Learning: Learning activities should connect with daily life experiences. This would help students appreciate the applications of mathematics to life's challenges.

Components of Engagement Theory:

Cognitive Engagement: This encompasses all the intellectual investment that a student makes to undertake academic tasks such as focus, effort, and persistence.

Emotional Engagement: This revolves around the aspects feelings and the emotions students attaches to a learning experience, such as interest, enjoyment, and motivation.

Behavioural Engagement: This concerns those actions and behaviours that demonstrate students' involvement, such as attending class, participating in activities, completing assignments, and engaging with content.

Application to game in probability: GBL strategy provide a hands-on, interactive way for students to explore probabilistic concepts. By engaging in mathematical games, students engaged more deeply with the content, which enhances cognitive engagement and improves their understanding of probability.

Collaborative Learning: Using GBL strategy in group activities allows students to work together, solving problems or exploring probability concepts in small groups. This promotes social interaction and peer learning, which can boost emotional engagement, making the learning experience more enjoyable and deeper.

Authentic Learning: GBL would enable students to have a direct experience probabilistic concepts in a tangible way, connecting the abstract ideas they study in the classroom with real-world demands force by chance and preferential reasoning. This reality would increase their interest and engagement in a subject of study thereby improving their academic performance and achievement.

Engagement Theory through GBL could increase SS II students' interest and achievement in probability by fostering active participation, collaboration, and real-world connections, thereby enhancing cognitive, emotional, and behavioural engagement.

The implication of the theory to this study is that, for meaningful learning to take place, mathematics teachers need to constantly use games when teaching. Learning is made meaningful and permanent if the abstractness of a concept is simplified to the learner's cognitive maturity through the use of games/instructional material. This will help in designing and applying interactive tasks and cooperative lessons to help students to be active

Operational Definition of Terms

The identified terms below are considered to connote the following contextual meaning in the study

Academic achievement measures the performance extent of students' accomplishment in specific learning goals.

Game-based learning is any instructional strategy that uses elements of games for content delivery.

Interest refers to the attributes given to the ratings of disposition towards learning of senior secondary school students

Engagement refers to a student's active involvement during learning

REVIEW OF RELATED LITERATURE

Games have a unifying and integrating effect. Research has revealed their capacity to offer opportunities to link learning with cultural and historical understanding (Griffiths, 2018). Also, they facilitate the development of probabilistic communication skills for students to innovatively communicate their ideas succinctly and justify their move to one another. This could foster collaborative engagements thereby deepening reasoning and skills. The teacher's regulatory role ensures that students are responsive to learning needs, focused on the learning activity and responsibly engaging with decorum. Educational games provide a unique opportunity for investigating the cognitive, affective and social aspects of learning. Cunmy (2023) posits that the consistent deployment of games and game-based learning in primary to high-school classrooms could result in more students developing their mathematics understanding and improve the retention rate of students who undertake STEM-related fields.

This section reviewed related scholarly literatures to the study. The review was presented under the following sub-themes namely; game playing, measuring game playing strategy, benefits and effectiveness of games in probability, concept of students' interest and achievement in probability.

Game Playing

Game in teaching and learning of probability is often misconstrued. The general conception of game as a time-filler or reward with little attempt to qualify in terms of probability learning why they are being used. A game should necessarily be played between two or more players who take turns, each competing to achieve a winning outcome that is not based on luck (Gough, 2017).

Benefits and Effectiveness of GBL in Probability

Game playing has a tremendous benefit to both players and spectators. Research has shown that social interaction and game playing fosters achievement (Trafton, 1990; Ernest 2019; Booker 2017).

Concept of Students' Interest

Developing interest in probability requires a coordinated interplay between mathematical concepts, cognitive psychology, and decision-making theories.

Mathematical concepts: relevant mathematical concepts are necessary for achievement in chance and the assessment of the underlying risk in uncertainty. Probabilistic reasoning requires a deeper understanding of probability of simple events, conditional probability, and the large numbers.

Cognitive psychology: Cognitive maturity and the psychological state of individuals regulate individuals' processing and reasoning capacity and their ability to think through with data. The curiosity for possible outcome and confidence in making reliable predictions amidst challenging uncertainties requires an understanding of the cognition behind probabilistic reasoning and this can help identify factors that influence interest in probability.

Decision-making theories: Resolving the issues of the best option among competing options are daily contentions in uncertain confrontations. It is expedient to weigh potential gains and losses in making decisions under uncertainty. By applying decision-making theories to the context of probability, researchers can investigate how individuals' preferences, biases, and risk attitudes influence their interest and engagement with probabilistic tasks.

An understanding of these elements could influence interest in probability and educate individuals with strategies for cultivating and sustaining this interest.

METHOD AND PROCEDURES

Research Design

The quasi-experimental design that was used for the study facilitated comparing the effectiveness of GBL and the conventional teaching approaches. It involves the use of intact classes (Thyer, 2012) of randomly selected schools, to come up with the control group and treatment (experimental) group. A pretest was given to both groups. Then the treatment group was taught probability using GBL approach while the controlled group was taught using the conventional approach. A second test (post-test) was then administered on both groups. This was to enable the research team compare the mean gains in test scores.

The design is displayed diagrammatically below for emphasis and clarity.

Group		**Pre-test**		**Treatment**		**Post-test**
Experimental	$\longrightarrow$	O_1	$\longrightarrow$	X_1	$\longrightarrow$	O_2
Control	$\longrightarrow$	O_3	$\longrightarrow$	X_0	$\longrightarrow$	O_4

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume IX Issue IIIS May 2025 | Special Issue on Education

Where: O_1 and O_3 represent the pre-test that was administered on both the experimental and control groups. The X_1 stands for treatment administered to the experimental group while the X_0 in the design indicates no treatment for the control group. The O_2 and O_4 in the design represent the post-test given to the experimental and control groups. While the line indicates non randomisation of the experimental and control groups.

Population of the Study

There are 24 public secondary schools in PLGA comprising of a total of 1473 SS II students in the 2022/2023 academic session.

Sample size

The sample size for the study comprised of the 294 SS II students in 4 selected secondary school in PLGA of Plateau State.

Sampling Technique

The simple random sampling technique was used to select the six school used for the study. All the SS II students in the sampled schools constituted the respondents for the study. The names of 24 schools in the study area was written on 24 pieces of paper squeezed and six were picked. The research team again used the simple random sampling procedure to select the two groups for the study. The words “Control” and “Experimental” were written on three identical pieces of papers, folded and dropped into a bowl. The papers were then picked, one after the other, by the representatives of the six school. The distribution is given below

	Name of school	**Group type**	**No. of Students**
1.	School C_1	Control Group 1	71
2.	School C_2	Control Group 2	43
3.	School C_3	Control Group 3	28
4.	School E_1	Experimental Group 1	97
5.	School E_2	Experimental Group 2	31
6.	School E_3	Experimental Group 3	24

Instrument for Data Collection

The data for this study was collected using the Probability Achievement Test (PAT) and the Probability Interest Inventory Test (PIIT). The instruments were administered on the students by the researcher team. The PIIT is a four (4) point Likert scale calibrated as follows: Strongly Agreed (SA) = 4, Agreed (A) =3, Disagreed (D) =2, Strongly Disagreed (SD) =1

Description of the Instrument

The PAT was a 20-item questionnaire that was designed by the researcher. It was prepared based on the SS II probability curriculum. The instrument was made up of two sections A and B. Section A was designed to generate students’ information (Bio-data) while section B was made up of twenty (20) items to test the performance of the student and two essay type question to test students’ solving skills. Each item had options A to E from which only one was correct. Each of the 20 questions only required students to find what the probability of a given problem was. Each correct answer attracted 1 mark which added to the allocated 20 marks for that set of questions while the essay part carried 5 marks, two and half marks for each. PIIT, on the other hand, was a ten-item questionnaire administered to assess students’ interest rating.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume IX Issue IIIS May 2025 | Special Issue on Education

Procedure of Instrument Development

The instrument development procedure was guided by table of specification designed by the researcher. The test instrument used was the Probability Achievement Test (PAT). The probability Achievement Test consisted of 20 item multiple choice objective type and one (1) essay adopted from WAEC standard questions. The marks were scored following WAEC's Marking schemes. The questions were constructed from secondary II Mathematics textbooks and WAEC past questions. The interest of students on probability was rated from their responses on the PIIT.

Procedure for Data Collection

The research team used six-40 minutes-periods for two weeks (three periods per week) in each of the sampled schools. The post-test was administered after the two weeks.

Method for Data Analysis

The research questions were analysed using mean and standard deviation while the hypotheses were tested using Z-test at .05 level of significance.

DATA ANALYSIS, RESULTS, AND DISCUSSION

Introduction

This section presents the data analysis, results, and discussion of the findings from the study on the effects of a game-based approach on students' interest and achievement in probability.

Data Analysis

The data generated PAT and PIIT were analysed using mean, standard deviation, and Z- test. The mean interest scores, problem-solving skills, and achievement scores of students taught with the game-based approach and those taught using conventional methods were compared to determine the effectiveness of the game-based approach.

The analysis also included the comparison of pretest and post-test scores of students to assess the impact of the GBL approach on students' interest and achievement in probability. The statistical significance of the results was tested at a significance level of alpha = 0.05.

Analysis of Research Questions

Research question one: What is the mean difference in interest scores of students due to teaching probability using GBL?

Table 1: mean interest score, standard deviation and mean difference of students taught using game-based approach

Type of test	Experimental Group Mean Standard Dev.	Control Group Mean. Standard. Dev
Pre-PII	22.15 2.965	22.29 2.813
Post-PII	44.44 3.241	22.92 2.838
Mean difference	22.29	0.63

Following from Table 1, GBL influenced a mean gain of 22.29. This implies that the interest of students taught probability using GBL improved significantly. This result is supported by Bhadawkar and Gupta (2021) who posited that GBL strategy has the capacity to improve students' interest.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume IX Issue IIIS May 2025 | Special Issue on Education

Research Question Two: What is the difference in mean problem-solving skills of students taught probability using game-based and those taught with conventional teaching method?

Table 2: Mean problem-solving skills score and standard deviation of students due to teaching with GBL.

Group	No of cases	Pre-test mean	SD	Post-test mean	SD	Mean difference	S.D deference
Experimental	152	8.8	3.6	12.3	3.9	3.5	0.3
Control	142	7.2	5.2	7.8	4	0.6	-1.2

It can be seen from Table 2 that the mean difference problem-solving scores for the experimental group was 3.5 while that of the control group was 0.6. The result suggests that GBL impacted positively on students' probability solving skills.

Research question three: What is the difference in mean achievement scores of students taught probability using GBL?

Table 3: Mean Achievement Scores, Standard Deviations and Mean difference of the experimental and control group in probability?

Group	No. of cases	Pre-test mean	Standard deviation	Post-test mean	Standard deviation	Mean different	S.D deference
Control	142	26.3	16.9	28.2	18.6	1.9	1.7
Experimental	152	27.5	18.0	40.9	15.9	13.4	-2.1

Table 3 above provides a detailed comparison of the achievement outcomes between the study groups. GBL was seen to influence a mean gain score on achievement of 13.4 compared to the 1.9 influenced by the conventional method. This outcome is in line with (Rondina & Roble, 2019; Turgut & Temur, 2017) who had earlier submitted that GBL improves students' achievement. The significance of this outcome is presented in Table 6. result shows that the control group had a mean achievement score of 26.3 and standard deviation of 16.9 while experimental group had a mean 27.5 and standard deviation of 18.0 and 7.48 respectively in pre-test. Similarly, in post-PAT, mean achievement score and standard deviations of control group are 28.2 and 18.6 respectively, while mean achievement scores and standard deviation of experimental group are 40.9 and 16.9 respectively. The mean difference between pre-PAT and post-PAT for control group is 1.9 while experimental groups had 13.4 respectively. This implies that students taught probability using game-based approach performed better than those taught with the conventional teaching method.

Testing of Hypothesis

Hypothesis one: There is no significant difference in students' mean problem-solving skills due to GBL strategy.

Table 4: The z-test for the different between the mean problem-solving skills of students taught with game-based approach and that of conventional teaching method.

Group	N	Mean	Standard Dev.	Z – value	Crit. Z – value
Experimental	152	13.4	-2.1		
Control	142	1.9	1.7		
Z – test				4.20	1.96

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS |Volume IX Issue IIIS May 2025 | Special Issue on Education

The Z-test analysis of students' problem-solving skills is displayed in Table 4. Here, the mean problem-solving skills of the experimental and control groups pull a z-value of 4.20, which is greater than the critical z-value of 1.96 at a significance level of 0.05. Consequent on this, the null hypothesis is rejected, and it is concluded that there is a significant difference in the mean problem-solving skills of students due to the effect of GBL on probability.

Hypothesis two: There is no significant difference in the mean interest scores of students due to teaching with GBL strategy.

Table 5: The z-test for the difference of mean interest scores of students due to teaching probability using GBL strategy.

Group	N	Mean	Standard Dev.	Z – value	Crit. Z – value
Experimental	152	22.29	0.276		
Control	142	0.63	0.025		
Z – test				2.34	1.96

In Table 5, the z-value of 2.34, which is greater than the critical z-value of 1.96 is presented at a significance level of 0.05. Therefore, the null hypothesis is rejected, and instead, it is concluded that there is indeed a significant difference in the mean interest scores of students due to teaching probability using the GBL approach.

Hypotheses three: There is no significant difference in the mean achievement scores of students due to teaching of probability using GBL strategy.

Table 6: The Z-test of the mean achievement score of students due to teaching with GBL strategy.

Group	N	Mean	Standard Dev.	Z – value	Crit. Z – value
Experimental	152	3.5	0.3		
Control	142	0.6	-2.1		
Z – test				5.78	1.96

The z-test analysis of students' achievement as presented in Table 6 shows a mean achievement scores of 3.5 for the experimental group as compared to the 0.6 for the control group with a z-value equivalence of 5.78, which is greater than the critical z-value of 1.96 at a significance level of 0.05. as a result, the null hypothesis is rejected in favour of the alternative to allow for the conclusion that is a significant difference in the mean achievement scores of students due to the effect of teaching probability using GBL strategy.

DISCUSSION OF FINDINGS

The study sought to find the effects of the game-based learning strategy on the interest and achievement of senior secondary school students. It was discovered that evidence exists for asserting that the effectiveness of a GBL approach in enhancing students' problem-solving skills, interest, and achievement in probability. The findings of the study demonstrates that students who underwent an instructional procedure through relevant gaming exposition turned out with superior problem-solving skills, increasing interest rating scores, and higher achievement scores. This significance in learning outcomes suggests that by incorporating educational games into the curriculum, learning would become more beneficial. It is therefore, necessary that educator strive to create a dynamic and stimulating learning environment that fosters and promotes active participation and engagement with content and existence.

CONCLUSION AND RECOMMENDATIONS

The learning outcomes presented in this study demonstrates the effectiveness of game-based learning instructional strategy harness students' intellectual capacity to drive a function learning process that allows learners to think through with data and thrive in the careers. This study has highlighted the necessity for exploring more deeply on the effect of GBL strategy with the aim of expanding to cover more areas of mathematics (Bhadawkar et al., 2021).

Following from the effort of the researchers which has provided content clarity on probability, it is instructive that educators become more strategic and specific in content delivery. They should be seen to make deliberate effort to begin to develop their ability to initiate, design and implement instructional strategies that are practical and appealing. Games in probability has added to the growing literature on GBL in mathematics. This is providing enormous possibilities for revolutionising the learning process. Policymakers should not allow this exposition slip through their critical minds and the strategic influence they presently will to support, promote and encourage the use of game-based approaches in education by providing relevant GBL resources and professional career development opportunities for teachers to incorporate games into their teaching practices. It is important to consider expanding this study on other areas of mathematics

REFERENCES

1. Bantero, A. (2016). Understanding student preferences in probability learning. Educational Research Journal, 4(1), 23–35.
2. Chernoff, E. (2014). Understanding the difficulties students face in learning fundamental probability concepts. Journal of Mathematics Education, 6(2), 45–56.
3. Dotun, A. (2015). Modernizing mathematics education: The need for new teaching strategies.
4. International Journal of Education and Learning, 7(3), 89–97.
5. Ebele, A., & Sam, D. (2015). Low interest in mathematics: The role of anxiety and phobia. Journal of Educational Research, 7(2), 56–67.
6. Hornby, R. (2018). The role of interest in mathematics learning: A conceptual review. Educational Psychology Journal, 20(1), 34–46.
7. Jamilah, S. (2017). Enhancing probability learning through problem-solving based instruction. Journal of Curriculum Development, 15(4), 89–102.
8. Joseph, J. (2016). Motivating learners in probability through cooperative learning and problem-solving strategies. Mathematics Education Today, 10(3), 56–68.
9. Prensky, M. (2019). Digital game-based learning. McGraw-Hill.
10. Vivian, S. (2015). Weak foundations in rational numbers leading to difficulties in probability among students. Educational Psychology Review, 8(3), 112–125.
11. Karakoç, B., Eryılmaz, K., Özpolat & Yıldırım, I, (2020). The Effect of Game-Based Learning on Student Achievement: A Meta-Analysis Study. Technology, Knowledge and Learning. 27. 1-16. 10.1007s10758-020-09471-5
12. Engin, A. O., Seven, M. A., & Turhan, V. N. (2004). The place and importance of games in learning. Atatürk University Journal of the Institute of Social Sciences, 4(2), 109–120.
13. Chen, P., Hwang, G., Yeh, S., Chen, Y., Chen, T., & Chien, C. (2022). Three decades of game-based learning in science and mathematics education: An integrated bibliometric analysis and systematic review. Journal of Computers in Education, 9(3), 455-476. https://doi.org/10.1007/s40692-021-00210-y
14. Johnson, R. (2023). Constructivism and Geometry Instruction: Bridging Theory and Practice. Educational Psychology Review, 15(1), 104-118.
15. Conmy, T. (2023). We are Still Playing: A Meta-Analysis of Game-Based Learning in Mathematics Education. A Doctoral Dissertation of the University of San Francisco. https://repository.usfca.edu/diss
16. Cicchino, M. (2015). Using game-based learning to foster critical thinking in student discourse. Interdisciplinary Journal of Problem-Based Learning, 9, 57-74. https://doi.org/10.7771/1541-5015.1481

17. Wang, L., Chen, B., Hwang, G., Guan, J., & Wang, Y. (2022). Effects of digital game-based STEM education on students' learning achievement: A meta-analysis. International Journal of STEM Education, 9(1). https://doi.org/10.1186/s40594-022-00344-0
18. Gao, F., Li, L. & Sun, Y. (2020). A systematic review of mobile game-based learning in STEM education. Education Tech Research Dev 68, 1791–1827 https://doi.org/10.1007/s11423-020-09787-0
19. Talan, T., Doğan, Y., & Batdı, V. (2020). Efficiency of digital and non-digital educational games: A comparative meta-analysis and a meta-thematic analysis. Journal of Research on Technology in Education, 52(4), 474–514. https://doi.org/10.1080/15391523.2020.1743798
20. Clark, D. B., Tanner-Smith, E. E., & Killingsworth, S. S. (2016). Digital games, design, and learning: A systematic review and meta-analysis. Review of Educational Research, 86, 79–122. http://www.jstor.org/stable/24752870
21. Nadolny, L., Alaswad, Z., Culver, D., & Wang, W. (2017). Designing with game-based learning: Game mechanics from middle school to higher education. Simulation and Gaming, 48, 814–831. https://doi.org/10.1177/1046878117736893
22. Naik, N. (2014). A Comparative Evaluation of Game-Based Learning: Digital or Non-Digital Games? Proceedings of the European Conference on Games Based Learning, 2, 437–445.
23. Lamb, R. L., Annetta, L., Firestone, J., & Etopio, E. (2018). A meta-analysis with examination of moderators of student cognition, affect, and learning outcomes while using serious educational games, serious games, and simulations. Computers in Human Behavior, 80, 158-167. https://doi.org/10.1016/j.chb.2017.10.040
24. Kamarudin,H., Ain,N., andMalek, A. (2019). Powertoon clues. Int. J.Modern Lang. Appl. Linguis. 2, 30–34. doi: 10.24191/ijmal.v2i3.7624
25. Ahmad, N. F., & Iksan, Z. (2021). Penerapan Kemahiran Proses Sains melalui Pembelajaran Sains Berasaskan Permainan Digital. Sains Insani 6, 75–81. doi: 10.33102/sainsinsani.vol6no1.246
26. Zou, D. (2020). Gamified flipped EFL classroom for primary education: student and teacher perceptions. J. Comput. Educ. 7, 213–228. doi: 10.1007/s40692-02 0-00153-w
27. Thyer, Bruce (2012). Quasi-Experimental Research Designs. Quasi Experimental Research Designs. 1-216. 10.1093/acprof:oso/97801953887384.001.0001.
28. Bhadawkar, H. R. & Gupta, K. (2021). A Study of the Effectiveness of Game Based Learning Strategies for Enhancing Achievement and Interest in Mathematics among Middle School Students. International Journal of All Research Education and Scientific Methods (IJARESM), ISSN: 2455-6211 Volume 9, Issue 5, May-2021