Effect of Ludo and Card Games on Senior Secondary School Students' Academic Achievement in Probability in Oyo Metropolis, Oyo State

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Certification

This is to certify that Dauda Adekunle KAREEM with matriculation number LCU/PG/004009 carried out this research work titled "Effect of Ludo and Card Games on Secondary School Students' Academic Achievement in probability in Oyo Metropolis, Oyo State" in the Department of Science Education, Faculty of Education, Lead City University, Ibadan, Oyo State for the award of Master of Science Education Degree in Mathematics Education and that has not been previously submitted to any institution for award of any degree or certificate.

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Dedication

This research is dedicated to Almighty God and my late parents.

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Acknowledgement

The researcher hereby acknowledge my citadel of learning, Lead City University, Ibadan, Oyo State for providing me with an enriching learning environment and resource necessary for this program. The researcher also appreciates all the principal, teachers, research assistance, and students of all the school where I carried out this research work. Thank you very much.

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Even though, the above-mentioned institution persons have assisted in the process of this research work, The researcher alone stands responsible for the errors if any found in the work.

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Abstract

Probability is a fundamental mathematical concept with widespread real-world applications to every area of life. Despite its importance, report from WAEC Chief examiner Reports indicated that Senior Secondary School Students in Oyo State face challenges in achieving feat in this subject area. This could be as a result of many factors such as the strategies used in teaching the topic. This informed the need for innovative teaching strategies to assist the teaching and learning in the topic. Hence, this study investigated the effect of Ludo and Card Games on Senior Secondary School Students` Academic Achievement in Probability in Oyo metropolis. The study was guided by seven hypotheses and adopted the pretest, posttest and quasi experimental design of 3x2 factorial matrix. The population of the study comprise all SS2 students in government owned secondary schools in Oyo Metropolis for 2023/2024 academic session. Simple random sampling technique was used to select 3 schools from each of the three local governments areas in Oyo metropolis in which three intact classes of 244 students were used. Results from the findings showed significant effect of Ludo and Card games on academic achievement of Senior Secondary Students in probability in Oyo Metropolis; [$F_{(1,\ 239)}$ = 65.297; P <0.05]; [$F_{(1,239)}$ = 42.111; P <0.05] and no significant interaction effect of Ludo and Card games with gender on Students' Academic Achievement in Probability in Oyo Metropolis [$F_{(16,\ 228)}$ = 13.480; P <0.05].

Keywords: Ludo, Card ,Games, Probability, Academic achievement.
Word Count:254

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Chapter One

Introduction

1.1 Background to the Study

Academic achievement refers to the level at which a student, teacher, or school has reached their educational objectives, whether short-term or long-term. A student's academic achievement is usually measured by teacher-made tests or standardized tests which in most cases are referred to as external examinations like the Basic Education Certificate Examination (BECE), Senior School Certificate Examinations (SSCE) conducted in Nigeria by the West African Examination Council (WAEC) and the National Examination Council (NECO)[1.] Achievement generally is the act of accomplishing a task well[2]. Students' achievement is a key indicator of the success or failure of an academic program. Academic achievement is the measure of what a person had accomplished after exposure to educational programme. Students' academic achievement can be influenced by several factors such as learning environment, teaching methods and gender differences among others. However, in line with the above, It has been noted that academic achievement is influenced by the amount of time a child spends actively engaged in learning, as more study time can enhance retention of the material, potentially improving the student's performance in tests or examinations[2]. Moreover, when a teacher initiates creative activities in the school, it enhances students' learning abilities and positively impacts their academic achievement in examinations[3].

The academic performance of students in Oyo State secondary schools seems to be inadequate, raising significant concern, as students consistently perform poorly in both internal and external examinations. For instance, in 2018only 13.95% of Oyo State students passed English and Mathematics in West African Examination. Also in the years 2020, 2021,

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and 2022 the percentage of students in Oyo State that passed five credits and above including Mathematics and English were 51.16%, 54.77% and 38.98% respectively[4].

The state of Mathematics education across all levels in Nigeria is generally poor, with various factors contributing to students' under achievement[5]. These factors include inadequate Mathematics foundations from primary education, lack of student interest, unqualified teachers, overcrowded classrooms, and a psychological aversion to the subject. Research highlights several key reasons for poor performance, such as a shortage of qualified Mathematics teachers, students' negative attitudes towards the subject, teachers' own difficulties with certain concepts, and ineffective teaching practices in classrooms. Additionally, the absence of appropriate instructional materials in lessons exacerbates the problem.

The National Mathematical Centre has investigated the causes of persistent failures in WAEC, SSCE, and JAMB Mathematics exams, concluding that ineffective teaching methods are a more significant issue than curriculum content[6]. This is largely due to the prevalence of traditional, teacher-centered instructional approaches that limit student engagement. Given that Mathematics performance is crucial for producing skilled graduates who contribute to national development, various studies have sought to understand the factors influencing academic outcomes. These studies often emphasize family, teacher, and student-related factors, with their impact varying across different educational and cultural contexts.

Mathematics holds a pivotal role in Nigeria's educational system, being a fundamental science of quantity and space. It is viewed as a human creation, arising from the need to address practical problems, and its importance spans across all disciplines and fields of study[7]. Mathematics continues to be essential for the development of individuals and

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nations, serving as a crucial tool in navigating today's technological world. Even the average person recognizes its significance in everyday life.

As an intellectually stimulating subject, Mathematics influences various aspects of human activity, including politics, economics, science, and technology. Its importance in nation-building is widely acknowledged, prompting the Federal Government of Nigeria to designate Mathematics as a core subject in the curriculum at certain educational levels, as it forms the foundation for scientific and technological progress. Additionally, Mathematics is a compulsory prerequisite for admission into specific university programs, with students required to have a credit in the subject to pursue higher education[8].

Despite the importance of Mathematics and its esteemed status among academic disciplines, students' performance in public examinations has continued to decline year after year[9]. It serves as a foundational discipline for various sciences such as Chemistry, Physics, Biology, and Geography, playing a crucial role in both social and scientific realms. It is regarded as a fundamental element in human cognition, predating scientific advancements, and is considered among the earliest areas of study in human history[10]. Mathematics was viewed as the pinnacle of rationality, embodying the highest aspirations of human reasoning across all domains[4]. Its indispensability in daily life is underscored that without Mathematics, science, technology, and ultimately modern society could be difficult[11].

The Nigerian Mathematics Curriculum for secondary schools, developed by the Nigerian Educational Research and Development Council, categorizes Mathematics into five distinct themes: Number and Numeration, Geometry, Algebra, Introductory Calculus, and Statistics and Probability.

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One of the branches of Mathematics that deals with calculating the likelihood of a given event's occurrences, which ranges between zero and one is probability. This branch of Mathematics is primarily theoretical, focusing on exploring the implications of mathematical definitions[12,13]. Probability exhibits a dual nature: one aspect is statistical, aiming to uncover the mathematical rules governing sequences of outcomes from random processes through data and experiments, while the other interprets probability as a subjective measure of belief[14]. Probability is a mathematical branch that helps to understand chance and manage numerical data through collection, organization, description, and analysis. It is applied in areas such as games of chance, genetics, weather forecasting, election predictions, and other everyday events, emphasizing the need for teaching probability to help citizens move beyond deterministic thinking and embrace the role of chance in nature[15].

Probability as an integral part of Mathematics curriculum is of great importance to learners, because the progressive nature that follows the use of technology, spread of empirical science in the society, the use of data to communicate information and modern decision-making system are all influenced by projected outcome based on estimated probabilities. Probability is a very useful topic in secondary school Mathematics as it is needed in many careers such that, students need to conceptualize it as they prepare for their careers in the future. It was reported that in spite of the importance of probability to man and National development, students continue to see it as abstract and difficult to understand[16]. Students find related questions difficult to understand and to interpret during examinations, thereby encourages difficulties in learning basic data analysis.

Among several explanations given on the reasons why students find it difficult to grasp the fundamental ideas of probability, the following are part; lack of basic Mathematics

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skills, inappropriate teaching method, lack of interest, anxiety elcetra[17]. Students' weakness in probability questions could be due to their weakness in foundations in rational number. While examining causes of difficulties in probability content. It has been acknowledged that students tend to rely on intuition rather than logic when attempting to understand probability concepts[18]. A large majority of students prefer the memorizing of formulae rather than making effort to understand the basis of probability content. It was further noted that nurturing negative attitude towards this content and the non-usage of teaching materials by teachers are major reasons behind poor performance and understanding. Other factors responsible for students' challenges in probability are wrong approach, poor linkages that exist between the natural and the academic languages of probability and the poor linkage that exist between intuition of chance and quantitative literacy[19].

Various teaching methods have been explored to enhance learners' interest in the probability component of the Mathematics curriculum. These include cooperative learning and peer interaction, video-based learning, internet-based instruction, the use of Geometer's Sketchpad and graphing calculators, cultural games, teacher- and student-led approaches, real-world problem-solving integration, innovative strategies, problem-solving-based learning, and game tournaments. To address these challenges, it has been suggested that adopting an experimental mindset with student-centered teaching methods can improve students' understanding of probability theory. Given the declining academic performance of senior secondary students in Mathematics, including Probability, there is a pressing need for innovative instructional approaches.

Traditional instructional methods may not always effectively engage students or provide them with the necessary support to master complex concepts in probability. This is

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where Ludo and Card games come into play, by leveraging on the elements of games such as challenges, rewards, and interactive activities, educators can create more immersive and enjoyable learning experiences that capture students' interest and motivation.

Inculcation of Ludo and Card games into educational practices have gained significant attention in recent years. Ludo and Card games, incorporate game design elements and principles into non-game contexts to engage and motivate learners[20]. On the other hand, providing students with ongoing games during the learning process to guide their understanding and improve their performance[16]. Additionally, incorporating Ludo and Card games into the learning process allows educators to provide timely and personalized guidance to students, thereby helping them identify their strengths and areas for improvement in understanding probability.[26]. This iterative game loop creates a supportive learning environment that empowers students to take ownership of their educational journey and achieve meaningful progress over time.

Understanding the potential impact of Ludo and Card games on senior secondary school students' achievement in probability is crucial for educational stakeholders conducting empirical research on this topic, educators can gain insights into effective instructional strategies and inform curriculum development efforts to enhance student learning outcomes. Ultimately, by embracing innovative approaches like Ludo and Card games, schools in Oyo State can better prepare students for academic success and future endeavors in a rapidly evolving world.

Ludo and Card games can serve as a foundation for learning strategies for students when they are adequately prepared for knowledge acquisition[21]. Ludo and Card games significantly enhance the development of problem-solving skills, which are crucial for

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students studying Mathematics. These games help students move beyond superficial thinking, engage in discussions about word problems, and gain a broader understanding of life. Moreover, subjects that are typically perceived as boring or difficult can become enjoyable and easier to grasp through the use of Ludo and Card games[22]. When Ludo and Card games are designed, presenting new information alongside existing knowledge allows the old information to be integrated with the new. Additionally, Ludo and Card games enable the reproduction of prior knowledge without monotony, encouraging passive, shy, or hesitant students to participate in class, thus facilitating learning for students across various proficiency levels. Ludo and Card games motivate students by boosting their desire to learn, which enhances their sense of competence; this success further increases their motivation for the lesson. Games are an undeniable element of the educational environment, as they offer opportunities for practice both during lessons and after school[23].

While Ludo and Card games are not a widespread approach in schools, they are utilized in fields such as economics, marketing, advertising, and production. A primary objective of Ludo and Card games is to enhance participants' motivation and help them have positive experiences in life events[24]. In contrast, many students do not perceive traditional classroom activities as enjoyable experiences. Therefore, incorporating Ludo and Card games into teaching and learning can enhance motivation and contribute positively to modern education systems[36]. Education researchers have taken keen interests in Ludo and Card games Combining educational and game elements has been likened to mixing peanut butter with chocolate to create a delightful experience[25,26].

Research indicates that Ludo and Card games positively impact the learning process, and their integration into education is considered significant[27]. Adapting Ludo and Card games

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allows students with different abilities to participate more effectively, leading to increased engagement and the formation of connections that enhance the learning experience. This increased participation can encourage students to be more actively involved in educational activities, suggesting that games could also be beneficial for secondary school Mathematics, the focus of this study.

Games incorporate relaxing elements, such as badges and leader boards, into educational contexts to make learning more enjoyable[28]. These elements help to address the monotony associated with traditional teaching methods by fostering a stimulating environment that rewards achievements and provides immediate game, which motivates students. In a game-based learning setting, the game components are designed to align with educational objectives, aiming to awaken students' interest and encourage competition, thereby internalizing the external motivation provided by the games. Studies have shown that game elements can influence students' cognitive and behavioral aspects, and the approach supports continuous learning, which can improve academic performance.

However, while Ludo and Card games are a recent pedagogical tool aimed at increasing student motivation, their impact on academic performance in Mathematics is not yet fully established. While some studies indicate that Ludo and Card games enhance active engagement, additional research is required to confirm their impact on students' academic performance and learning outcomes. Researchers recommend conducting more rigorous and well-defined studies to confirm the educational benefits of games and establish them as a recognized instructional tool. The adoption of Ludo and Card games has already contributed to a heightened interest in learning among students[29].

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The games considered in this study are categorized as follows;

Token, dice, or coin games are categorized based on the use of tossing a die, token, or coin. Seven distinct games within this category include: (i) Difference of the Dice, (ii) Game of 'Fives,' (iii) Banana Game, (iv) Efron's Dice, (v) Token Game, (vi) Pass the Pigs, and (vii) Flipping Out. Brief descriptions of each game are provided below.

In the game "Difference of the Dice," two students each roll two dice and find the difference by subtracting the smaller number from the larger one. The first player wins if the difference is 0, 1, or 2, while the second player wins if it is 3, 4, or 5. After approximately 20 rounds, the players assess whether the game is fair. "Game of Fives" can involve the whole class, groups, or pairs; each team rolls the dice for 10 rounds, scoring a point each time a five is rolled. The team with the most points after 10 rounds wins. In Banana Game, two players imagined to be stranded on an island with a single banana, play this game to decide who gets the banana. Both players roll a die simultaneously; In this game, if the larger number rolled is 1, 2, 3, or 4, player one wins; if it is 5 or 6, player two wins. Efron's Dice consists of four distinct dice: Die A has four faces with four dots and two blank faces; Die B has six faces, each showing three dots; Die C features four faces with two dots and two faces with six dots; and Die D has three faces with five dots and three faces with one dot. Various games can be created with these dice, such as one where the player with the highest number wins. Token Game uses three tokens, each with different combinations of letters (A, B, or C) on their sides. The first token contains A and B, the second token includes A and C, and the third token comprises B and C. Players flip all three tokens together; if any sides match, player one wins. In this game, if there are no matching sides, player two scores a point, and the first player to reach 20 points wins. In "Pass the Pig," players toss a small toy pig and tally points

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according to a scoring sheet, with the player having the highest score after 10 tosses declared the winner. "Flipping Out" involves two players tossing a coin: player one scores a point if both coins land on heads, while player two scores if the coins show heads and tails (HT) or tails and heads (TH). The player with the most points after 10 tosses wins this game as well.

The variable of interest in this study is Ludo and Card games. Ludo and Card games refers to the ongoing, constructive game given during the learning process to guide and support students' progress towards achieving specific learning goals or outcomes. It is typically provided by teachers, peers, or self-assessment, and is used to: Identify areas of strength and weakness; Clarify understanding and misconceptions; Set goals and targets; Develop skills and strategies; and Encourage reflection and self-regulation. Ludo and Card games is characterized by: specificity, that is clear and detailed game focused on specific aspects of performance; timeliness which is provided during the learning process, while there is still time to adjust and improve; focus on process which emphasizes the learning process and strategies, rather than just the product or outcome; supportive tone which encourages and motivates students to take ownership of their learning; and actionable, which Provides concrete suggestions for improvement and growth. Examples of Ludo and Card games, include: Oral game during class discussions or one-on-one conferences, Written comments on assignments or drafts, Peer review and game, Self-assessment rubrics and checklists, game assessments and quizzes.

Recent research has highlighted the significance of assessment with games in the learning process, which aids in diagnosis, self-monitoring, and the development of evaluative and judgment skills, while also promoting learners' self-regulation[30]. Effective assessment practices are closely linked to the practice of providing game. The objectives of assessment

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are most successfully met when games are both involved and impactful. Utilizing effective games lay the groundwork for learner autonomy and creates a framework for high achievement; it also serves as essential scaffolding that supports and enhances students' learning[44]. Teachers are expected to inform students about their shortcomings in specific subject matter to ensure improved learning outcomes. Providing games on students' strengths and weaknesses through timely game strategies are crucial for enhancing their academic achievement[51]. Therefore, in order to improve students' learning, games are encouraged, which requires the adoption of game assessment practice in instructions, especially in Mathematics instruction.

Research studies have shown that games offer both reinforcement effects and corrective information[31]. However, games have been reported to have detrimental effect. Games may not fulfill their facilitative role under two conditions: first, when it is highly available to the learner before they respond, and second, when the material being studied is particularly difficult for the learner[32]. It was also noted that, in the absence of these conditions, studies based on both theories indicate that game on performance not only reinforce correct responses but also help identify and correct errors. This corrective function are likely the most significant aspect of games, and if given a choice, games on incorrect responses is likely to yield a positive effect[47]. In this study, games were employed as a means to facilitate corrections and reinforce students' learning outcomes. It was suggested that when individuals are informed about their successful performance on games, they are likely to develop an interest in the subject and may seek ways to excel in future tasks[33].

Conversely, negative games on performance can have several effects. First, students may use it to make corrections and improve on subsequent tests, leading to a positive

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influence. However, on the other hand, some students may feel defeated or intimidated, developing a sense of inadequacy in the subject, which could result in continued poor performance and a loss of interest in the area of study. The findings from these studies suggest that effective implementation of formative testing combined with games and remediation strategies can enhance teaching and learning in secondary schools.

Ludo and Card games, recognized as one of the most effective strategies for enhancing student learning, particularly by boosting motivation[34]. Research shows that when students receive descriptive games and are given the opportunity to revise their work, their performance improves[35]. However, studies also indicate that incorrect games can negatively impact learning, emphasizing the need for teachers to understand students' strengths and weaknesses to provide games that promote motivation and achievement. Effective games require specific conditions, such as student awareness of the learning goal, an understanding of their current progress, and taking steps toward the desired learning outcome.

Another study highlighted that games must align with students' learning goals to be effective, as grades alone do not significantly improve achievement[36]. Surprisingly, combining grades with comments may even hinder learning due to "ego-involving" games, which lead students to compare themselves to others rather than focus on the learning objective[37].

Additionally, gender differences in Mathematics achievement have been a concern for educators and researchers, as studies show varying results on whether boys or girls perform better, with some findings indicating no significant difference during early education[38]. Given these considerations, it is important to evaluate any instructional method that may enhance Mathematics performance and interest, including its impact across genders. This

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study, therefore, aims to investigate the effect of Ludo and Card games on the academic achievement of secondary school students in Mathematics, considering gender as a moderating factor.

1.2 Statement of the Problem

For a country or a state to excel in technological and scientific fields, the performance of students in Mathematics especially in probability should be excellent. Despite efforts to improve mathematics education, secondary school students in Oyo Metropolis continue to struggle with probability concepts, as evident in the consistently poor performance in probability-related questions in external examinations[38]. WAEC Chief Examiners' Reports have consistently highlighted students' weaknesses in probabilistic thinking, citing difficulties in applying theoretical concepts to practical problems. A significant factor contributing to poor performance in probability is the use of ineffective teaching strategies by teachers. Traditional instructional methods fail to adequately engage students and provide them with the necessary support to master probability concepts. Meanwhile, recreational activities like Ludo and Card games have been suggested to improve probabilistic thinking. As a result, there is a need to investigate innovative instructional approaches, such as Ludo and Card games and their potential effect on secondary school students' achievement in probability in Oyo State.

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1.3 Aim and Objectives of the Study

The aim of this study was to investigate the effect of Ludo and Card games on senior secondary school students' Academic Achievement in Probability in Oyo Metropolis.

The objectives of the study are to:

i. examine the main effect of Ludo games on the academic achievement of senior secondary school students in Probability in Oyo Metropolis;

ii. examine the main effect Card games on the academic achievement of senior secondary school students in probability in Oyo Metropolis;

iii. investigate the main effect of gender on academic achievement of senior secondary students in probability in Oyo Metropolis;

iv. examine the interaction effects of Ludo and Card games on academic achievement of senior secondary students in probability in Oyo Metropolis;

v. examine the interaction effect of Ludo games with gender on academic achievement of senior secondary students in probability in Oyo Metropolis;

vi. examine the interaction effects of Card games with gender on academic achievement of senior secondary students in probability in Oyo Metropolis and

vii. examine the interaction effects of Ludo and Card games with gender on academic achievement of senior secondary students in probability in Oyo Metropolis.

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1.4 Hypotheses

In line with the specific objectives of the study the following Hypotheses were formulated and tested at 0.05 level of significance:

$H_0$1: There is no significant main effect of Ludo and Card games on the academic achievement of senior secondary school students in Probability in Oyo Metropolis.

$H_0$2: There is no significant main effect Ludo and Card games on academic achievement of senior secondary school students in probability in Oyo Metropolis.

$H_0$3: There is no significant main effect of Ludo and Card games gender on academic achievement of senior secondary students in probability in Oyo Metropolis.

$H_0$4: There is no significant interaction effects of Ludo and Card games on academic achievement of senior secondary students in probability in Oyo Metropolis.

$H_0$5: There is no significant interaction effects of Card games on academic achievement of senior secondary students in probability in Oyo Metropolis.

$H_0$9: There is no significant interaction effects of ludo and gender on academic achievement of senior secondary students in probability in Oyo Metropolis.

$H_0$7: There is no significant interaction effects of Cards, Ludo, and gender and on students' academic achievement of senior secondary students in probability in Oyo Metropolis.

1.5 Significance of the Study

This study would contribute to educational innovation by exploring the potential of games and Ludo and Card games, as alternative instructional approaches in probability education. By introducing novel teaching methods, the study addresses the need for innovative pedagogical strategies in Oyo State's senior secondary schools.

Also, investigating the impact of Ludo and Card games , on student achievement in probability has implications for student engagement and motivation. By designing learning experiences that incorporate gamified elements and provide timely game, educators can foster a more interactive and engaging learning environment conducive to student success.

Furthermore, understanding the effectiveness of Ludo and Card games, interventions in probability education can lead to improved learning outcomes for senior secondary students

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in Oyo State. By identifying effective instructional strategies, educators can tailor their teaching approaches to better meet the diverse needs of students and promote deeper understanding and mastery of probability concepts.

The findings of the study can inform curriculum development efforts aimed at integrating innovative teaching methods into the Mathematics curriculum in Oyo State's senior secondary schools. By incorporating Ludo and Card games, principles into the curriculum, policymakers and curriculum developers can enhance the quality and relevance of Mathematics education, ultimately preparing students for success in further education and future careers.

The study contributes to the existing body of literature on card games, ludo game, and Mathematics education by providing empirical evidence of their effects on student achievement in probability. By filling a gap in the literature, the study offers valuable insights into the potential benefits of adopting these instructional approaches in Oyo State and beyond, thus enriching the academic discourse on effective teaching and learning strategies.

Overall, the study's findings have practical implications for educators, policymakers, and curriculum developers seeking to improve the quality of Mathematics education and enhance student outcomes in Oyo State's senior secondary schools. By embracing innovative instructional methods, stakeholders can work towards fostering a supportive and dynamic learning environment that empowers students to succeed in Mathematics and beyond.

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1.6 Scope of the Study

The scope of the study addressed in terms of content scope, geographical scope, and population scope. The geographical scope will be Oyo State, with a focus on Atiba, Oyo East, and Oyo West Local Governments. The population scope will encompass students in Senior Secondary School Two in public schools within these areas. The content scope will include Probability topics in Mathematics, as this topic is typically taught at this educational level according to the curriculum. Additionally, the study will consider gender as a moderating variable, examining the effects of the independent variables (like Ludo, Card games and Conventional methods) on students' academic achievement in Probability. The study will specifically focus on using Ludo and Card games as teaching tools for Probability.

1.7 Limitation of the Study

The study exploring the impact of like Ludo and Card games, on secondary school students' academic achievement in probability in Oyo Metropolis has several limitations.

Firstly, the geographical scope is restricted to Oyo Metropolis, which limits the generalized ability of the findings to other regions. Secondly, the sample size may not be representative of the entire population of secondary school students, potentially introducing selection basis. Thirdly, the study's duration does not allow for a long-term assessment of the effectiveness of like cards and ludo game. Additionally, reliance on achievement tests may not fully capture students' understanding of menstruation concepts. Teacher variables, such as effectiveness, experience, and training, may also influence study outcomes. Moreover, technological limitations, including access to technology and internet connectivity, may

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impact like Ludo and Card games, effectiveness. Lastly, findings may not be generalizable to other mathematical subjects or disciplines. By acknowledging these limitations, the study's findings can be contextualized, providing valuable insights for educators and policymakers.

1.8 Operational Definition of Terms

The meaning of the following words as being used in the study are given below:

Academic Achievement: this is the degree of success or accomplishment in academic pursuits, measured test scores by students of Oyo State.

Card: A set of rectangular pieces of paper used for playing games to learn Probability concept often featuring numbers, symbols, or images.

Ludo: A popular board game of chance and strategy, played with dice and game pieces in learning Probability.

Probability: Probability is a topic in senior secondary school Mathematics curriculum which measure the likelihood of an event occurring.

Gender: This is referred to the male and female students in senior secondary school who are involved in this study.

Probability Achievement Test (PAT): This is the researcher-made instrument that consisted of 50 items objectives questions coined from SSS 2 Mathematics curriculum in Probability to measure the students' academic achievement.

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Chapter Two
Literature Review

The review of related literature is discussed under the following subheadings;

2.1 Conceptual Review

2.1.1 Academic Achievement

2.1.2 Educational Games

2.1.2.1 Ludo Game

2.1.2.2 Cards Games

2.1.4 Gender

2.2 Theoretical Framework

2.2.1 Cognitive Load Theory (CLT)

2.2.3 Social Learning Theory

2.3 Review of Empirical Studies

2.3.1 Cards and Students' Academic Achievement

2.3.2 Ludo and Students' Academic Achievement

2.4 Conceptual Model

2.5 Summary of the Gap in the Literature Reviewed

2.1 Conceptual Review

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2.1.1 Academic Achievement

Academic is explained as "academic work, school work[1]. The term "academic work" pertains to the outcomes achieved by students from their cumulative learning experiences, while "school work" refers to the learning tasks assigned by the school and is characterized by different stages. "Achievement" denotes the completion and attainment of a specific level a student can reach following a period of education or training, whereas "performance" relates to the results obtained from an examination in a particular subject or across an entire course[2]. However, some scholars equate achievement with grades, leading to differing definitions of academic achievement based on varying interpretations of achievement and grades.

In general, academic achievement can be categorized into broad and narrow definitions. In a broad sense, academic achievement refers to the enhancement of students' overall quality during their school years, encompassing cognitive and non-cognitive outcomes, as well as psychological and behavioral outcomes. It includes knowledge, values and attitudes, as well as skills or appropriate behaviors[3,4]. The National Leadership Council on Liberal Education and America's Promise asserts that student academic achievement should not be solely defined by admission rates and the percentage of degrees earned, as it once was. Instead, the more critical question is whether students have gained the knowledge and competencies necessary for their future lives, work, and civic engagement. Thus, academic achievement encompasses not only students' academic performance in school but also all facets of their knowledge, competence, and literacy development[5].

In a narrow sense, academic achievement refers to the measured performance of students through examinations at a specific stage of study. In empirical research on academic

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achievement, many scholars adopt this definition, particularly when studying primary and secondary school students, where academic achievement is often defined as students' examination results. For instance, it is described as a measure of a learner's performance in teaching and learning assessments, such as the results of final examinations attained in school[6].

Mathematics is widely recognized as a universal and essential tool for individual development and societal progress. It is fundamental and indispensable across all areas of human endeavor. Its significance in science and technology cannot be overstated, as it serves as both a tool and the language of science. Mathematics forms the foundation upon which technology is constructed, and thus, advancements in science and technology heavily rely on a strong knowledge of Mathematics[7]. Furthermore, Mathematics is recognized as a systematic and dynamic field of knowledge that permeates all aspects of life. Its versatile nature allows it to be applied across various subjects and professions.

According to Wikipedia, Mathematics is the study of quantity, structure, space, and change. It seeks patterns, formulates new conjectures, and establishes truths through rigorous deduction based on carefully chosen axioms and definitions. Through abstraction and logical reasoning, Mathematics has evolved from counting, calculation, measurement, and the motion of physical objects. Thus, Mathematics is fundamentally a process of thinking that involves constructing and applying abstract, logically interconnected networks of ideas, often emerging from the need to solve problems in science, technology, and everyday life. The purpose of Mathematics classes in schools is to equip students with problem-solving skills and reasoning abilities, enabling them to make connections, generalize concepts, establish communication, and develop other Mathematical skills. These competencies are intended to

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help students address and solve problems they encounter in real life[8]. The real aim of the educational system is to achieve voluntary and positive changes in individuals' behavior as a result of the education process.

Despite the significant benefits of mathematics, many students often believe that Mathematical concepts are either impossible to learn or can only be mastered with great difficulty[9]. Many students struggle in Mathematics classes, leading to increased anxiety as they believe they cannot succeed, which in turn fosters negative attitudes toward the subject. It has long been recognized that there is a strong correlation between success in mathematics and students' attitudes toward it[10]. Therefore, the matter of attitudinal changes among students in Mathematics classrooms remains a perennial issue that cannot be ignored.

Learners' attitudes have been found to influence both their scholastic achievement and overall educational experience[11]. For instance, a learner's attitude toward a school subject, which reflects their level of attraction to or repulsion from the subject, influences all aspects related to it. This includes the student's attendance at lessons, their behavior toward learning activities in the subject, and even their attitude toward the teacher. Consequently, attitude toward a subject will directly affect the student's achievement in that particular area.

According to BusinessDictionary.com, attitude is defined as a predisposition or tendency to respond positively or negatively toward a particular idea, object, person, or situation. It influences an individual's choice of action and responses to challenges, incentives, and rewards collectively known as stimuli. Another definition describes attitude as a stable, long-lasting, but learned predisposition to respond to certain things in a specific way[11].Attitude encompasses cognitive (belief), affective (feeling), and psychomotor (action) components. It is described as a state of readiness or a tendency to act or react in a certain

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way, generally regarded as a learned disposition or tendency for an individual to respond positively or negatively to a situation or another person[14]. It was further noted that attitude toward mathematics involves beliefs, interests, perceptions, aspirations, and practicing habits related to the subject. Attitude plays a significant role in the comprehensibility of mathematical concepts[12]. Individuals with high math anxiety tend to avoid mathematics, which ultimately undermines their math competence and limits important career opportunities. Math anxiety disrupts cognitive processing by interfering with ongoing activities in working memory[13].

Students' conceptions, attitudes, and expectations toward Mathematics and its teaching are significant factors influencing their school experiences and academic achievement[14]. These beliefs often shape how students approach Mathematical tasks, sometimes leading them to unproductive methods. Many students view Mathematics as a subject centered on rules and procedures, expecting problems to be solved quickly in a few steps with the main goal being to obtain "correct answers." They perceive the role of the student as simply receiving knowledge and demonstrating it, while the teacher's role is to transmit that knowledge and ensure its acquisition. Such views may hinder students from realizing that multiple strategies and approaches can be used to solve Mathematical problems, limiting their exposure to important aspects of Mathematical thinking, such as formulating questions, making conjectures, and testing hypotheses.

Research has demonstrated a positive relationship between students' attitudes and academic achievement. Contemporary educational practices promote a transition from teacher-centered approaches to learner-centered strategies, aligning with educational policies that emphasize the importance of focusing on the learner for optimal self-development[15]. This shift requires

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active student participation in the learning process and calls for innovative, activity-oriented strategies to foster positive attitudes toward Mathematics. One such strategy is the use of games in Mathematics education, as they have the potential to capture students' interest and sustain engagement. Given the prevalence of Mathematics anxiety among young learners, employing methods that accommodate diverse interests and actively involve students is essential for effective teaching.

Despite being perceived as challenging by many students, Mathematics remains a mandatory subject throughout senior secondary education and Basic education in Nigeria. It is often seen as intimidating, yet it is a compulsory part of the curriculum from pre-primary to senior secondary levels, as outlined in the National Policy on Education. Regardless of students' perceptions of its difficulty, the importance of Mathematics in education and national development is undeniable, which is why the Federal Republic of Nigeria has mandated it from Early Child Care and Development (ECCD) through to O Level education.

Mathematics is broadly defined as the abstract science of number, quantity, and space, which can be considered in theoretical terms (pure mathematics) or applied to fields such as physics and engineering. It encompasses the study of measurement, numbers, and quantities, acting as a foundational tool for social transformation and the realization of ideas[16]. Mathematics enables students to solve basic numerical problems, perform everyday tasks like calculating store purchases, determining quantities, and measuring distances, making it essential for a well-rounded and functional life[17].

The researchers regard knowledge of mathematics as essential for everyday living. Mathematics is seen as a precise and logical language, serving as the most applicable science

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subject across all disciplines and fields of human work and study. It is a system of concepts related to shape, size, quantity, and order used to describe diverse phenomena[18]. In other words, the importance of mathematics in schools and society cannot be overstated. Some findings indicate that mathematics is a powerful tool for instilling lifelong skills that can lead to individual self-reliance.[19]. Mathematics has also been described as an essential tool that opens doors to various career opportunities[20].

Despite the significant importance attributed to mathematics in society, the majority of Nigerian schoolchildren generally perceive it as complex, difficult, and abstract. Furthermore, some mathematics teachers themselves may not fully convey the benefits of studying mathematics beyond its necessity for entry into higher education[21]. A major issue identified is that teachers often provide assessments but do so with inadequate or no proper implementation of formative assessment practices. Consequently, the achievement levels in mathematics within the study area remain below average, despite the perceived complexity and difficulty of the subject.

Mathematics requires effective transmission of knowledge from previous, current, and subsequent learning for academic achievement. It significantly impacts various aspects of life and serves as a fundamental prerequisite for understanding most fields of study. Additionally, it acts as a strong link among other scientific subjects, including physics, chemistry, biology, social sciences, and even the arts. Mathematics is essential for the scientific and technological development of any nation and is recognized as one of the major subjects in upper basic education[22].

Recently, the researchers have noted a decline in students' achievement in mathematics, particularly in senior secondary schools. There is a prevailing impression that

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mathematics is inherently difficult, leading many students to develop a phobia for the subject. This ongoing decline in students' mathematics achievement, especially in external examinations, has raised widespread concern among the public. The poor academic performance of students in mathematics assessments has become a significant issue for all stakeholders, including parents, teachers, and the government[23]. The poor achievement of senior secondary school students in mathematics, a core subject, often results in examination malpractice or forfeiture of career aspirations, which is indeed a disheartening observation for stakeholders in the education sector.

2.1.2 Probability

Probability is defined as the ratio of the number of favorable outcomes to the total number of outcomes for a given event. In this context, the number of favorable outcomes is represented by "x," while the total number of outcomes is denoted by "n." The formula for calculating the probability of an event is given by:

$$\text{Probability of an event}\} = \frac{Favourable\ outcomes}{Tota;l\ Outcome} = \frac{x}{n}$$

By dividing the number of favorable outcomes by the total number of possible outcomes, one can estimate the probability of an occurrence. Since the number of favorable outcomes cannot exceed the total number of outcomes, the probability of an event occurring ranges from 0 to 1, and the number of favorable outcomes cannot be negative.

Probability is the measurement of uncertainty that is prevalent in various situations we encounter in everyday life[24]. "Every event is characterised by a sort of estimation about its probable, possible, improbable, desirable or unlikelyoutcome"[25]. Probability serves as a tool for modeling and shaping reality, with concepts of risk closely tied to and dependent on probability. Misunderstandings of probability can significantly impact decision-making in

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critical situations, such as medical tests, jury verdicts, and investments. Recognizing the importance of probability in both academic and real-world contexts, many countries have initiated movements to incorporate probability at all levels of mathematics curricula[26]. These developments are evident in official documents and materials created for teachers worldwide. To enhance students' probabilistic thinking, the use of meaningful contexts that draw on students' experiences and understandings is recommended. One effective way to provide these meaningful contexts for teaching probability is through the use of games.

Terminology related to Probability

The following terminology in probability can aid in better understanding probability concepts:

Experiment: An experiment is a trial or operation conducted to produce a specific outcome.

Sample Space: The sample space is the set of all possible outcomes of an experiment. For instance, the sample space for tossing a coin includes heads and tails.

Favorable Outcome: A favorable outcome is an event that produces the desired result. For example, when rolling two dice, the favorable outcomes that result in a sum of 4 are (1,3), (2,2), and (3,1).

Random Experiment: A random experiment is one with a well-defined set of outcomes. For example, when tossing a coin, we know the possible outcomes are heads or tails, but we cannot predict which outcome will occur.

The total number of outcomes in a random experiment is referred to as an event.

Equally Likely Events: Equally likely events are those that have the same chance or probability of occurring. The outcome of one event does not affect the outcome of another. For instance, when tossing a coin, there is an equal probability of getting heads or tails.

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Exhaustive Events: Exhaustive events occur when the set of all possible outcomes of an experiment encompasses the entire sample space.

Types of Probability

Different perspectives or types of probabilities can exist depending on the nature of the outcome or the method used to calculate the likelihood of an event occurring. The four major types of probabilities are:

1. Classical Probability: Also known as theoretical probability, it states that if there are \(B \) equally likely outcomes in an experiment and event X has exactly A of them, then the probability of X is expressed as $P(X) = \frac{A}{B}$. This type is often illustrated through examples like tossing a coin or rolling dice, where you list all possible outcomes and track the actual results. For instance, when tossing a coin, the possible outcomes are heads or tails, and if you toss it ten times, you would note which outcome occurred each time.

2. Axiomatic Probability: This type is based on a set of rules or axioms established by Kolmogorov. These axioms apply to all forms of axiomatic probability and allow for the calculation of the probability of each event occurring or not occurring. The axioms state that the smallest and greatest probabilities are 0 and 1 , respectively. Additionally, the probability of a specific event occurring is equal to one. According to the union of events, only one of two mutually exclusive events can occur simultaneously.

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3. Subjective Probability: This form of probability is based on personal judgment or opinion rather than empirical evidence. It reflects an individual's belief about the likelihood of an event occurring and may vary between individuals.

4.Empirical Probability: This type is determined through observation or experimentation. It is calculated by taking the ratio of the number of times an event occurs to the total number of trials conducted. This approach relies on historical data and practical experiences rather than theoretical assumptions.

2.1.3 Educational Games

The use of games in education dates back to Plato's writings in 'The Republic', where he argued that learning should not be forced, as compulsory education does not stay with the learner[27]. Instead, he advocated for teaching children through play to better understand their natural inclinations. Researchers have supported Plato's idea that play is essential for child development and has educational value, reiterating that children learn most effectively through playful activities. Plato also believed that behaviors exhibited during play could influence adult behaviors[28]. Aristotle, in 'Politics and Ethical Nicomachea', echoed Plato's stance on the necessity of play for children's development and learning.

Significant contributions to the recognition of the importance of play in education were made by Piaget and Vygotsky, who emphasized its role in cognitive development[29]. Despite Plato's early assertion of play's educational value, it was not widely recognized as essential to child development until the late 18th century. Children, regardless of social class, were previously seen as merely immature adults with minimal societal recognition. The perspectives on children and play shifted thanks to classical theorists like Rousseau, Froebel, and Dewey, who challenged traditional views. Pioneers such as Friedrich Schiller and Jean-

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Jacques Rousseau laid the groundwork for acknowledging play as a fundamental right of childhood, recognizing it as an intrinsically meaningful activity.

Games have historically served as a means for children to express themselves in their own world[30]. The distinction between games and play lies in the establishment of rules, which set logical boundaries for various playful activities. Educational games in the 1960s and 1970s predominantly utilized paper and pencil formats. Historically, games were mainly viewed as tools for entertainment; however, a significant shift occurred in the early 20th century when educational games began to be recognized for their potential to enhance learning and teaching practices. This evolution marked a turning point, leading to the development of more structured and purposeful educational games designed to facilitate learning in various subjects.

Several terms have been used to refer to educational games, including "business games," "gaming and simulation," "edutainment," "political games," and "serious games," with "educational games" being the most recent designation. Scholars attribute the specific term "educational games" to Clark Abt, who played a significant role in formalizing the concept within the academic community, emphasizing the dual purpose of these games in both entertainment and education[31].Educational games are characterized by explicit and well-designed educational purposes, with Clark Abt credited for popularizing the term "serious games." These games offer opportunities to address motivational deficiencies within the American educational system, and the 1970s marked a pivotal period for the development and enhancement of serious games as a recognized field, laying the groundwork for their continued evolution in education.

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A notable distinction exists between play and game-based practices and other technology-centered pedagogical methods[32]. Additionally, there was a significant surge in the video game industry 20 to 30 years ago, coinciding with advancements in human-computer interaction, which paralleled a rise in research on serious games. It is posited that the application of serious games in education saw substantial growth from the 1980s through 2002[33]. Conversely, researchers have expressed disappointment with these games, citing their simplistic features. It has been theorized that these games tend to encourage drill and practice, focusing on rote learning rather than fostering higher-order thinking skills[34]. Moreover, these games encouraged motivation based on the behaviorist principle of reinforcement. The 1990s saw the rise of computers and educational technology in classrooms, coining the term "edutainment" to describe this fusion of education and entertainment. The goal was to enhance the enjoyment and attractiveness of learning. However, the quality of edutainment diminished, largely due to the release of poorly designed games by various publishers.

From the mid-1980s to the late 1990s, there was a decline in research focused on non-digital games, as attention increasingly shifted toward digital games[35]. Malone and Turkle emerged as prominent researchers in the early 1980s for their work on integrating commercial digital games into educational settings. The concept of educational games was developed in 2003 by British-born computer programmer and inventor Nick Pelling, though the term did not gain full recognition until 2010[26]. While the first documented use of "educational games" occurred in 2008, it gained popularity among industry professionals and conferences in the mid-2010s. Some scholars believed that educational games are not a new phenomenon in education[39]. For many years, educators have been using game-like elements[37].

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The use of educational games has significantly enhanced students' interest in learning. These games incorporate elements such as badges and leader boards in non-gaming settings to create a game-like atmosphere that makes education more enjoyable[38]. By integrating gaming components into the learning process, educational games address the limitations of traditional teaching methods, which students often find monotonous, thereby increasing engagement. Many schools advocate for educational games because they offer stimulating incentives like rewards, a sense of accomplishment, and immediate feedback, all of which positively influence students' behavior[49].

In a gamified educational setting, the components of games are structured to align with learning objectives, sparking students' interest and motivating them to compete in assigned tasks. The aim is to internalize the external motivation provided by game features. Research has shown that game elements can impact both the behavioral and cognitive dimensions of students. When implementing educational games, it is important to account for students' cognitive abilities to ensure they can effectively engage with the games, retain knowledge, and develop new skills[40]. This approach has fostered continuous learning, which is reflected in students' improved performance. As technology evolves, educational reformers are adopting innovative teaching methods that cater to the diverse needs of learners. Educational games not only help students manage setbacks associated with learning but also stimulate curiosity, leading to increased participation in the classroom[41].

Integrating entertainment elements into learning has enhanced students' comprehension of concepts. Educational games positively affect students' psychology by boosting their interest in and capability to excel in their academic tasks.[42]. Additionally, educational games enhance overall student productivity. They maximize classroom benefits

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by aligning student focus with learning objectives through engaging and challenging activities[43]. One example of an educational gaming tool is Dimensional, which features a variety of math games that support academic learning and foster critical thinking skills[38]. It has been utilized to enhance students' test performance speed and boost their motivation, as the gaming element offers immediate feedback following test completion. Consequently, educational games have positively influenced student engagement across various subjects within the learning environment.

Educational games have had a positive impact on the relationship between students and teachers by fostering a platform for knowledge exchange and encouraging higher-order thinking and cognitive engagement. As a result, classrooms have become more vibrant and enjoyable, with students feeling motivated and happy. These activities allow teachers to quickly monitor and assess each student's learning performance. Furthermore, educational games encourage students to seek additional information online, enhancing their understanding of the coursework, making it an effective strategy for increasing learner engagement[44].

However, educational games also present some drawbacks. Technical issues can hinder the effectiveness of these systems, leading to student frustration and decreased motivation when studying. Additionally, they may pose challenges for instructors trying to evaluate student engagement levels. The competitive nature of educational games can confuse some learners and may not motivate all students equally; stronger students may feel less driven to participate since they consistently perform well, while less competitive learners may feel discouraged by the emphasis on competition. To address these negative effects,

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course designers should develop platforms that cater to diverse learning profiles, ensuring that educational games remain beneficial for all students.

Educational games enhance students' activity levels in the classroom. The competitive nature of these games motivates students to step outside their comfort zones, fostering skill development and creativity[45]. These activities allow learners to take pleasure in their schoolwork due to the diverse range of tasks they engage in. The capacity to assess performance in educational games keeps students attentive and grounded in class, while the gaming technology offers them the chance to encounter failures and learn from them, emphasizing the value of the freedom to fail[46]. Educational games are an effective resource for enhancing students' learning progress and performance in the classroom.

The competitive nature of educational games can hinder student engagement and participation in the classroom. While these games can boost productivity, they may also demoralize some students by heightening stress and anxiety as they strive to meet specific targets for rewards. Consequently, students may struggle to grasp the intended purpose of incorporating gaming elements into learning, leading to decreased motivation in their schoolwork due to constant peer comparisons. Additionally, according to cognitive load theory, excessive cognitive demands can negatively impact an individual's performance[41]. As a result, students experiencing stress and anxiety from educational games may see a decline in both their motivation and performance levels. Consequently, students who experience stress and anxiety from educational games are likely to have decreased motivation and performance levels.

A game is defined as a structured system where players participate in a rule-governed challenge that leads to a quantifiable result[47]. In contrast, educational play comprises

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intentional, rule-based activities that positively influence a child's physical, mental, and spiritual growth, enhance self-awareness of their abilities, and instill positive behaviors[48]. The following are the fundamental components necessary for an activity to qualify as a game: rules that define the boundaries of the game, goals and objectives that create a sense of responsibility in the player, feedback mechanisms, challenges, interaction among players, and the overall presentation of the game[46]. These essential elements are equally applicable to mathematical games.

A mathematical game can be viewed as a mathematical problem. While there isn't a definitive classification for mathematical games, they can be organized into 12 categories based on their characteristics and intended purposes: puzzle-type games, games designed to reinforce concepts, games for skill practice, games that stimulate mathematical discussions, games that promote strategy use, multicultural games, mental games, computer games, collaborative games, compatibility games, calculator games, and games that emphasize fundamental mathematical structures. Additionally, mathematical games can be grouped into race-style games, board games, card games, and domino games according to the materials used and the players' actions. Regardless of the specific type, successful engagement of students in mathematical activities can be achieved when a connection is made between the games and the students' experiences.

In the Mathematics curriculum, it is stated that games provide students with affective skills such as being aware of the contribution of Mathematics to scientific development and the importance of Mathematics in real life, feeling self-confidence, believing that they can learn Mathematics, being willing to learn, enjoying problem solving, being patient, believing that Mathematics develops thinking skills, and working efficiently in Mathematics lessons.

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A mathematical game is a form of play governed by specific rules, with a clear objective or desired outcome, and involves competition either against other players or obstacles inherent in the game[51]. A game is considered "mathematical" when players are able to recognize and/or impact the game's progression through mathematical reasoning[52]. Mathematical games can be utilized to introduce concepts before formal teaching, practice skills, or reinforce a concept after explicit instruction[53]. Educational games have been shown to enhance learning, with researchers citing benefits such as strong motivation, engagement, and the cultivation of positive attitudes toward learning, which are considered crucial and essential.

Games are also beneficial for promoting social skills, sparking discussions, fostering understanding, developing strategies for learning new concepts, and reinforcing skills as aids to symbolization and logical thinking[54]. Mathematical games are culturally specific, with each culture possessing its own set of mathematical games, reflecting the universal nature of mathematical ideas, which encompass numbers, logic, spatial configurations, and the organization of these elements into systems or structures. These games and ideas manifest in diverse contexts across and within cultures, which may be distinct or overlapping.

Formal mathematics instruction, without incorporating real-life contexts like games, fails to adequately support students' understanding of probability[51]. Moreover, many textbook problems lack appeal and rely on procedural information rather than real-life scenarios, whereas real-world problems can foster conceptual understanding and help students relate to mathematical formulas. Improving problem-solving skills is essential, and addressing gender stereotypes is crucial, as they influence mathematics performance[54]. Establishing a

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supportive environment that encourages open communication and classroom participation for all students, regardless of gender, can help close the gender gap in mathematics achievement.

Historically, games have been closely linked to mathematics, as they often embody mathematical principles[55]. "Games are primarily mathematical, and mathematics is fundamentally a game." Elements such as reasoning, creative thinking, and inference, which are integral to mathematics, are also present in games[56]. This relationship makes it practical to incorporate games into mathematics education. Utilizing games in the teaching process can help students learn mathematics in a more enjoyable manner, positively influencing their attitudes toward the subject, enhancing their motivation to learn, and promoting active participation[57]. Consequently, learning environments become more engaging for students[58].

Given students' enthusiasm for games, it stands to reason that integrating games into mathematics instruction could foster a more positive attitude toward the subject. Therefore, games can serve as effective learning activities. It has been suggested that combining fun and enjoyment with instruction can make mathematics more appealing[59]. Mathematics games are a key strategy employed by the National Mathematical Centre (NMC) to enhance the teaching and learning of mathematics in schools. These games are powerful tools for stimulating interest in mathematics. The play method is an essential pedagogical approach; for instance, the Montessori method emphasizes the effectiveness of play as a learning strategy. Learning through play can revitalize the educational experience, making it more engaging and enjoyable while maintaining academic value. Incorporating mathematical games, particularly at the primary and secondary school levels, can make learning Mathematics more enjoyable and stimulating.

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Mathematics games are defined as enjoyable social activities that involve specific rules, clear objectives, and educational purposes[60]. They typically involve two or more players collaborating to solve mathematical problems. In these games, winners, losers, and spectators all have the opportunity to learn the mathematical concepts being addressed. Additionally, mathematics games present a challenge, often involving competition against one or more opponents, governed by a defined set of rules, with a clear structure and specific mathematical objectives. Enjoyment is a critical aspect of mathematics games; without it, they may feel more like tedious workbook activities than genuine play. Therefore, it is essential to implement effective strategies to ensure that these games remain enjoyable.

Mathematics games are distinct from quizzes and should not be treated as such. Their role in the classroom includes making practice sessions more enjoyable and effective, enriching vocabulary, introducing new concepts, accommodating individual differences, improving study habits, and fostering positive attitudes toward mathematics[62]. Due to these significant benefits, mathematics games have been recommended for inclusion in the curriculum. The benefits of mathematics games include enhanced engagement, development of problem-solving skills, reinforcement of concepts, accommodation of diverse learning styles, promotion of social interaction, and fostering a positive attitude toward learning Mathematics[63]:

i. Mathematics games create meaningful contexts for applying mathematical skills;
ii. They foster motivation in children by allowing them to choose to participate and enjoy the experience;

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iii. These games provide opportunities for building self-esteem and developing positive attitudes toward mathematics by alleviating the fear of failure or making mistakes;

iv. Mathematics games lead to greater learning compared to more formal activities, as they promote increased interaction among children and provide chances to test intuitive ideas and problem-solving strategies;

v. They enable children to engage at varying cognitive levels and learn from one another; for example, one child may encounter a concept for the first time, while another is deepening their understanding, and a third is consolidating previously learned concepts;

vi. Mathematics games can help teachers assess students effectively, as children's thought processes often become evident through their actions and decisions during gameplay, allowing for diagnosis and assessment in a non-threatening environment;

vii. Mathematics games offer engaging interactive tasks suitable for both school and home environments and

viii. They promote independence, allowing children to work autonomously without constant teacher guidance, as the game's rules and inherent motivation typically keep them focused on the task.

To effectively appreciate and utilize mathematics games in delivering learning tasks in school mathematics, teachers should be acquainted with fundamental principles related to these games. These principles encompass the philosophy behind mathematics games, their roles in mathematics education, and the benefits they provide. Mathematics games come in

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various types, tailored to different mathematical topics and student levels, and can be either computer-based or manual. This study employs four mathematics games focused on algebra and trigonometry: spinner algebra, algebra snadder joint, trig ratio, and trigoludo.

An instructional game is a structured activity with established rules for play, involving two or more students who interact under well-defined instructional objectives[60]. In such games, participants make decisions as if they are in real-life scenarios, combining enjoyment with serious competition toward specified objectives while adhering to the rules. Games necessitate strategies, tactics, and initiative from the players, ultimately leading to a winner. They are valuable for fostering social skills, stimulating mathematical discussions, developing strategies for learning new concepts, reinforcing skills and concepts as aids to symbolization and logic, and enhancing mathematical understanding.

People of all ages enjoy playing fun and inspiring games that spark their interest in learning and discovering new approaches[65]. Mathematical games enable students to explore fundamental number concepts, including counting sequences, numeration, basic operations, one-to-one correspondence, and computational strategies. These engaging games encourage students to investigate number combinations, place value, patterns, arithmetic processes, and other essential mathematical concepts. Additionally, mathematical games facilitate a deeper understanding of mathematics, reasoning, and applications in areas such as sets and logic, measurement, geometry, trigonometry, graphing, probability, and statistics. Teachers should frequently provide opportunities for students to play these games, allowing mathematical ideas to emerge as students uncover new patterns, relationships, and strategies.

The greatest strength of games in mathematics teaching and learning lies in their ability to provide both practice and practical application. As a result, students can develop

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and refine their mathematical skills in a playful manner, reducing any aversion associated with the subject. This aversion often stems from teaching and learning processes that can induce fear and a sense of failure. Examples of mathematical games include dice or Ludo games for teaching probability, geoboard games for exploring geometric concepts such as angles, identifying and differentiating polygons, and describing and locating coordinate points; coordinate games for the Cartesian plane and coordinates; and card games for fundamental number concepts, arithmetic processes like addition, simplifying algebraic expressions, ordering fractions, as well as probability and randomness[64].

The significance of mathematical games in the teaching and learning processes cannot be overstated. The values of educational games include;

1. Games provide enjoyment and recreation while stimulating mathematical thinking. Playing games encourages strategic mathematical reasoning as students explore various strategies for problem-solving, deepening their understanding of numbers.
2. Games can be used to assess students' previous experiences and the extent to which concepts have developed, offering opportunities for practice without requiring teachers to supply problems. This allows teachers to observe and assess students and work with individuals or small groups.
3. They help strengthen knowledge of color, size, shape, and thickness before counting begins in primary education.
4. Games reinforce what has been taught in class, allowing students to become familiar with the number system and benchmark numbers (such as 10s, 100s, and 1000s), while engaging in computation practice to build a deeper understanding of operations.

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5. Games serve as motivating factors for slow learners, below-average students, and those with dyscalculia, an impairment in solving mathematical problems often resulting from brain dysfunction. They also support a connection between school and home, allowing parents to learn about their children's mathematical thinking through gameplay.
6. Promotion of Discovery and Creativity: The concentration and skills required often lead to discovery and creativity, such as identifying geometric shapes.
7. Games satisfy the love of meeting challenges and provide a refreshing way to think when played for enjoyment and recreation.
8. They create beauty in mathematics, for instance, by allowing students to create patterns with triangles or numbers or to construct sequences (e.g., 1, 1+3, 1+3+7, 1+3+7+13), highlighting mathematics as an aesthetic discipline.
9. When played repeatedly, games support the development of computational fluency among students.[65,66,67].

In other words, there are significant advantages to using games in the teaching and learning of mathematics. Mathematics enables learners to derive meaning from their environment; as they develop reasoning skills, connect ideas, analyze situations, and think logically, they acquire essential tools and concepts that help them make sense of real-life situations[65].

i. Games facilitate parent-child interaction and provide opportunities for exploring ideas, fostering communication and discussion that often go beyond what is typically available in the classroom.

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ii. Games encourage the use of mathematical language, especially if this language is pre-structured. It is crucial for math activities to be enjoyable so that both parents and children can relax while engaging in the activity, thus maintaining high motivation to continue.

iii. Games are highly motivating because children actively participate and feel a sense of control.

iv. They offer immediate feedback and incorporate an element of competition, enhancing the learning experience.

v. Games have well-defined rules and objectives, providing clarity in gameplay.

vi. They offer meaningful experiences that bridge concrete reality and the abstract concepts of mathematics.

vii. Games can be used to reinforce classroom learning or to help children extend their skills.

Experiences indicate that ideal games should meet the following criteria:

a. Enjoyable

b. Promote equal competition or cooperation between child and parent

c. Easy to understand

d. Flexible and allow extension

e. Encourage discussion

f. Not look like school work

g. Attractive

h. Well packaged and easily kept together

i. Inexpensive.

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Mathematics learning through games can take place outside the classroom in a way that is fun and educational for elementary school students.

While mathematical games offer numerous benefits, there are also some demerits in their use for teaching and learning. These include:

1. Time-Consuming: Implementing games can take significant time away from traditional teaching methods.
2. Potential for Aversion: If not carefully selected to align with mathematical objectives, games may lead to student aversion.
3. Classroom Noise: Games can generate noise levels that may disrupt the learning environment; it's important to manage discussions to maintain a controllable noise level.
4. Risk of Passivity: To ensure active participation, the number of players in a game should not exceed five.
5. Impact on Weaker Students: If roles are not rotated, weaker students may be marginalized or left out, leading to a decline in their skills[68]

Sometimes, teachers use games solely for practicing number facts, which often fail to engage students for extended periods since they rely heavily on recall or memorization. While some students can quickly memorize facts, others may take time to compute related information. When success is determined by recall speed, students may conclude that being "smart" in mathematics equates to providing correct answers quickly, rather than valuing the thinking process involved. As a result, students who use number patterns or related facts to arrive at solutions may feel inadequate and develop a dislike for mathematics, leading to what is commonly referred to as mathematics phobia[69].

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Despite the demerits of mathematical games, several compelling reasons exist for their use in teaching and learning mathematics, including;

Practice: Utilizing games to teach mathematics ensures that students practice facts and formulas, even if this practice is confined to the classroom. Through games, students not only recite formulas but also learn to apply them in common scenarios, thereby enhancing their problem-solving abilities and building a foundation for higher-level processes.

Motivation: Many students perceive mathematics as tedious and boring. Incorporating games into math instruction generates excitement, transforming it into a fun subject. When mathematics is engaging, students are more inclined to study, especially when competitive elements in games encourage them to perform well.

Anxiety: Mathematics often induces anxiety among students of all ages. Since games emphasize enjoyment over performance, they are effective in alleviating math-related anxiety. Furthermore, games allow students to observe that their peers possess varying levels of competence, which can reduce the fear of being left behind.

Understanding: Students may struggle to grasp certain mathematical concepts or may understand them without being able to apply them effectively. Games facilitate the teaching of mathematics by helping students develop a better understanding of both concepts and their applications.

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2.1.3.1 Ludo Game

Ludo is a strategy board game designed for two to four players, where participants race their four tokens from start to finish based on the rolls of a single die. Similar to other

cross-and-circle games, Ludo has its origins in the Indian game Pachisi[78].The game, along with its variations, is widely popular across many countries and goes by various names. The Ludo board typically features bright yellow, green, red, and blue areas. Each player is assigned a specific color and has four tokens of that color. The board is generally square, with a cross-shaped play area, where each arm of the cross contains three columns of squares, usually six per column. The central columns typically have five colored squares, which serve as a player's home column. Additionally, there is a sixth colored square, located outside the home column, designated as the starting square. At the center of the board, a large finishing square is usually depicted, often featuring colored triangles that point towards the finish, resembling arrows aimed at the players' home columns.

Rules:

Two, three, or four can play, without partnerships. At the beginning of the game, each player’s four tokens are out of play and staged in the player’s yard (one of the large corner areas of the board in the player’s colour). When able to, the players enter their tokens one per turn on their respective starting squares and proceed to race them clockwise around the board along the game track (the path of squares not part of any player’s home column). When reaching the square below their home column, a player continues by moving tokens up the column to the finishing square. The rolls of a single die control the swiftness of the tokens, and entry to the finishing square requires a precise roll from the player. The first to bring all their tokens to the finish wins the game. The others often continue to play to determine second-, third-, and fourth-place finishers.

At the start of the game, each player rolls a die, with the highest roller going first. Players take turns in a clockwise direction. To bring a token from their yard to the starting square, a

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player must roll a six. Players can either draw a token from home whenever they roll a six (provided home is not empty) or move a piece six spaces. The starting box is unique as it has two of the player's tokens (making it a doubled space). If a player rolls a number other than six and has no tokens in play, their turn passes to the next player.

Players must always move a token according to the die value rolled. Once a player has tokens in play, they choose one and move it forward along the track by the number of squares indicated by the die. If a token lands on a space occupied by an opponent's token, that opponent's token is sent back to their home base, requiring them to roll another six to bring it back into play. If a token lands on a space occupied by a token of the same color, a "block" is formed. If an opponent lands on this block, their token is also sent back to their home base.

If a player cannot draw a token from home and rolls a six, they receive an additional “bonus” roll during that turn. If this bonus roll results in another six, they get another bonus roll. However, if the third roll is also a six, the player cannot move and must pass the turn to the next player.

A player's home column squares are always safe, meaning opponents cannot enter them. In the home column, players cannot jump over their own tokens; after completing one full rotation around the board, they must enter the home area by rolling the exact number needed to move each token onto the home triangle.

2.1.3.2Cards Games

Card games are an excellent way to introduce probability concepts, as they inherently involve chance and uncertainty. Here are a few examples of card games that can be used to teach probability:

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War:

In the game of War, players divide a standard deck of cards evenly and each player flips over the top card from their deck. The player with the higher card wins both cards and adds them to their pile. If the cards are of equal value, a "war" occurs, and additional cards are drawn until one player wins. This game can be used to explore the probability of winning based on the cards remaining in each player's deck.

Blackjack:

Blackjack is a popular casino card game where players try to beat the dealer by getting as close to 21 points as possible without going over. The game involves probability calculations related to the likelihood of drawing certain cards from the deck, as well as strategic decision-making based on the probabilities of busting or winning.

Poker:

Poker is a family of card games that involve betting and strategic gameplay. Different variants of poker, such as Texas Hold'em or Five Card Draw, can be used to teach probability concepts such as calculating the odds of drawing certain hands (e.g., flush, straight, full house) or determining the probability of winning based on the cards visible to each player.

Solitaire:

Solitaire is a single-player card game that involves arranging cards according to specific rules and objectives. While primarily a game of strategy, solitaire can also be used to introduce probability concepts, such as the likelihood of successfully completing the game based on the initial layout of the cards.

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Bridge:

Bridge is a trick-taking card game played with a standard deck of cards by four players in two partnerships. The game involves bidding, card play, and communication between partners. Bridge can be used to teach probability concepts related to card distribution, predicting opponents' hands, and making strategic decisions based on probabilities.

2.2 Theoretical Framework

2.2.1 Cognitive Load Theory (CLT)

Cognitive Load Theory (CLT), introduced by Sweller in the late 1980s, posits that learning is influenced by the cognitive load imposed on working memory during instruction. It distinguishes between intrinsic (related to the complexity of the task), extraneous (related to how information is presented), and germane (related to cognitive processing that leads to learning) cognitive load. CLT emphasizes the importance of reducing extraneous cognitive load to optimize learning outcomes, advocating for instructional design strategies that manage cognitive load effectively. While CLT has received empirical support across various domains, critiques include challenges in precisely measuring cognitive load and the need for further research to explore its applicability across different instructional contexts.

In Mathematics education, Cognitive Load Theory (CLT) offers several implications:

Task Design: Designing tasks that minimize extraneous cognitive load by presenting information in a structured and coherent manner can enhance learning. For example, breaking down complex Mathematical problems into smaller, more manageable steps.

Feedback Provision: Providing timely and specific feedback can help manage cognitive load by directing attention to relevant aspects of the task and facilitating schema development.

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Use of Visual Aids: Integrating visual aids, such as diagrams or graphs, can reduce cognitive load by offloading information from working memory and promoting deeper understanding of Mathematical concepts.

Scaffolded Instruction: Gradually increasing the complexity of tasks while providing appropriate support and guidance can help students develop their Mathematical skills while managing cognitive load effectively.

Metacognitive Strategies: Teaching students' metacognitive strategies, such as self-regulation and reflection, can help them become more aware of their cognitive processes and better regulate their cognitive load during Mathematical problem-solving.

Cognitive Load Theory (CLT) is highly relevant in teaching and learning probability in secondary schools through the following ways:

Task Complexity: Probability concepts often involve intricate calculations and abstract reasoning, which can impose a high intrinsic cognitive load. Applying CLT principles can help educators design tasks that scaffold learning, breaking down complex concepts into more manageable components to reduce cognitive overload.

Visual Representation: Probability lends itself well to visual representations, such as tree diagrams and probability models. CLT emphasizes the use of visual aids to offload cognitive burden, making abstract concepts more concrete and accessible for students.

Feedback and Practice: Providing formative feedback on probability exercises can guide students' cognitive processing and schema development, aligning with CLT's emphasis on managing cognitive load through effective feedback mechanisms.

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Variability in Instruction: CLT acknowledges the importance of adapting instruction to students' prior knowledge and skill levels. In probability education, this may involve varying instructional strategies and levels of complexity to match students' cognitive capabilities and optimize learning outcomes.

Metacognitive Strategies: Teaching students' metacognitive strategies, such as breaking down probability problems into smaller steps or monitoring their understanding during problem-solving, can enhance their ability to manage cognitive load effectively, aligning with CLT principles.

Criticism of Cognitive Load Theory (CLT) includes:

Overemphasis on Working Memory: Some critics argue that CLT places excessive focus on the role of working memory in learning, potentially overlooking the contributions of long-term memory, motivation, and other cognitive factors to learning outcomes.

Simplistic View of Learning: CLT may oversimplify the learning process by reducing it to a matter of managing cognitive load, neglecting the complex interplay of individual differences, socio-cultural influences, and motivational factors that also shape learning experiences.

Limited Transferability: CLT's principles may not always generalize across diverse learning contexts or subject domains, as cognitive load management strategies may vary depending on the nature of the task, learners' prior knowledge, and instructional approaches.

Difficulty in Measuring Cognitive Load: Quantifying cognitive load in real-time learning situations poses methodological challenges, as traditional measures such as self-report surveys or physiological indicators may not fully capture the dynamic nature of cognitive load during learning activities.

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Neglect of Affective Factors: CLT tends to focus primarily on cognitive aspects of learning, sometimes overlooking the influence of affective factors such as emotions, attitudes, and self-efficacy beliefs on learning outcomes.

Potential for Oversimplification in Instructional Design: Critics caution against over-reliance on CLT principles in instructional design, as overly simplistic applications of cognitive load management strategies may inadvertently limit learners' opportunities for deep learning and critical thinking.

Cultural and Contextual Considerations: CLT's applicability may be limited in culturally diverse or non-Western educational contexts, where cognitive processes and instructional practices may differ from those assumed by CLT frameworks developed in Western contexts.

Addressing these criticisms requires a nuanced understanding of CLT principles, informed by interdisciplinary perspectives and empirical research, to ensure that instructional practices effectively support diverse learners' cognitive development, motivation, and learning outcomes

Overall, integrating CLT principles into probability instruction can promote more efficient learning, deeper understanding, and improved academic achievement in secondary school settings.

2.2.2 Social Learning Theory

Social learning theory emphasizes that learning occurs within a social context, happening in natural settings and everyday situations relevant to the environment. This theory posits that individuals learn from one another through mechanisms such as observational learning, imitation, and modeling. It asserts that humans possess unique abilities to symbolize

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experiences, anticipate the consequences of their actions, learn vicariously through others, modify behaviors through self-regulation, and engage in self-reflection. Social cognitive learning theory is often regarded as an alternative to Piaget's cognitive development theory, suggesting that people learn most effectively by observing others and interacting with information. Learning is meaningful when it occurs in real-life situations and is influenced by culture and social interactions. Essentially, "individuals are both shaped by and shape their environments and social systems." A key aspect of social learning theory is self-efficacy, which refers to a person's belief in their capabilities to perform specific tasks and can evolve over time through experiences.

2.3 Review of Empirical Studies

2.3.1 Cards Game and Students' Academic Achievement

Numerous studies have explored the impact of Mathematics games on students' achievement and attitudes towards the subject. One investigation focused on the effect of number-based games on learning among Junior Secondary School 3 students, finding that integrating Mathematics games into instruction significantly improved student achievement compared to traditional teaching methods. Additionally, it was noted that Mathematics games are effective for both primary and secondary school students. Another study indicated that these games positively impacted the achievements of both male and female students.

Regarding the influence of Mathematics games on students' attitudes, research conducted in a secondary school in Osun State, Nigeria, examined the effects of a simulation game environment on student achievement and attitudes towards Mathematics. The findings revealed that using simulation games improved both achievement and attitudes. Furthermore,

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the teaching style employed by educators was identified as a crucial factor in motivating students. A study involving 176 pupils who engaged with educational computer games reported that these games fostered a positive attitude towards learning Mathematics. The research highlighted that educational computer games could complement other teaching methods aimed at improving educational outcomes. Additionally, playing computer games was found to enhance spatial orientation and abilities, which are often challenging for students in geometry, with notable differences favoring boys in spatial orientation skills. Ultimately, using computer games in education increased students' active participation, motivation, and social interaction, leading to enhanced achievement and satisfaction in learning Mathematics.

A study titled “Effect of the Use of Algebraic Substitution Game Approach on Students’ Performance in Some Selected Concepts in Algebra” found that students instructed in Algebra using the Algebraic Substitution Game outperformed those taught through conventional methods[148]. The results indicated that the game benefitted both male and female students equally, demonstrating its effectiveness in enhancing performance in Algebra for all students.

Another study indicated a notable difference in performance between students who were taught using the Ludo game and those who received instruction via traditional lecture methods[67]. It was found that low-scoring students in the experimental group exhibited the highest mean gain score, demonstrating greater benefits from the Ludo game approach to teaching probability compared to their high and medium-scoring peers. Additionally, research revealed that the Mathematical game approach was more effective than conventional methods for enhancing achievement in Mathematics[60]. Although males

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performed better than females using the Mathematical game approach, the difference in mean performance between genders was not statistically significant, and there was no significant interaction between gender and instructional method regarding student performance in quadratic expressions.

A similar study found that Mathematical games, particularly the orbit game, play a crucial role in the education of exceptional children[65]. It was revealed that special educators received adequate training on the handling and application of games to address the challenges faced by exceptional learners. A review of empirical studies indicates that the use of games significantly enhances the teaching and learning of Mathematics. Furthermore, games have proven to be particularly effective in engaging exceptional students in Mathematics. Research in the literature shows that games positively influence students' attitudes toward Mathematics, foster favorable opinions about the use of games in lessons, and boost motivation[63].

Additionally, research indicates that teaching with games enhances students' success in Mathematics lessons[166]. While many studies highlight the effectiveness of games in education, there are limited investigations focusing on the perspectives of prospective teachers or current educators regarding game-based instruction. Notably, despite the frequent claims about the benefits of games in teaching, there is a lack of studies providing concrete examples of Mathematical games integrated into classroom settings.

A study involving thirty-eight prospective Mathematics teachers categorized the games they created based on factors such as game type, playing location, learning area, grade level, intended purpose, and number of players[69]. Findings indicated that nearly all the games were developed for reinforcement, with the majority being board or card games. Another

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study with twenty-two prospective Mathematics teachers utilized an observation form to evaluate the designed games while also gathering the teachers' perspectives on the design and implementation process. The study found that prospective teachers displayed deficiencies in both theoretical and practical knowledge regarding the design of educational games. This lack of skills hindered their ability to translate positive attitudes towards educational games into effective practice. However, the descriptions of games designed by these future teachers could serve as valuable examples for other Mathematics educators interested in incorporating games into their lessons. Additionally, these examples provide insights into the teachers' prior educational experiences, areas of interest in Mathematics, pedagogical knowledge, and creative thinking abilities.

A study aimed at evaluating the effect of educational games on learning motivation and achievement involved 24 junior high school students in Indonesia[95]. Data collected through questionnaires and analyzed using t-tests revealed that educational games in an e-learning context did not significantly enhance students' learning motivation or achievement. Additionally, a meta-analysis of 1,746 studies found that only 52 met the criteria for inclusion, focusing on middle school, high school, and university students in Turkey. The findings indicated that educational games did not significantly impact academic performance in technology-based courses, with physical games demonstrating a more positive effect compared to digital ones.

A study was conducted to evaluate the effectiveness of a blended learning environment that incorporated educational game elements, involving 63 freshmen students in Turkey enrolled in a course on information technologies in education[70]. Data were collected through surveys, academic achievement tests, and focus group interviews, revealing a

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significant increase in post-test scores for both the control and experimental groups, with no notable differences in teaching presence, social presence, cognitive factors, or motivation scores. Additionally, a meta-analysis of 20 studies in Turkey compared the impact of digital games to non-digital games in primary Mathematics teaching[96]. The findings indicated that non-digital games were more effective, achieving better academic outcomes than their digital counterparts.

A study explored the effectiveness of web-based educational games on fostering creative thinking and academic achievement among primary school students in Saudi Arabia[72]. Utilizing a quasi-experimental design with two groups of 30 students enrolled in an English course, the research employed a tolerance test for creative thinking. Results indicated a significant difference in post-test academic achievement scores, favoring the experimental group, suggesting that the web-based educational games enhanced conceptual understanding and made the learning process more engaging and enjoyable.

An independent researcher carried out a mixed-method study to examine the components of educational games in online teaching and their influence on student success in online courses, specifically focusing on an introductory child development course. Involving 106 undergraduate students from a university in the midwestern United States, the study revealed that students generally viewed the educational games positively[71]. Among the three gaming components evaluated unlimited lives, badges, and level-locking—only unlimited lives were found to negatively affect student achievement.

Another scholar conducted a study to assess the impact of an educational game's strategy on academic achievement and motivation among 68 ninth-grade students enrolled in a science class in Oman[67]. Using a quasi-experimental design and descriptive-analytic

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methodology, the results favored the experimental group, revealing a statistically significant difference between the experimental and control groups in terms of both academic motivation and achievement.

Another study investigated the influence of educational games methodology on Mathematics learners[54]. The sample included fifth-grade students, divided into an experimental group of 28 students using game-based learning methods and a control group of 22 students. Employing a mixed-method research design, data were collected through unstructured interviews and in-class observations, alongside quantitative methods using a semi-experimental design for pre-test and post-test analysis. Results analyzed using SPSS indicated no significant difference in achievement and attitude scores between the experimental and control groups, though the experimental group showed a slight increase in achievement compared to the control group.

A group of researchers conducted a study to examine the impact of educational game elements in the e-learning experiences of students studying basic Linux commands[79]. The sample comprised 139 students, divided into an experimental group of 92 students and a control group of 47 students. While the exam grades between the groups did not show statistically significant differences, the findings indicated that the motivation to learn was significantly higher among students using the gamified e-learning platform.

Similarly, another study sought to explore the Mathematical games created by prospective secondary school Mathematics teachers and their perspectives on the design process[98]. Using a case study approach, the research involved 45 prospective teachers enrolled in a Teaching Mathematics with Games course. Descriptive and content analyses were conducted on the collected data. The findings revealed that most of the games developed were board or card

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games, with numbers and operations being the most favored learning area. The majority of games were designed for the 8th grade, while the least were for the 5th grade. Prospective teachers aimed to facilitate meaningful learning, enhance procedural skills, reinforce prior knowledge, and make Mathematics enjoyable. Despite facing challenges during the design process, the experience positively influenced their cognitive, affective, and pedagogical development. The study recommends establishing a digital game pool to evaluate the suitability of educational Mathematics games.

Similarly, a study aimed to investigate a learning environment supported by games and simulations[80]. The research focused on assessing the basic probability knowledge of prospective teachers, demonstrating the role of problem-solving in the development of mathematical knowledge, and facilitating discussions about mathematical ideas through worksheets. Conducted with 40 prospective teachers at a state university in Turkey, the study employed a case study methodology and collected data through nine open-ended questions related to the games, worksheets, and simulation activities. The questions encompassed predictions about game fairness, playing variations of the games, observing scores, calculating winning probabilities both experimentally and theoretically, and comparing these findings. Qualitative analysis of the worksheets, simulations, and in-class observations revealed that the structured learning environment enhanced the prospective teachers' understanding of probability and its teaching. Participants expressed positive opinions regarding the learning situation, indicating its effectiveness in contributing to their Mathematical knowledge and pedagogical skills.

A study was conducted to investigate the efficiency of educational games on Mathematics learning among second-grade elementary students in Tehran[81]. Utilizing a descriptive-survey

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method, data were collected through questionnaires from a sample of 30 female students, divided into an experimental group and a control group, each consisting of 15 students. The data were analyzed using SPSS software, revealing that educational games significantly influenced the motivation and Mathematics learning of the participants, as well as enhancing their intelligence quotient (IQ).

A study conducted in Nigeria examined the impact of a game-based instructional technique on students' achievement and interest in Algebra at the basic educational level[45]. Using a quasi-experimental, non-equivalent control group design, the research involved 134 Junior Secondary School II students from four schools in the Obio-Akpor Local Government Area of Rivers State. Intact classes were randomly assigned to either the experimental or control group, and both groups were pre- and post-tested using the Algebra Achievement Test (AAT) and an Algebra Interest Inventory. The analysis, employing mean, standard deviation, and Analysis of Covariance (ANCOVA) at a significance level of $p < 0.05$, revealed that game-based instruction positively affected students' achievement and interest in Algebra, with no significant interaction effect between teaching method and gender. The study recommends incorporating game-based teaching in mathematics classes, as well as organizing workshops and seminars for educators on the effective use of games in teaching.

A comparative study analyzed the effects of using dice and spinner games on students' academic performance in probability among junior secondary schools in the Ogba/Egbema/Ndoni Local Government Area of Rivers State[84]. Utilizing a quasi-experimental two-group pretest-posttest design, the study sampled 144 students from a population of 19,478 across 24 public junior secondary schools. Data was collected using the Probability Performance Test, and analyzed through mean, standard deviation, and Analysis

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of Covariance (ANCOVA) at a 0.05 significance level, with a reliability coefficient of 0.88. Findings indicated no significant difference in performance between students taught probability using dice versus spinner games; however, a significant difference was observed between male and female students' performance when taught using dice, while no such difference existed with the spinner game. The study recommends that secondary school Mathematics teachers adopt mathematical game approaches to enhance student performance in mathematics.

An action research study was conducted to assess whether the digital educational game Speedy Rocket could enhance interest and engagement in Mathematics among pupils in rural Ado-Ekiti, Nigeria[85]. The game, designed to teach estimation as part of the Mathematics curriculum, was implemented in three schools, and the evaluation utilized a Mathematics attitude questionnaire and classroom observations. Results indicated significant improvements in students' attitudes towards and engagement with mathematics after two weeks of using the game. The findings highlighted that learner became active participants in their learning, engaging in knowledge co-creation, sharing ideas, and fostering collaboration. Moreover, the study shed light on how integrating digital technology can transform traditional classroom dynamics, particularly in environments where such technology has not been previously utilized.

A study investigated the impact of incorporating Mathematics games into the teaching and learning process on secondary school students' attitudes towards mathematics[86]. The sample consisted of 180 SS2 students selected from three schools through a stratified random sampling technique. The research was guided by three questions and two hypotheses, with data collected using a Mathematics Attitude Questionnaire that had a Cronbach alpha

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reliability coefficient of 0.84. Analysis of the research questions was conducted using percentages and means, while hypotheses were tested with Analysis of Covariance (ANCOVA). The results indicated that the integration of Mathematics games significantly enhanced students' attitudes towards Mathematics.

Another study aimed to examine the effect of gamification methodology on 5th-grade students' achievement and attitudes in mathematics classes[87]. The subject of fractions was prepared using game-based approaches and applications from the Educational Informatics Network (EBA) in Turkey. The study included 50 students, with 28 in the experimental group and 22 in the control group, employing a mixed-methods approach that combined quantitative and qualitative research. For the quantitative analysis, a pretest-posttest control group quasi-experimental design was utilized, while qualitative data were collected through in-class observations and unstructured student interviews. Data analysis was conducted using SPSS, revealing no statistically significant difference in achievement and attitude scores between the experimental and control groups. However, the results indicated that the achievement of students in the experimental group showed a greater increase compared to those in the control group.

A study was designed to investigate the effect of gamification techniques on students' academic achievement in an online learning environment[88]. Utilizing a quasi-experimental approach, the research involved two 3rd-grade mathematics classes totaling 50 students, with one class designated as the experimental group receiving gamification elements and the other as the control group not receiving such treatment. Both groups participated in online learning via the Microsoft Teams platform and were assessed with pretests and posttests. The findings

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indicated that gamification techniques did not significantly impact the academic achievement of the students.

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2.4 Conceptual Framework

From the objective of this study, the following model is constructed:

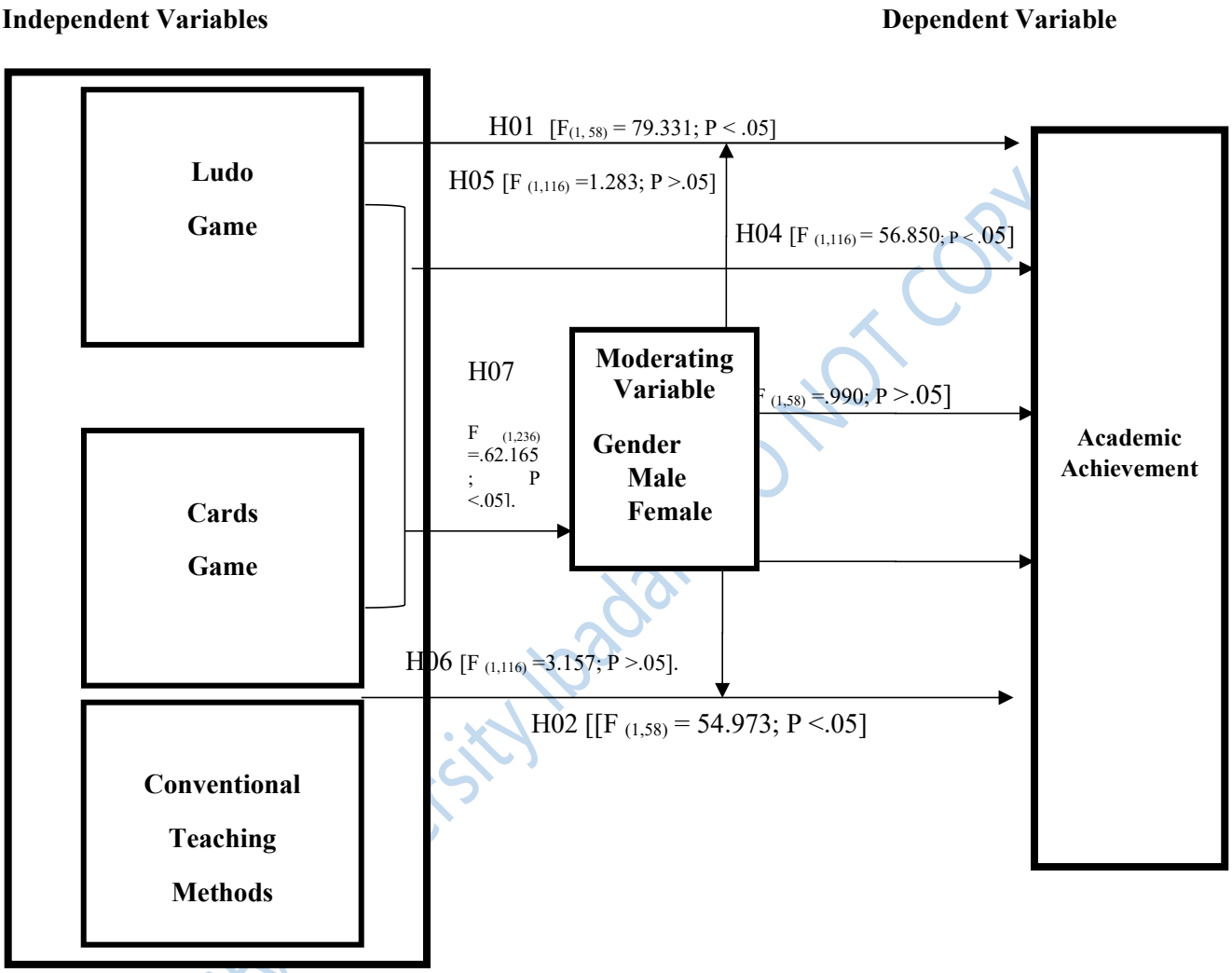

Figure 1: Model of Determinants of Students' Academic Achievement in Probability

Source: Developed by authors, 2024

The independent variables of this study are Ludo games and Card game are measured using game-based learning activities like educational games, simulations and interactive exercises. On the other hand, the dependent variable is students' academic achievement in probability and is measured using students' scores in the achievement test developed by the researcher. The relationship between the independent and dependent variable is that educational games

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provide opportunities for hands-on, experiential learning, allowing students to engage actively with probability concepts in a fun and interactive way. By immersing students in simulated scenarios or decision-making tasks, games can enhance their understanding of probability principles and foster problem-solving skills.

The combination of Ludo and Card games creates a dynamic learning environment where students receive immediate reinforcement and corrective guidance as they engage with probability tasks. With game-based activities, teachers can tailor instruction to students' individual needs and promote deeper learning outcomes.

Overall, the conceptual framework suggests that the use of Ludo and Card games can positively impact the academic achievement of secondary school students in probability by enhancing engagement, understanding, and retention of probability concepts. By examining the interplay between these variables, the research can provide insights into effective instructional strategies for improving students' performance in probability.

2.5 Summary of the Gap in the Literature Reviewed

This study highlights the potential of using Ludo and Card games instruction, noting that when games are accessible and teachers are trained in their theory and construction, they are likely to embrace them as effective educational tools. Such an approach could encourage teachers, researchers, and parents to engage in the creative design of Mathematics games, ultimately increasing students' interest in the subject. Given that Mathematics is often viewed as a challenging subject, it's crucial for students to master fundamental concepts before progressing to more complex applications, with each level building on the previous one. The repetitive nature of learning facts and formulas can become tedious and time-consuming,

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leading students to avoid Mathematics altogether. Incorporating games into Mathematics teaching not only makes the subject more enjoyable and less stressful but also allows students to learn from their peers and enhance their understanding in a way that traditional lectures may not facilitate.

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Chapter Three
Methodology

3.1. Research Design

This study adopted a 3 x 2 factorial design. The treatments at 3 levels (Ludo, Card games and conventional method) and gender at 2 level which consists of Male and Female.

Table 3.1. Schematic Representation of 3x2 Factorial Matrix

Group	Pretest	Treatment	Post test
E_1	O_1	X_1	O_2
E_2	O_3	X_2	O_4
E_3	O_5		O_6

Key:

E_1 = Experimental group 1. (Ludo Game)

E_2 = Experimental group 2 (Card Game)

E_3 = Control group 3 (Conventional method)

O_1 = pretest for E_1 O_2 = Post test for E_1 O_3 = Pretest for E_2 O_4 = Post test for E_2 O_5 = Pretest for E_3 (Control Group) O_2 = Posttest for E_3(Control Group)

X_1 = Treatment for E_1

X_2 = Treatment for E_2

X_3 =for E_3(conventional method)

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3.2 Population of the study

The population for this study consisted done hundred and sixty thousand six hundred and ninety-nine (160,699) students which represents all the 2023/2024 academic year Senior Secondary School two (SSS 2) students of government owned secondary schools in Oyo Town, Oyo State, Nigeria[1]. There are fifty-two (52) Senior Secondary schools in the study area. These 52 schools are made up of 21 co-educational schools and 1 single-sex schools of girls only.

3.3 Sample and Sampling Techniques

Two hundred and forty-four Secondary Two (SSII) students from three (3) secondary schools in Oyo Metropolis of Oyo State, one of the thirty-six states in the Federal Republic of Nigeria, constituted the subjects of this study. The selection of the three (3) schools was based on purposive sampling. In each of the three (3) schools sampled, only one (1) randomly selected intact SSII class was involved in the experiment. Two of the three schools were randomly assigned as experimental group and one as the control group. Out of the two experimental schools, one was assigned to Ludo Games and the other was assigned to Card games. The last school was assigned to Conventional Teaching Method. The selected schools are as follows;

Table 3.3: List of Schools for the Study

S/N	Local Government	Schools
1	Atiba	Oranyan Grammar School, Oyo
2	Oyo East	Olivet Baptist High school, Oyo
3	Oyo West	Ladigbolu Grammar school, Oyo

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3.4. Description of Research Instrument

Four instruments were used to collect data for this study: (1) Probability Achievement Test (PAT). PAT was the researcher – made instrument that consisted of 50 items objectives questions coined from SSS 2 Mathematics curriculum in Probability. The 50 items were multiple-choice objective questions with four options (A, B, C, and D). PAT was scored out of 100% meaning each item correctly answered is 5 marks. (2) Ludo game was used as the second instrument for the study

(3) Card games was the third instrument for the study

(4) Lesson plans on the topic was used to guide the teaching in each of the schools to facilitate the learning of probability (See Appendix 2)

3.5 Validity of Research Instruments

All the instruments validated by the supervisor and two experts in the Department of Science Education, Lead City University, Ibadan for face validity, Content validity and Construct validity. However, content of the instruments was subjected to table of specification while the lesson notes will also be made available for the teaching of probability topics. All corrections will be affected before producing the final draft for the study.

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Table 3.4 Table of Specification for Probability Achievement Test (PAT)

S/N	Topic	Sub topic	Objective	No of questions	%
01	Experimental Probability I	Definition and Example of Experimental outcomes, random experiment, sample space and event.	At the end of this topic, students should be able to use the language of probability	8	16
02	Experimental Probability II	Event Space and Probability of chance instruments	At the end of this topic, students should be able to describe and evaluate events involving chance	8	16
03	Theoretical Probability I	Definition and Example of theoretical probability	At the end of this topic, students should be able to use the language of probability	7	14
04	Theoretical probability II	Calculation of Problem involving Chance	At the end of this topic, students should be able to use theoretical Probability to calculate problem involving chance	7	14
05	Combined Probability I	Addition and subtraction of Probability	At the end of this topic, students should be able to solve problem relating to mutually and non-mutually exclusive events	10	20
06	Combined Probability II	Multiplication of Probability	At the end of this topic, students should be able to solve problem relating to dependent and independent events	10	20
	TOTAL			**50**	**100**

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3.6 Reliability of the Instruments

Kuder-Richardson (KR-20) was used to test the reliability of the instrument after the test instruments would have been tried on sample of the population who will not participate in the main study to test the internal consistency of the instrument.

3.7. Method of Data Collection

The regular mathematics class teachers of the three (3) secondary schools selected for the study was trained to assist in the study. This took a week before the actual study. The training was based on the purpose of the study, the topics taught, the use of the lesson plan, the use of the instructional games (Ludo and Card games) general conduct of the study. The three trained teachers taught the two experimental and control groups. The study lasted for 8 weeks. For the experimental groups, the teacher used ludo game based instructional technique to teach the students in school one and card game in school two, both the game based instructional technique and conversional teaching method was used in school three while the conventional method was used to teach the control group in school three.

1. Before the commencement of the experiment, the researcher administered the pre-tests (PAT) to all the subjects in both groups. The scores were collated for use after experiment. After the experiment, the post-tests (PAT) were administered to all the subjects in both groups. However, in these post-tests the items of the PAT were re-arranged/reshuffled to avoid familiarity with the items of the instrument by the students. Data for the pre-tests and post-tests was recorded separately for each of the groups. Below is the schedule of the activities;

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Week 1 – Training of research assistants

Week 2 – Administration of pretest

Week 3-7 – Treatment of experimental and control group

Week 8 – Administration of post test

3.8 Method of Data Analysis

The hypotheses were tested at 0.05 level of significance using three-way Analysis of Covariance (ANCOVA). The pretest scores served as the covariates.

3.9 Ethical Approval

Ethical approval includes obtaining full informed Consent from any participant used in the study, explaining the research to the respondents ahead of time, ensuring that all participants participate voluntarily, maintaining confidentiality at all times, and taking all reasonable measures to protect participants physically and psychologically. The participants were also told what was expected of them and why they will oblige to participate. The consent form was given to each participant to complete. This was done to ensure that students took part voluntarily and without fear of being coerced. Furthermore, participants' responses were interfered with or contested by the researcher during the research, and all participants were treated equally. Anonymity and participant protection was preserved. The participants' anonymity was ensured by not requesting their names. Before each set of data collection, the participants were additionally assured that the information will be used solely for academic purposes.

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Endnotes

1. Oyo State Ministry of Education Oyo State Schools' Register, Agodi Gate Secretariat, Ibadan, 2024.

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Chapter Four

Results and Discussion of Findings

4.1 Presentation of Data

Table 4.1 Demographic Data

Variable	Frequency	Percentage
Gender		
Male	112	45.9%
Female	132	54.1%
Total	**244**	**100.0%**

Source: Field Survey Report, 2024

Table 4.1 presents the distribution of participants based on gender. Out of the total 244 participants, 112 (45.9%) identified as male, while 132 (54.1%) identified as female. This shows a relatively balanced representation of both genders in the study.

Table 4.2 Descriptive Statistics of the Dependent Variable – Students Performance in Probability

	Pretest	Posttest
N	244	244
Missing	0	0
Mean	31.95	55.02
Median	34.00	56.00
Standard deviation	9.436	17.77
Minimum	10.00	20.00
Maximum	66.00	93.00

Source: Field Survey Report, 2024

Table 4.2 provides descriptive statistics for the dependent variable, students' academic performance in Probability as measured by the Probability Achievement Test (PAT). For pretest, the sample size (N) is 244, indicating the number of learners that took part in the

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pretest. There are no missing values, meaning that all participants had scores for the pretest. The mean value of the pretest is 31.95, indicating that, on average, the pretest in the sample scored relatively below the average which is 50.00. The median value is 34.00, which suggests that the distribution of responses is slightly skewed towards lower performance. The standard deviation is 9.436, which implies that there is a moderate amount of variability in the pretest scores. Furthermore, the least and the maximum scores are 10 and 66 respectively. Similarly, for posttest, the sample size is also 244, and there are no missing values. The mean value for posttest is 55.02, indicating a relatively high average score. The median value of 56.00 suggests that the distribution of responses is slightly skewed towards higher performance score. The standard deviation is 17.77, indicating a moderate amount of variability in the responses for the posttest score. While the least and the maximum scores are 66 and 93 respectively. This implies there is an improvement in the performance of students after the intervention (use of new teaching strategies) but the magnitude of the improvement will be determined with the below Analysis of Covariance (ANCOVA).

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4.2 Hypotheses

Findings from the study are presented below following the hypotheses tested.

$H_0$1: There will be no significant main effect of ludo on the academic achievement of senior secondary school students in Probability in Oyo Metropolis.

Table 4.3: Summary of Analysis of Covariance (ANCOVA) of Main Effect of Ludo and Card games, on the Post-test Achievement Scores in Probability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Main Effect						
Corrected Model	13739.589[a]	1	13739.589	79.331	.000	.578
Intercept	180257.455	1	180257.455	1040.795	.000	.947
Ludo	13739.589	1	13739.589	79.331	.000	.578
Error	10045.145	58	173.192			
Total	195948.000	60				
Corrected Total	23784.733	59				

a. R Squared = .578 (Adjusted R Squared = .570)

Source: Field Survey Report, 2024

Table 4.3 shows that there was a significant main effect of ludo on the academic achievement of senior secondary school students in Probability in Oyo Metropolis [$F_{(1, 58)} = 79.331$; $P < .05$]. Hence the Ho is rejected. This implies that there is significant difference in the pretest and posttest scores of students taught with Ludo.

Furthermore, the partial eta square (.578) shows Cards contribute 58% of variation in the students' academic performance in probability.

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$H_0$2: There will be no significant main effect of Card game on the academic achievement of senior secondary school students in probability in Oyo Metropolis.

Table 4.4: Summary of Analysis of Covariance (ANCOVA) of Main Effect of Card game on the Post-test Achievement Scores in Probability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Main Effect						
Corrected Model	11573.762[a]	1	11573.762	54.973	.000	.487
Intercept	182373.762	1	182373.762	866.244	.000	.937
Card game	11573.762	1	11573.762	54.973	.000	.487
Error	12210.971	58	210.534			
Total	195948.000	60				
Corrected Total	23784.733	59				

a. R Squared = .487 (Adjusted R Squared = .478)

Source: Field Survey Report, 2024

From table 4.4 above, there was significant main effect of Card game on the academic achievement of senior secondary school students in probability in Oyo Metropolis. [$F_{(1,58)}$ = 54.973; P <.05]. Since P < .05, the Ho is therefore rejected. The partial eta square of value .487

Indicates that Card game contributes 49% of the variation in the students' academic performance in probability.

$H_0$3: There will be no significant main effects of gender on academic achievement of senior secondary students in probability in Oyo Metropolis.

Table 4.5: Summary of Analysis of Covariance (ANCOVA) of Main Effect of Gender on the Post-test Achievement Scores in Probability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Main Effect						
Corrected Model	312.966[a]	1	312.966	.990	.321	.004
Intercept	736173.621	1	736173.621	2329.361	.000	.906

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Gender	312.966	1	312.966	.990	.321	.004
Error	76481.932	242	316.041			
Total	815445.000	244				
Corrected Total	76794.898	243				

a. R Squared = .004 (Adjusted R Squared = .000)

Source: Field Survey Report, 2024

As depicted in the table 4.5above, there was no significant main effects of gender on academic achievement of senior secondary students in probability in Oyo Metropolis.[$F_{(1,242)}$ =.990; P >.05], the Ho is therefore not rejected. The value of eta square, .004 implies that gender contributes approximately nothing to the variation in the students' academic performance in probability. This implies that gender has no significant effect on the SS2 students' academic performance in probability.

$H_0$4: There will be no significant interactive effects of Ludo and Card games on academic achievement of senior secondary students in probability in Oyo Metropolis.

Table 4.6: Summary of 2-Ways Analysis of Covariance (ANCOVA) of Ludo and Card games on the Post-test Achievement Scores in Probability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
2- Ways Interaction						
Corrected Model	24468.040[a]	3	8156.013	56.850	.000	.595
Intercept	199669.608	1	199669.608	1391.770	.000	.923
Ludo and Card	24468.040	3	8156.013	56.850	.000	.595
Error	16641.885	116	143.465			
Total	359071.000	120				
Corrected Total	41109.925	119				

a. R Squared = .595 (Adjusted R Squared = .585)

Source: Field Survey Report, 2024

From table 4.6 below, it was observed that there was significant interactive effects of Ludo and Card games, on academic achievement of senior secondary students in probability in Oyo Metropolis.[$F_{(1,118)}$ = 56.850; P < .05]. The Ho is therefore rejected. Considering the size of the effect value of 0.595, the two teaching strategies jointly contribute 60% of the

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variation in students' academic performance in probability. This implies that Ludo and Card games, combined with Ludo and Card games, will have significant effect on the students' academic performance.

$H_0$5: There will be no significant interactive effects of gender and Ludo games on academic achievement of senior secondary students in probability in Oyo Metropolis.

Table 4.7: Summary of 2-Ways Analysis of Covariance (ANCOVA) of Gender and Ludo games on the Post-test Achievement Scores in Probability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
2- Ways Interaction					
Corrected Model	1320.304[a]	3	440.101	1.283	.284
Intercept	313287.166	1	313287.166	913.336	.000
Gender and Ludo	1320.304	3	440.101	1.283	.284
Error	39789.621	116	343.014		
Total	359071.000	120			
Corrected Total	41109.925	119			

a. R Squared = .032 (Adjusted R Squared = .007)

Source: Field Survey Report, 2024

As shown in table 4.7 above, there was no significant interactive effects of Gender and Ludo on academic achievement of senior secondary students in probability in Oyo Metropolis. [$F_{(1,118)}$ =1.283; P >.05], hence, the Ho is not rejected.

$H_0$6: There will be no significant interactive effects of Gender and Card game on academic achievement of senior secondary students in probability in Oyo Metropolis.

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Table 4.8: Summary of 2-Ways Analysis of Covariance (ANCOVA) of Gender and Card game on the Post-test Achievement Scores in Probability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
2-Ways Interaction					
Corrected Model	20418.671[a]	3	6806.224	3.157	.000
Intercept	330450.068	1	330450.068	1852.580	.000
Gender and Card	20418.671	3	6806.224	3.157	.124
Error	20691.254	116	178.373		
Total	359071.000	120			
Corrected Total	41109.925	119			

a. R Squared = .497 (Adjusted R Squared = .484)

Source: Field Survey Report, 2024

From table 4.8 above, there was no significant interactive effects of gender and card game on academic achievement of senior secondary students in probability in Oyo Metropolis. [$F_{(1,118)}$ =3.157; P >.05], hence, the Ho is not rejected.

$H_0$7: There was no significant interactive effects of Ludo and Card game, and gender on students' academic achievement of senior secondary students in probability in Oyo Metropolis.

Table 4.9: Summary of 3-ways interactions Analysis of Covariance (ANCOVA) of Educational Games, Ludo, Card games and Gender on the Post-test Achievement Scores in Probability

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
3- Ways Interaction						
Corrected Model	49791.280[a]	7	7113.040	62.165	.000	.648
Intercept	331837.584	1	331837.584	2900.118	.000	.925
Ludo, Card games and Gender	49791.280	7	7113.040	62.165	.000	.648
Error	27003.618	236	114.422			
Total	815445.000	244				
Corrected Total	76794.898	243				

a. R Squared = .648 (Adjusted R Squared = .638)

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Source: Field Survey Report, 2024

Table 4.9 shows that there was no significant interactive effects of Ludo, Card games and gender on students' academic achievement of senior secondary students in probability in Oyo Metropolis.[$F_{(1,236)}$ =.62.165; P <.05], hence, the Ho is rejected.

4.4 Discussion of Findings

The findings of this study are discussed based on the objectives of the study as guided by research hypotheses. Seven (7) hypotheses were raised and tested to guide the study. The first three hypotheses were tested to test for the main effects of Ludo, Cards games and gender on students' academic achievement in probability.

The first objective of this study is to investigate the main effect of Ludo game, on students' performance in probability. The findings of this study reveal a significant positive effect of Ludo game, on students' academic performance in probability. This result is consistent with previous research that has shown the effectiveness of game-based learning in improving student outcomes; incorporation of Mathematics games in the teaching of Mathematics enhanced the achievement of students more than the conventional teaching method[1]. Mathematics games are effective in teaching both primary and secondary school children[2]. Furthermore, another study revealed that Mathematics games equally enhanced the achievement of male and female students[3]

The significant effect of Ludo game, on academic performance in probability suggests that interactive and engaging learning experiences can enhance students' understanding and retention of complex statistical concepts. Ludo game, may provide a more enjoyable and

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motivating learning environment, leading to increased student engagement and participation. The results also imply that Ludo game, can be a valuable tool for teachers to supplement traditional teaching methods and improve student learning outcomes. By incorporating games into their instructional practices, teachers can create a more dynamic and interactive learning environment that caters to diverse learning styles.

However, it is essential to note that the effectiveness of Ludo game, may depend on various factors, such as game design, implementation, and student characteristics. Therefore, further research is needed to explore these factors and optimize the use of Ludo game, in probability education. Overall, this study's findings have implications for teaching and learning practices in probability education, highlighting the potential benefits of Ludo game, in enhancing student academic performance.

The second objective of the study is to investigate the main effect of Card game, on students' academic achievement in Probability. The findings of this study reveal a significant main effect of Card game, on students' academic performance in probability. This result underscores the importance of regular, constructive, and specific game in enhancing student learning outcomes. The significant main effect of Card game suggests that students who received regular game during the learning process performed better in probability compared to those who did not receive game. This finding aligns with previous research that has highlighted the benefits of Card game in improving student achievement[4,5,6,7,8]. The study indicates that including an additional assessment point may improve students' outcomes, but that this impact is not attributed to the Card game may have facilitated students' understanding of probability concepts by identifying knowledge gaps and misconceptions;

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providing opportunities for corrective action; encouraging self-reflection and metacognition and enhancing motivation and engagement.

The results imply that educators should prioritize Card game in their instructional practices, particularly in subjects like probability where students often struggle with abstract concepts. By providing regular, high-quality game, educators can create a supportive learning environment that fosters student growth and improvement. However, it is crucial to consider the quality, timing, and frequency of game to maximize its impact. Future research should explore these factors to optimize the effectiveness of Card game, in probability education. Overall, this study's findings emphasize the significance of Card game, in enhancing student academic performance in probability, highlighting its potential as a valuable instructional strategy.

The third objective is to examine the main effect of gender difference on students' academic achievement in probability. Similarly, the findings of this study reveal no significant main effect of gender on students' academic performance in probability. This result suggests that gender does not play a significant role in determining students' understanding and performance in probability.

This finding aligns with previous research that has consistently shown no significant gender differences in mathematics and statistics achievement[4,5,6]. It implies that both male and female students have equal potential to excel in probability, and any differences in performance are likely due to factors other than gender. The lack of significant gender effect may be attributed to various factors, including: equal access to education, since both male and female students have equal opportunities to learn probability concepts; similar learning styles as gender differences in learning styles are minimal, and both males and females can

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adapt to various teaching methods; and no inherent ability differences. There is no evidence to suggest that males or females have inherent advantages in understanding probability concepts.

This finding has implications for educators, as it suggests that gender should not be a consideration in teaching probability. Instead, educators should focus on creating an inclusive learning environment that supports all students, regardless of gender, in developing their understanding of probability concepts. Further research should explore other factors that may influence student performance in probability, such as learning styles, motivation, and teaching methods, to identify effective strategies for teaching probability to all students.

The next three objectives of this study are to investigate the interaction effects of Ludo and Card games,, gender. To achieve these, three (3) hypotheses were formulated and tested. Below is the discussion of findings as shown in table 4.4 above.

The fourth objective of this study is to examine the interactive effects of Ludo and Card games, on students' academic achievement in Probability. The findings of this study reveal a significant interactive effect of Ludo and Card games, on students' academic performance in probability. This result suggests that the combination of Ludo and Card games, has a synergistic effect, leading to enhanced student learning outcomes in probability. The interactive effect implies that Ludo and Card games, complement each other, creating a powerful learning environment that fosters student engagement, motivation, and understanding. Ludo and Card games, may provide an interactive and enjoyable learning experience, while Ludo and Card game offers guidance and support, helping students to correct misconceptions and solidify their understanding of probability concepts.

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This finding aligns with previous research that has highlighted the benefits of combining game-based learning with game mechanisms[7]. The interactive effect may be attributed to the following factors: enhanced engagement since Ludo and Card games, increase student engagement, while Ludo and Card game provides a sense of accomplishment and motivation. Improved understanding as Ludo and Card games, clarifies misconceptions, while Ludo and Card games, help students connect abstract concepts to real-life scenarios. Personalized learning. The combination of games and game allows for tailored instruction, catering to individual learning needs.

The results have implications for educators, suggesting that integrating Ludo and Card games, can create a robust learning environment that supports student success in probability. Further research should explore the optimal combination and implementation of these strategies to maximize student learning outcomes.

The fifth objective of this study is to examine the interactive effects of Ludo and gender on students' academic performance in probability. From table 4.4 above, there is no significant interactive effects of Ludo and gender on students' academic performance in probability. The absence of a significant interactive effect of Ludo and gender on students' academic performance in probability suggests that the impact of Ludo and gender, on learning outcomes is consistent across genders. This result is in agreement with past studies [7,8,9]. The studies found no significant interaction between Ludo and gender on mathematics achievement.

This finding implies that Ludo and gender, can be a valuable instructional tool for improving student understanding of probability concepts, regardless of gender. The lack of interaction between Ludo and gender may be attributed to the fact that Ludo and gender, can cater to

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diverse learning styles and abilities, making them accessible and effective for both male and female students. Additionally, Ludo and gender, can provide a neutral learning environment, reducing potential gender biases and stereotypes that may influence student engagement and motivation.

This finding has implications for educators, suggesting that Ludo and gender, can be a useful addition to probability instruction, without concerns about differential effects on male and female students. Educators can consider incorporating Ludo and gender, into their teaching practices, without needing to tailor their approach to specific genders. Furthermore, this finding highlights the potential of Ludo and gender, to promote gender equity in Mathematics education. By providing an engaging and inclusive learning environment, Ludo and gender, can help reduce gender gaps in Probability achievement and participation, ultimately promoting greater diversity in STEM fields.

Similarly, the sixth objective is to examine the interactive effects of effect of Card and gender on students' academic performance in probability. The absence of a significant interactive effect Card and gender on students' academic performance in probability suggests that the impact of Card and gender on learning outcomes is consistent across genders. This result is consistent with previous studies which found no significant interaction between Card and gender and gender on Mathematics achievement[10,11.]

This finding implies that Card and gender, can be a valuable instructional tool for improving student understanding of probability concepts, regardless of gender. The lack of interaction between Card and gender, may be attributed to the fact that Card and gender, addresses individual learning needs, providing targeted support and guidance that transcends gender

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differences. Additionally, Card and gender, can help reduce gender-based anxiety and stereotypes in mathematics, creating a more inclusive learning environment.

This finding has implications for educators, suggesting that Card and gender can be a universally effective strategy for enhancing student learning in probability, without concerns about differential effects on male and female students. Educators can implement Card and gender, techniques, such as regular quizzes, class discussions, and one-on-one meetings, to support all students' learning, regardless of gender.

Furthermore, this finding highlights the potential of card game to promote gender equity in Mathematics education. By providing individualized support and Card and gender, educators can help reduce gender gaps in Mathematics achievement and participation, ultimately promoting greater diversity in STEM fields.

Finally, the seventh objective is to examine the interaction effect of Ludo, Card games, and gender on students' academic performance in probability. The results from table 4.4 above shows that there is no significant interactive effect of Ludo, Card games, and gender on students' academic performance in probability. The absence of a significant interactive effect of Ludo, Card games and gender,, and gender on students' academic performance in probability suggests that the impact of these instructional factors on learning outcomes is consistent across genders. This finding implies that the combination of Ludo, Card games and gender can be equally effective for both male and female students in learning probability concepts.

The lack of interaction between Ludo, Card games and gender may be attributed to the fact that these instructional factors address learning needs and styles that are not specific to one

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gender. Ludo, Card games and gender, can engage students of both genders, while ludo can provide targeted support and guidance, regardless of gender.

This finding has implications for educators, suggesting that instructional strategies incorporating Ludo, Card games and gender can be implemented without concerns about differential effects on male and female students. However, it is essential to consider other factors that may influence student learning outcomes, such as learning style, prior knowledge, and individual differences.

Furthermore, this finding highlights the potential of Ludo, Card games and gender, to promote gender equity in mathematics education. By providing an inclusive and supportive learning environment, educators can help reduce gender gaps in mathematics achievement and participation, ultimately promoting greater diversity in STEM fields.

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Chapter Five

Conclusion

5.1 Summary of Findings

The results of the ANCOVA, as shown in Table 4.3, indicate a significant main effect of Ludo and Card games, on academic achievement of senior secondary students in probability in Oyo Metropolis; [$F_{(1, 58)} = 79.331$; $P < .05$]; [[$F_{(1,58)} = 54.973$; $P < .05$] respectively. However, from the same table, the results show that gender has no significant main effect on academic achievement of senior secondary students in probability in Oyo Metropolis; [$F_{(1,58)} = .990$; $P > .05$],

Furthermore, results from table 4.3 shows that there were significant interactive effects between Ludo and Card games, on academic achievement of senior secondary students in probability in Oyo Metropolis [$F_{(1,116)} = 56.850$; $P < .05$]; while there were no interactive effects between gender and Ludo and Card games, on academic achievement of senior secondary students in probability in Oyo Metropolis [$F_{(1,116)} = 1.283$; $P > .05$]; between Ludo and Gender on academic achievement of senior secondary students in probability in Oyo Metropolis [$F_{(1,116)} = 3.157$; $P > .05$].

Finally, there was significant interactive effects of Ludo and Card games, gender and conventional method of learning on students' academic achievement of senior secondary students in probability in Oyo Metropolis. [$F_{(1,236)} = .62.165$; $P < .05$].

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5.2 Conclusion

Based on the findings of the study, it can be concluded that Ludo and Card games, have both main and interactive effects on students' academic achievement of senior secondary students in probability in Oyo Metropolis. However, gender of the students has been proven to be insignificant factor in the students' academic achievement in Probability.

5.3 Recommendations

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

1. Mathematics teachers should integrate Ludo and Card games, into probability curricula to enhance student engagement and understanding.
2. They should implement Ludo and Card games, strategies, such as regular quizzes, group discussions, and peer review, to monitor student progress.
3. They should develop and utilize technology-based Ludo and Card games, to increase accessibility and motivation.
4. Government should provide teachers with training and resources to effectively incorporate Ludo and Card games, into their teaching practices.
5. Educational policymakers should prioritize the development and implementation of game-based learning initiatives.
6. They should incorporate formative assessment and game into educational standards and evaluation frameworks.

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5.4 Contribution to Knowledge

This study contributed to the existing knowledge in the following ways;

The study makes a significant theoretical contribution by Validating the effectiveness of Ludo and Card games, in enhancing student learning outcomes in probability. It also supports the cognitive load theory and constructivist theory in the context of probability education and enhances understanding of how Ludo and Card games, influence student motivation, engagement, and academic achievement.

The study offers practical implications for policymakers and practitioners in the education sector. It provides educators with evidence-based strategies for improving probability education. It also informing curriculum design and instructional methods for probability courses, and offers insights for developers of Ludo and Card games, and software.

The study significantly enhances our understanding of the impact Ludo and Card games, on students' academic achievement in Probability in particular and Mathematics as a subject. Empirical evidence from the study adds to the growing body of research on game-based learning and Ludo and Card Games. It also provides new evidence on the effectiveness of Ludo and Card games, in probability education.

5.5 Suggested Areas for Further Research

Based on the findings and contributions of this study, several areas for future research can be suggested:

1. Investigate the impact of Ludo and Card games, on students' critical thinking and problem-solving skills.
2. Explore the effectiveness of different types of Ludo and Card games,(e.g., puzzles, simulations, role-playing) on probability learning.

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3. Examine the role of individual differences (e.g., learning style, prior knowledge) in the effectiveness of Ludo and Card games.

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Appendix 1

Probability Achievement Test (PAT)

Name of School:_____

Name of Student: _____

Gender: _____

Class: _____

1. The probability of obtaining a number less than 5 in a single toss of a fair die is

   A .$^1/_6$

   B. ⅓

   C. ½

   D. ⅔

2. The probability of obtaining an odd number in a single toss of a fair die is

   A. $^1/_6$

   B. ⅓

   C.½

   D. ⅔

3. The probability of obtaining a prime number in a single toss of a fair die is

   A. ½

   B. ⅓

   C. ¼

   D. $^1/_6$

4. A number is selected randomly from the set of integers 1 to 20 inclusive. Use this information to answer questions 4 to 6. The probability that the number is equal to or greater than 15 is

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A. ¼

B. $^{3}/_{10}$

C. $^{7}/_{10}$

D. ¾

5. The probability that the number is either a multiple of 3 or a multiple of 5 is

A. ½

B. $^{11}/_{20}$

C. $^{9}/_{20}$

D. $^{3}/_{10}$

6. The probability that the number is prime is

A. $^{7}/_{20}$

B. $^{2}/_{5}$

C. $^{9}/_{20}$

D. ½

7. The letter of the word MISSISSIPPI are cut and placed in a bag. If one letter is drawn randomly from the bag, the probability that it is neither an I nor an S is

A. $^{8}/_{11}$

B. $^{6}/_{11}$

C. ½

D. $^{3}/_{11}$

8. A figure is selected randomly from a group of figures consisting of a square, a triangle, a rectangle, a trapezium and a rhombus. The probability that the figure selected is a parallelogram is

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A. $^{4}/_{5}$

B. $^{3}/_{5}$

C. $^{2}/_{5}$

D. $^{1}/_{5}$

9. The probability that a number selected at random from 1 to 40 is a multiple of 7 is

A. $^{1}/_{6}$

B. $^{1}/_{8}$

C. $^{3}/_{20}$

D. $^{7}/_{40}$

Use the information below to answer questions 10 and 11.

	Boys	Girls
Class A	25	15
Class B	20	10

10. If a boy is selected at random from a congregation of the two classes, the probability that he is from class B is

A. $^{2}/_{7}$

B. $^{3}/_{7}$

C. $^{4}/_{9}$

D. $^{2}/_{3}$

11. The probability that a student selected randomly from the class scored 5 marks is

A. 0.15

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B. 0.20

C. 0.30

D. 0.50

The table below shows the scores of students in a class test on Mathematics:

Score	2	3	4	5	6	7	8
No of Students	1	4	6	3	3	2	1

12. The probability that a student selected randomly score at least 6 marks is

A. 0.85

B. 0.70

C. 0.30

D. 0.15

13. The probability that a student selected randomly from the class scored 5 marks is

A.0.15

B. 0.20

C. 0.30

D. 0.50

The data below shows the distribution of workers in a certain secondary school. Use the information to answer questions 14 and 15.

Teachers	30	Gardeners	15
Typists	9	Cleaners	6
Clerks	12	Messengers	3

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14. If one of the workers is absent from work on one particular day, the probability that he is a clerk is

A. $^{4}/_{25}$

B. $^{3}/_{25}$

C. $^{2}/_{25}$

D. $^{1}/_{25}$

15. If one of the workers is on leave, the probability that he is either a teacher or a gardener is A. $^{3}/_{25}$

B. $^{1}/_{5}$

C. $^{2}/_{5}$

D. $^{3}/_{5}$

16. A bag contains 4 red, 8 green and 6 blue balls of identical size. The probability that a ball selected randomly is either red or green is

A.$^{2}/_{3}$

B. $^{4}/_{9}$

C. $^{1}/_{3}$

D.$^{2}/_{9}$

A die is rolled 100 times with the following outcomes:

Number	1	2	3	4	5	6
Frequency	15	20	18	14	17	16

Use the information to answer questions 17 and 18.

17. The experimental probability of obtaining a 2 is

A. 0.10

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B. 0.20

C. 0.40

D. 0.80

18. The experimental probability of obtaining at most 4 is

A.0.14

B. 0.47

C. 0.67

D. 0.84

Of the 30 students in a class, 8 surnames begin with A or O and 18 begin with a consonant. No surname begins with any of the letters C, Q, U, V, X and Z. Use this information for questions 19 and 20.

19. The probability that the surname of a student selected at random begins with a vowel is

A. $^{2}/_{15}$

B. $^{4}/_{15}$

C. $^{4}/_{13}$

D.$^{2}/_{5}$

20. The probability that a surname selected randomly begins with E or I is

A. $^{13}/_{15}$

B.$^{3}/_{5}$

C. $^{4}/_{15}$

D. $^{2}/_{15}$

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21. A ball is selected and replaced in a bag containing blue, green and red identical balls. The results of 50 selections are shown below:

Colour of ball	Blue	Green	Red
NO of occurrences	8	15	27

The experimental probability of picking either a blue or a red ball is

A.0.70

B. 0.54

C. 0.30

D. 0.16

Two events M and N are mutually exclusive and P(M) =1/4 and P (N) = 2 / 3. Use this information for questions 22and 23.

22. P(MnN)is

A. 0

B. $^{1}/_{6}$

C. $_{5}/_{12}$

D. $^{1}/_{3}$

23. P(MUN)is

A. 1.

B.$^{11}/_{12}$

C. $^{1}/_{2}$

D.$^{1}/_{12}$

24. The probability that a baby born by a certain couple will grow up to be tall is $^{1}/_{4}$. The

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probability that the couple will have a tall daughter is

A. $^{1}/_{8}$

B. $^{1}/_{4}$

C. $^{3}/_{8}$

D. $^{1}/_{2}$

25. The probability that a sum of 10 will appear in two tosses of a fair die is

A. $^{5}/_{18}$

B. $^{1}/_{6}$

C. $^{5}/_{36}$

D. $^{1}/_{12}$

26. Two fair dice are thrown together. The probability that the sum of the outcomes is at least 10 is

A. $^{5}/_{36}$

B. $^{1}/_{4}$

C. $^{1}/_{6}$

D. $^{1}/_{12}$

27. The probability that the two dice in question 26 will show the same number of points is

A. $^{1}/_{36}$

B. $^{1}/_{6}$

C. $^{1}/_{3}$

D. $^{1}/_{2}$

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28. Two numbers are drawn randomly from the four numbers 1,3, 5 and 8. The probability that the sum of the two is not odd is

A. ¼

B. $^1/_3$

C. $^1/_2$

D. $^2/_3$

29. The probability of an event X is $^2/_3$ and that of another event Y is $^1/_4$. If the probability of both X and Y is $^1/_6$,the probability of either X or Y is

A.1

B. $^{11}/_{12}$

C. ¾

D. $^1/_3$

30. The chances of occurrence of three independent events X, Y and Z are $^1/_3$, $^1/_4$ and $^2/_5$. What are the chances of occurrence of only Y and Z?

A. $^1/_{30}$

B.$^1/_{15}$

C. $^1/_{10}$

D. $^{13}/_{30}$

31. A group of 40 adults read either newspapers or magazines. If 20 read newspapers and 35 read magazines, the probability that one of them reads both newspapers and magazines is

A. $^3/_8$

B.$^2/_3$

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C. $^{3}/_{11}$

D. $^{1}/_{2}$

32. P is a probability function of an exhaustive set S = { w ,x , y , z } . I f P (x) = 1 / 4 , P (y) = 1 / 3 , P (z) = 1 / 6 ,then P(w) is

A. $^{1}/_{72}$

B. $^{1}/_{12}$

C. $^{1}/_{4}$

D. $^{3}/_{4}$

33. Four of the faces of a fair die are coloured black and the remaining two faces are coloured white. On throwing the die two consecutive times, the probability that both throws will show a black face is

A. $^{2}/_{3}$

B. $^{4}/_{9}$

C. $^{2}/_{9}$

D. $^{1}/_{9}$

34. Two fair coins are tossed. The probability of getting at least one tail is

A. $^{3}/_{4}$

B. $^{2}/_{3}$

C. $^{1}/_{2}$

D. $^{1}/_{4}$

35. A box contains 2 green and 3 red balls of identical size. If two balls are picked randomly, one after the other, without replacement, the probability of picking two balls of different colours is

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A. $^{3}/_{5}$ B. $^{2}/_{5}$C. 1/5 D. $^{2}/_{3}$

Three balls are drawn one after the other, without replacement from a bag containing 4blue, 6white and 5 red identical balls. Use this information for questions 36 to 38.

36. The probability that the three balls are: one blue, one white and one red is

A. ⅓

B. $^{16}/_{225}$

C.$^{8}/_{225}$

D.$^{4}/_{91}$

37. The probability of picking 2 blue and 1 red ball is

A. $^{4}/_{225}$

B. $^{4}/_{91}$

C. $^{2}/_{91}$

D.$^{6}/_{91}$

38. The probability that all three balls are the same colour is

A. $^{34}/_{455}$

B. $^{4}/_{91}$

C.$^{2}/_{91}$

D. $^{4}/_{455}$

39. Two cards are drawn, one after the other, with replacement from a pack of 52 cards containing four aces and four queens. The probability that the cards are either both aces or both queens is

A. $^{4}/_{13}$

B. $^{2}/_{13}$

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C. $^{2}/_{221}$

D. $^{2}/_{169}$

40. A bag contains 5 red balls and 3 green balls. Two balls are picked, one after the other, with replacement. The probability that both are the same colour is

A. $^{17}/_{32}$

B. $^{25}/_{64}$

C. $^{15}/_{64}$

D. $^{9}/_{64}$

41. The probability that the two balls selected in question 40 are of different colours is

A. $^{17}/_{32}$

B. $^{15}/_{32}$

C. $^{15}/_{64}$

D. $^{1}/_{8}$

42. Three guests X, Y and Z arrive in that order for a dinner party. If guests are served randomly, the probability that the three guests will be served in the sequence of their arrival is

A. $^{1}/_{6}$

B. $^{1}/_{3}$

C. $^{1}/_{2}$

D. $^{2}/_{3}$

43. A box contains 5 red, 6 green and 7 yellow pencils of the same size. What is the probability of picking a green pencil at random?

A. $^{1}/_{6}$

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B. ¼

C. $^{1}/_{3}$

D. $^{1}/_{2}$

44. A box contains 2 white and 3 blue identical balls. If two balls are picked at random from the box, one after the other with replacement, what is the probability that they are of different colours?

A. $^{2}/_{3}$

B. $^{3}/_{5}$

C. $^{7}/_{20}$

D. $^{12}/_{25}$

Number of goods	1	2	3	4	5	6	7
Number of teams	3	1	6	6	4	2	3

The table shows the distribution of goals scored by 25 teams in a football competition. Use it to answer questions 45 and 46.

45. Calculate the probability that a team selected at random scored at most 3 goals.

A. $^{3}/_{25}$

B. $^{1}/_{5}$

C. $^{6}/_{25}$

D. $^{2}/_{5}$

46. Find the probability that a team selected random scored either 4 or 7 goals.

A. $^{9}/_{25}$

B. $^{11}/_{25}$

C. $^{3}/_{5}$

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D. $^{18}/_{25}$

47. A bag contains 5 red and 4 blue identical balls. If two balls are selected at random from the bag, one after the other, with replacement, find the probability that the first is red and the second blue.

A.$^{2}/_{9}$

B. $^{5}/_{18}$

C.$^{20}/_{81}$

D.$^{5}/_{9}$

Given the sets A ={2, 4, 6, 8 and B ={ 2 , 3 , 5 , 9

Use the information to answer questions 48-50.

48. If a number is selected at random from set B,what is the probability that the number is prime?

A. 1

B. ¾

C. ½

D. ¼

49. If a number is picked at random from each of the two sets, what is the probability that their product is odd?

A.1

B.$^{3}/_{4}$

C. ¼

D.0

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50. If a number is picked at random from each of the two sets, what is the probability that their difference is 6 or 7?

A. $^{1}/_{256}$

B. $^{1}/_{16}$

C. $^{1}/_{8}$

D. ½

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Appendix 2
Lesson Note

Week : **1**
Subject: Mathematics

Class: S.S2

Duration: 40 minutes

Topic: Experimental probability

Sub Topic: Definition of Experimental Probability

Instructional Objective(s): At the end of the lesson, students should be able to use the language of probability.

Entry Behavior: Students can identify some games

Instructional Material: Ludo Game and Playing Card

Reference Book(s):A.O Kalejaiye, etal, *New General Mathematics for Senior Secondary School 2*. **Lagos Pearson Education Limited**2018,112 – 113

Introduction:

Teacher introduces the lesson by making reference to their previous knowledge thus:

What are the names (Ludo and Playing Card) of these objects?

Presentation:

Step 1

Teacher leads the students on the definition of probability thus:

Probability is defined as the likelihood of a desired event happening

Step 2

Teacher leads the students to list method of finding probability thus:

There two methods of finding probability

(a) By Experiment

(b) By observation of statistical data

Step 3

Teacher leads the students to the definition of experimental probability thus:

Experimental probability is defined as the ratio of number of required outcome to total number of possible outcomes.

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$$\text{Probability} = \frac{Number of required outcomes}{\text{Number of possible outcomes}}$$

$$\text{Probability} = \frac{\text{Event}}{\text{Sample space}}$$

Evaluation

Teacher evaluates the lesson by giving the exercise to the students

(a) What is probability?

(b) List the methods of finding probability

(c) What is experimental probability?

Conclusion

Teacher concludes the lesson by doing the corrections for the students .

Assignment(s):

Teacher gives this assignment to the students.

What is total number of playing card?

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Week : **2**
Subject: Mathematics

Class: S.S2

Duration: 40 minutes

Topic: Experimental probability

Sub Topic: Event, space and Probability of chance instruments

Instructional Objective(s): At the end of the lesson, students should be able to describe and evaluate event involving chance.

Entry Behavior: Students can define experimental probability

Instructional Material: Ludo Game and Playing Card

Reference Book(s):A.O Kalejaiye, etal, *New General Mathematics for Senior Secondary School 2*. **Lagos Pearson Education Limited**2018,113 – 114

Introduction:

Teacher introduces the lesson by making reference to their previous knowledge thus:

What is experimental probability?

Presentation:

Step 1

Teacher leads the students to the analysis of playing card, by showing it to them, thus:

The pack of playing card consists of 52 playing card. Twenty – six cards are black while twenty – six cards are red, The cards are divided into four by shapes. Examples are


Black 13 Club


ack 13 spade


13 Diamond


13 Hearts

Step 2

Teacher leads the students to analysis of Ludo Game, by showing it to them, thus;

Ludo Game contains two dice. Each die has six faces. Each face has one dot, two dots up to six dots.

Step 3

Teacher leads the students to use experimental probability to solve problem thus:

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Example:
(1) A die is rolled once. What is the probability of getting 4?
Solution

Sample Space = 6

Event (4) = 1

Probability $= \frac{\text{Event}}{\text{Sample space}}$

Pr(4) $= {}^{1}/_{6}$

2. A card is picked from the pack of playing card. What is the probability of picking king of club?

Solution

Sample Space = 52

Event (King of club) = 1

Pr (King of club) = ${}^{1}/_{52}$

Evaluation

Teacher evaluates the lesson by giving the exercise to the students

(i) What is the probability of getting prime in roll of a die

(ii) What is the probability of picking black card a pack of playing card

Conclusion

Teacher concludes the lesson by doing the corrections for the students.

(i) Sample space = 6

Event (prime number) = (2, 3, 5, 2) = 3

Pr(prime Number) ${}^{3}/_{6} = ½$

(2) Sample space = 52

Event (Black card) = 26

Pr (Black card) = ${}^{26}/_{52} = ½$

Assignment(s):

Teacher gives this assignment to the students.

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What is theoretical Probability?

Week : **3**

Subject: Mathematics

Class: S.S2

Duration: 40 minutes

Topic: Theoretical probability

Sub Topic: Definition of Theoretical probability

Instructional Objective(s): At the end of the lesson, students should be able to use the language of probability.

Entry Behavior: Students can solve problem on Experimental probability

Instructional Material: Ludo Game and Playing Card

Reference Book(s):A.O Kalejaiye, etal, *New General Mathematics for Senior Secondary School 2*. **Lagos Pearson Education Limited**2018.

Introduction:

Teacher introduces the lesson by making reference to their previous knowledge thus:

What is the probability of getting 5 in a single throw of a die?

Presentation:

Step 1

Teacher leads the students to the definition of theoretical probability thus:

Theoretical probabilities are exact values which can be calculated by considering the physical nature of the given situations.

Since experimental probabilities use numerical records of past event to predict the future, its prediction are not absolutely accurate.

Probability $= \frac{Number of required outcomes}{\text{Number of possible outcomes}}$

Step 2

Teacher leads the students onthe probability for event not to happen thus:

If P is the probability of an event happening then P lies in the range $0 \leq P \leq 1$. The probability of event not happening is P^1 where $P^1 = 1 - P$.

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Step 3

Teacher leads the students to solve example thus:

Example:

Find the probability that Jessie does not throw a 4

Solution

Event (4) = 1

Sample Space = 6

Pr(a 4) = $^1/_6$

Pr(not a 4) = 1 – $^1/_6$ = $^5/_6$

Evaluation

Teacher evaluates the lesson by asking the question from the students thus:

(a) What is theoretical probability?

(b) What is the probability of event not happens

Conclusion

Teacher concludes the lesson by doing the corrections for the students.

Assignment(s):

Teacher gives this assignment to the students.

A letter is chosen from the alphabet. Find the probability that it is (a) F (b) T (c) One of the letters of the word FREQUENCY (d) Not one of the letter of the word TABLE.

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Week : **4**
Subject: Mathematics

Class: S.S2

Duration: 40 minutes

Topic: Theoretical probability

Sub Topic: Solving problem with Theoretical probability

Instructional Objective(s): At the end of the lesson, students should be able to use Theoretical

probability to solve problem involving chance.

Entry Behavior: Students can define Theoretical probability

Instructional Material: Ludo Game and Playing Card

Reference Book(s):A.O Kalejaiye, etal, *New General Mathematics for Senior Secondary School 2*. **Lagos Pearson Education Limited**2018.

Introduction:

Teacher introduces the lesson by making reference to their previous knowledge thus:

What is Theoretical probability?

Presentation:

Step 1

Teacher leads the students to solve example thus:

Example:

A letter is chosen from the alphabet. Find the probability that it is (a) F (b) T (c) One of the letters of the word FREQUENCY (d) Not one of the letter of the word TABLE.

Solution

Sample space = 26

(a) E (F) = 1 (b) E (T) = 1

Pr(F) = $^{1}/_{26}$ Pr (T) = $^{1}/_{26}$

(c) E (FREQUENCY) = 8 (d) E (TABLE) = 5

Pr (FREQUENCY) = $^{8}/_{26}$ Pr (TABLE) = $^{5}/_{26}$

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Pr (Not TABLE) = $1 - {}^{5}/_{26} = {}^{21}/_{26}$

Step 2

Teacher leads the students to solve more example thus:

Example:

Jessie throws a fair six – sided. What is the probability that she throws (a) a9 (b) a 4 (c) a number greater than 2 (d) an even number (e) either 1, 2, 3, 4, 5 or 6?

Solution

Sample Space = 6

(a) E (a9) = 0

Pr (a 9) = ${}^{0}/_{6} = 0$

(b) E (a 4) = 1,

(c) Pr (a 4) = ${}^{1}/_{6}$

E (a number greater than 2) = 4

Pr(a number greater than 2) = ${}^{4}/_{6} = {}^{2}/_{3}$

(d) E (an even number) = 3

Pr(an even number) = ${}^{3}/_{6} = ½$

(e) E (either 1, 2, 3, 4, 5, or 6) = 6

Pr (either 1, 2, 3, 4, 5, or 6) = ${}^{6}/_{6} = 1$

Evaluation

Teacher evaluates the lesson by giving the exercise to the students:

1. A school contains 357 boys and 323 girls. If a students is chosen at random, what is the probability that a girl is chosen?
2. A letter is choose at random from the alphabet, Find the probability that it is

   (a) M (b) Not A or Z (c) Either P, Q, R or S (d) One of the letters of NIGERIA

Conclusion

Teacher concludes the lesson by doing the corrections for the students.

1. Number of possible outcome = 680

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Number of required outcome = 323

Pr(a girl is chosen) = ^{323} / $_{680}$

2. Sample space = 26

(a) E (m) = 1, Pr (m) = 1/26

(b) Pr (A or Z) = $^{2}/_{26} = {}^{1}/_{13}$

Pr (not A or Z) = $^{12}/_{13}$

(c) Pr (P, Q, R or S) = $^{4/}_{26} = {}^{2}/_{13}$

(d) Pr (NIGERIA) = $^{6}/_{26} = {}^{3}/_{13}$

Assignment(s):

Teacher gives this assignment to the students.

A coin is tossed three time, what is the probability of getting

(a) Two head and one tail

(b) At least one head

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Week : **5**
Subject: Mathematics

Class: S.S2

Duration: 40 minutes

Topic: Combined probability

Sub Topic: Addition and subtraction of probability

Instructional Objective(s): At the end of the lesson, students should be able to solve problems relating to mutually and non –mutually exclusive events.

Entry Behavior: Students can solve problems on theoretical probability

Instructional Material: Ludo Game and Playing Card

Reference Book(s):A.O Kalejaiye, etal, *New General Mathematics for Senior Secondary School 2*. **Lagos Pearson Education Limited**2018.

Introduction:

Teacher introduces the lesson by making reference to their previous knowledge thus:

Jessie throws a fair six – sided. What is the probability that she throws (a) a9 (b) a 4 (c) a number greater than 2 (d) an even number (e) either 1, 2, 3, 4, 5 or 6?

Presentation:

Step 1

Teacher leads the students to solve the example thus:

Example:-

A fair die is throw once. What is the probability of getting prime number or odd number?

Solution

Sample space = 6

Event of prime number = 3

Probability of prime number = $^3/_6$

Event of odd number = 3

Probability of odd number = $^3/_6$

Probability of prime or odd number = $^3/_6 + {}^3/_6 - {}^2//_6 = {}^4/_6 = {}^2/_3$

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Step 2

Teacher leads the students to the solve more example

Example

Find the probability that a letter chosen at the random from the Alphabet is either a vowel or one of the letters X, Y, Z

Solution

Evaluation

Teacher evaluates the lesson by giving the exercise to the students

A number is choose at random from the set (2, 4, 6…., 18, 20). Find the probability that it is either a factor of 18 or a multiple of 5.

Conclusion

Teacher concludes the lesson by doing the corrections for the students.

Solution

Pr(either a factor of 18 or multiple of 5) = ½

Assignment(s):

Teacher gives this assignment to the students.

A die is thrown and a coin is tossed.

What is the probability of getting both a 6 and a tail

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Week : **6**
Subject: Mathematics

Class: S.S2

Duration: 40 minutes

Topic: Combined probability

Sub Topic: Multiplication of probability

Instructional Objective(s): At the end of the lesson, students should be able to solve problems relating to dependent and independent events.

Entry Behavior: Students can solve addition of probability

Instructional Material: Ludo Game and Playing Card

Reference Book(s):A.O Kalejaiye, etal, *New General Mathematics for Senior Secondary School 2*. **Lagos Pearson Education Limited**2018.

Introduction:

Teacher introduces the lesson by making reference to their previous knowledge thus:

Jessie throws a fair six – sided. What is the probability that she throws (a) a9 (b) a 4 (c) a number greater than 2 (d) an even number (e) either 1, 2, 3, 4, 5 or 6?

Presentation:

Step 1

Teacher leads the students to list the events on the multiplication of probability thus:

On the multiplication of probability, we have

(i) Independent event
(ii) Dependent event

Step 2

Teacher leads the students to the definition of independent event thus:-

Two or more events are independent if they have no effect on each other, we use the product law for independent events.

If A, B, C, ….. are independent, the probability of A and B and C and …… happening is Pr (A) x Pr(B) x Pr(c)

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Step 3

Teacher leads the students to solve problem on independent event thus:

Example:

A die is thrown and a coin is tossed.

What is the probability of getting both a 6 and a tail

Solution

Pr(a 6) = $^1/_6$

Pr(a tail) = ½

Pr(a 6 and a tail) = Pr (a 6) x Pr (a tail)

$= {}^1/_6 \text{ x } ½ = {}^1/_{12}$

Evaluation

Teacher evaluates the lesson by giving the exercise to the students

A card is chosen from a pack of playing cards then returned to the pack. A second card is chosen. What is the probability of both cards are black?

Conclusion

Teacher concludes the lesson by doing the corrections for the students.

Solution

1st Pick

E (black card) = 26

Sample Space = 52

Pr (black card) = $^{26}/_{52} = ½$

Second pick

E (Black Card) = 26

Sample Space = 52

Pr(black card) $^{26}/_{52} = ½$

Pr (Both card are black) = ½ x ½ = ¼

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Assignment(s):

Teacher gives this assignment to the students.

Five Cards are lettered A, B, C, D, E. Three card are chosen at random, one after the other , without replacement and are placed in the order (1^{st}, 2^{nd} and 3^{rd}), what is the probability that the card spell the word BED?

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Bio-data

A. Personal Data

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B. Education Background:

Institution Attended	**Qualification**	**Year**
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Oba Adeyemi High School, Oyo	SSCE	1991
Oyo State College of Education	NCE	2004
University of Ilorin	BSc(Ed)	2010

C. Award and Fellowship: Nil

D. Work Experience with Date:

Oyo State Post Primary Teaching Service Commission 2014 – till date

E. Membership:

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Mathematics Association of Nigeria

F. Publication:-

D.A Kareem & C.O Sam – Kayode (P.h.d), *Effect of Educational Games and Formative Feedback on Secondary School Students' Academic Achievement in probability in Oyo Metropolis, Oyo State*. **Advance Journal Of Education and social Sciences**, 9(12) 2004

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G. **Date of Viva** :- 22/11/2024

H. **Major Conference Attended with Date** : Nil

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The University Compliance Certificate

This is to certify that this thesis by Dauda Adekunle KAREEM with the Matric number LCU/PG/004009 in the Department of Science Education, Faculty of Education, Lead City University, Ibadan, Oyo State is in full compliance with the approved University format and style.

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Signature **Date**