THE IMPACT OF MATHEMATICS GAMES ON SECONDARY SCHOOL STUDENTS' PROBLEM SOLVING SKILLS AND PERFORMANCE IN TRIGONOMETRY IN EGOR, BENIN CITY, NIGERIA

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A PROJECT WORK SUBMITTED TO THE DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY, FACULTY OF EDUCATION, UNIVERSITY OF BENIN IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE AWARD OF BACHELOR OF SCIENCE (ED) DEGREE IN MATHEMATICS EDUCATION

CERTIFICATION

This is to certify that this project was carried out by **Olley Oritsetserudede Precious** with Matriculation Number **EDU1903168** in the Department of Curriculum and Instructional Technology, Faculty of Education, University of Benin in partial fulfillment for the award of Bachelor of Science (ED) Degree in Mathematics Education.

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DEDICATION

This project work is dedicated to God almighty for his unending love, wisdom, strength and provision; To my parents who saw the need to give me the needed motivation to love education early in life.

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ABSTRACT

The secondary school system of education in Nigeria assumes the role of training and producing students for tertiary institutions and manpower for national development and world of work. The general poor academic performance of students in Mathematics has become a source of great concern to all the stakeholders in education particularly the Mathematics educators, parents and the government. Educational Game is one of the strategies that have been found to enhance the attitude and academic achievement of students in many subjects including Mathematics. But many Mathematics teachers lack the knowledge of the role of Mathematical Games. The study therefore, examined the effects of Mathematical Games on 6 public senior secondary students' academic performance in Mathematics in Egor, Edo State, Nigeria. The researchers adopted a quasi-experimental research design and used simple random sampling technique to select a secondary school for the study. A total of 100 students (32 experimental and 41 control groups) were involved in the study. The experimental group was exposed to Mathematical Games during the teaching of Mathematics for a period of three weeks while the control group was not exposed to Mathematical Games. Mathematics Performance Test (MPT) was used for data collection on students' academic performance. The findings of the study revealed that the use of Mathematical Games has a significant positive effect on the academic performance of the students in Mathematics; the use of Mathematical Games was beneficial to students irrespective of their gender and scoring ability. It was recommended among other things that government should provide Mathematical Games for secondary school students and Mathematics teachers should incorporate the use of Mathematical Games into the teaching and learning of Mathematics.

CHAPTER ONE
INTRODUCTION

BACKGROUND OF THE STUDY

Nigeria is the tenth biggest country in the planet, and by a long-shot the biggest in Africa. Nigeria is separated geographically into six geopolitical districts;
North-Central, North-East, North-West, South-East, South-South, South-West., with the North-East being the most educationally back ward and the most vulnerable to insecurity, poverty, illiteracy, lack of social infrastructures [Falola, 2011]. However, as we progress in the course of this work, much attention will be channeled to the south-south political district of the country and how the issue of teaching and learning of mathematics and problem solving skills in secondary schools is affected by the application of mathematical games in Benin metropolis.
Enhanced post primary school training is vital to successful human capital in any nation [Evoh, 2007]. In this way, the necessity for enhanced problem solving skills in Nigeria post primary institution popularly referred to as secondary schools cannot be overstressed. In this era of rapid motivated innovation development, everyone needs to be mathematically inclined and needs problem solving skills to progress. In my few years of learning and teaching mathematics plus my one year of teaching and observing mathematics in Egor, Benin city; I have noticed that when students are motivated, they tend to learn mathematics more successfully. In other words motivation as a tool is very active in the effective teaching/learning mathematics in secondary schools. As an educator in mathematics, i have strived to figure out what I can do to increase the motivation level of my students with respect to mathematics teaching/learning. I have come to discover that as an educator in mathematics, incorporating different pedagogues in my lessons that

will improve my student's perception of the learning environment, their beliefs in them as learners, and their attitude towards mathematics and their achievement is a huge and very important part of my job. Therefore, i have incorporated games [mathematics games] to enhance the student's learning of mathematics. I feel certain that through games, students are motivated. With this in mind, i have decided to formulate my study based on the determination of whether or not the introduction of the 'jeopardy' type game into the secondary schools in Egor mathematics classes can help improve students' perception of learning environment, their beliefs in themselves as learners of mathematics and their attitude towards mathematics and achievement.

Students' lack of motivation when it comes to learning mathematics in Egor can have a negative impact on them and even on the society at large; it can also affect their achievement. The result of past studies has shown that mathematics games can improve students' attitude [Rose, M.Z & Conner, A. (2006)]. But this has not being critically researched on and systematically verified in Egor particularly in the secondary school level. Past research has also proven that teachers who design, develop and implement innovative teaching methods in their class room are more likely to capture student's interests and to fully optimize their learning outcomes than those who do not [Chandra and Fisher, 2009].

When students are more motivated and engaged in a task, learning is more likely to occur [Ernest, 2012]. Introducing and practicing mathematical concept through the active involvement such as game-playing, could contribute to developing the learning process [Bragg, 2006]. The use of games is beneficial; both in terms of examination performance and students perceptions of the learning experience [Massey et at, 2005]. Game not only simulates students' interest in mathematics, but can also promote creativity and student' knowledge [Papastergiou, 2009, Story 2001].

What actually are mathematical games? Mathematical games can be described as those practical activities which bring about fun, excitement and challenges between two or more contestants and at the same time enhance learning of subject matter. It can help in maintaining and sustaining interest in students, thus leading to good academic results. Odili (2006) says that games in general serve the purpose of recreation and often generate excitement and the spirit of competition. Games serve as reinforcement to both winners (to strive to maintain their lead) and losers (to strive to overcome their defeat).

National Mathematical Centre (2002) stated that one of the roles of mathematical games is to develop positive attitude towards mathematics. The informality and excitement of games can lead to the development of positive attitudes. Students tend to like activities that excite them. Bonnie‟s (2008) study found the following:

The use of mathematical games can foster the spirit of competition, acquisition of new skills and increased logical reasoning. It helps in releasing tension, removing boredom and providing environment where the students can develop their skills and acquire more knowledge. It increases the eagerness and zeal to win and not to lose.

In the classrooms, teachers can assess their students through the use of games. Teachers who observe and interact with students while they are playing mathematical games can diagnose a wide variety of their mathematical strengths and weaknesses. Games also provide students with a powerful way of assessing their own mathematical abilities. The immediate feedback students receive from their peers while playing games can help them evaluate their mathematical concepts and algorithms and revise inefficient, inadequate or erroneous ones.

Using mathematical games in the classroom requires active involvement of use of concrete objects and manipulative. Game provides opportunities for students to work in small groups, practice team work, cooperation and effective

communication. Students learn from one another as they talk, share and reflect throughout game period. Language acquisition is meaningful and understandable.

Games can easily be one of the components of cooperative learning. Mathematical games, if used in a cooperative learning context can improve students‟ attainment in mathematics. Greater learning can occur through the use of games due to increased interaction between students. Also opportunities to test intuitive ideas and problem solving strategies can be increased.

Mathematical games have repeatedly been proven to increase students understanding and achievement in mathematics in Washington, D.C. (Ortiz, 2003). Wetsh, Russel, Williams, Reisner and White (2002) reported that in New York City, opportunities to engage in mathematical games and teaching gave students the practice, application and special help they needed to achieve higher levels of performance.

Thus, the use of games in the teaching and learning of mathematics is supposed to bring a positive effect in the academic achievement of students in mathematics results at different levels of examinations.

HISTORY AND PURPOSE OF *JEOPARDY-TYPE* GAME

McFarlane, Sparrowhawk and Heald [2002] found that games provide a forum in which learning arises as a result of tasks stimulated by the content of the games. The also concluded that games promote thinking and problem-solving skills, which might be transferable to other activities. Facer [2003] notes that the key features that contribute to motivation to play games are challenge, fantasy and curiosity. All goals and objectives, outcomes and feedback, conflict, competition, challenge, opposition and interaction [Prensky, 2007].

From the students' perspective, there are many advantages of using games in the classroom. Rather than passive regurgitation of concepts, games allow students to engage in an interesting deviation from the classroom norm [Grabowski and Price, 2003]. Story [2007], a mathematics professor at Akon University, USA, recognized the potential of using games in the classroom, and developed a mathematics game that is based on the popular American television game Jeopardy! Jeopardy! Is an American quiz show that features topics such as history, literature, the arts, pop culture, science and sports? The show has a unique question-and-answer format in which contestants are presented with clues in the form of answers and must phrase their responses in question form. Five categories are announced, each with a column of five trivia clues, each one incrementally valued more than the previous.

The clues are read by the host and a contestant ‘rings in' using a hand-held signaling device. The first contestant to ring in successfully responds and, if correct, earns the dollar value of the clue and has the opportunity to select the next clue from the board. An incorrect response or failure to respond within five-second time limit leads to a deduction of the dollar value from the contestant's score. Based on the television quiz, Story [2001] developed Jeopardy!-type games, that was modified by Ernest [2012] for use in the UAE. The game involves a board upon which four different mathematical concepts are posted, with a series of point value under each. Each row provides problems worth different amount of points, the point value increases from top to bottom. Each point value has an associated problem or question. Generally the higher the point value, the more difficult the problem is.

In mathematics classes, when playing the Jeopardy!-type game, students are placed into teams and take turns to select a mathematical concept and a corresponding question from the board. When the teacher clicks on the cell selected by the student,

the question is exposed. The members of the team are then expected to work together to solve the problem. If they get the correct answer, they earn the point value of that question and, if the answer was incorrect, the point value is subtracted from their total. A member of the group that gets the correct answer is then asked to present the correct solution to the class. After all the question has been answered, the team with the most points is declared the winner.

According to Rotter [2004], Jeopardy!-type game have the potential for teachers to access the current level of student knowledge, clarify problem areas and to reinforce critical information.

STATEMENT OF THE PROBLEM

Globally, the wind of technology is sweeping across all facets of life, and education is not left out. New methods of doing things have taken the front stage in almost all aspects of education including the teaching and learning of mathematics. The persistent poor/bad poor performance in mathematics assessment in the Benin metropolis has been a cause for concern among the educational communities and other concerned parties. The problem has the ability/potential to hinder educational accomplishment. The use of games in teaching secondary school students mathematics is a very crucial method to enhance student's problem solving skills. With the use of mathematics games this problem can be tackled immensely.

Why is mathematics games not explored to incorporate world views and standard of teaching and learning of mathematics in Nigeria? Could it be that the teaching and learning of mathematics is limited to thoughts within the local confines of Nigeria? Is it that the world views on elementary teaching of mathematics through mathematics games are not relevant to the Nigeria clime?

However, it appears that much has been done and no measures have been implemented to improve the application of mathematics games in the teaching and

learning of mathematics in Benin metropolis. It is worrisome to see that secondary schools in Nigeria are yet to incorporate the teaching and learning of mathematics through mathematics games, it seems mathematics in Nigeria is confined to the old fashioned 'blackboard or marker board explanation' method alone. Sometimes the traditional way of teaching mathematics can be a bit limiting; little wonder a senior secondary school student in the Benin metropolis finds it difficult to fully grasp its concept.

Most students around the world can now enjoy the full impact of mathematics games and its contribution to the process of mathematics teaching/learning. But its contribution to the teaching and learning process has not been set up to investigate the use of games in the teaching and learning of mathematics among students in Benin City.

RESEARCH QUESTIONS

To guide this study, four research questions were raised;

1. What are the students' opinions on the use of mathematics games to teach mathematics in their schools?
2. What conditions do constrain or enable utilization of games in mathematics teaching and learning process?
3. Is there a relationship between the nature of the classroom learning environment and student attitudes to mathematics?
4. Is using mathematics games effective in improving
    - The classroom learning environment?
    - Students' attitude to mathematics?
    - Students' mathematics achievement?

PURPOSE OF THE STUDY

The main objective of this study is to investigate the effectiveness of mathematics games to enhance students' problem solving skills in secondary schools in Benin metropolis, Nigeria specifically, the study also sought to;

1. Examine the students' opinion on the use of mathematics games in their classroom in the mathematics teaching/learning process.
2. Examine the constraints and stimulating factors that will aid games usage in the mathematics teaching/learning process.
3. Determine the relationship between the nature of the classroom learning environment and the students' attitudes to mathematics.
4. Determine how an effective mathematical game is in improving.
    - The classroom learning environment
    - Students' attitude to mathematics.
    - Students' mathematical achievement.

SIGNIFICANCE OF THE STUDY

This study is significant because it is one of the few studies of the learning environment that focused on the effects of mathematical games on the classroom environment of students. Specifically, the study provided information about the effect of jeopardy-type games on students' problem solving skills also their attitude towards the learning of mathematics and mathematics achievement.

Moreover, the study is timely and relevant because today mathematics education in Nigeria are faced with some certain challenges including inadequate teacher training and lack of students engagement and motivation plus the perception that mathematics is difficult and irrelevant to daily living, which can affect their interest and performance in the subject and in turn affect their problem solving

skills and therefore effect the Nation at large hence the need for this study is a positive and practical approach to mathematics education. It can make not only the region but the country at large a highly progressive Nation.

The study is significant as its results have the potential to encourage mathematics teachers to incorporate the use of games in their classroom as a viable alternative pedagogical approach. Particularly, this study provides valuable information that could help teachers and researchers in Nigeria to improve their pedagogical practices. The results of the present study have the potential to influence educators, researchers and curriculum developers to incorporate the use of mathematical games into the curriculum as a practical way to improve students' problem solving skills, students' attitude towards mathematics and mathematics achievement.

DELIMITATION OF THE STUDY

This study is limited to the public secondary schools in towns and cities of selected local government areas due to a number of reasons which include insecurity, bad roads and financial constraint.

LIMITATION OF THE STUDY

The study focused on public secondary school students and mathematics teachers.

DEFINITION OF TERMS

In this study, the terms stated below are operationally defined for the purpose of research work:

Public Secondary School: A post-primary institution of learning financed and managed by government from tax-payers' money.

Pedagogical: it refers to the methods, strategies and approached used in teaching and education.

Mathematics Game: These are fun an interactive activities that involve mathematical concepts and problem solving

Teaching: To guide, conduct and pass on knowledge especially in one's profession.

Learning: To acquire or attempt to gain knowledge of a profession

Academic Achievement: mathematics performance as a dependent variable. Also, knowledge attained in mathematics by test scores obtained.

Games: those instructional materials that bring about active involvement of one or more students in mathematics learning.

CHAPTER 2
REVIEW OF RELATED LITERATURE

My study is all about the investigation of the effectiveness of games activities in mathematics teaching/learning in secondary schools in Benin, Nigeria. Therefore, this chapter reviews related literature pertinent to my study under the following headings

- Status of secondary school students mathematics performance in Nigeria[Theoretical Framework]
- Impact of the use of games in mathematics class
- Students' attitude towards mathematics
- Students' academic efficacy
- Chapter summary

Status of Secondary School Students Mathematics Performance in Nigeria [Theoretical Framework]

Mathematics, as described by Maliki, Ngban, and Ibu (2009: 131), plays a crucial role in various aspects of human life. Its significance in enhancing mental discipline and logical thinking cannot be overstated. It is a fundamental branch of science that greatly contributes to the progress of science and technology in the modern era. The importance of mathematics in public secondary schools in Nigeria is undeniable. According to Cockcroft (1996: 1), "It would be very difficult – perhaps impossible – to live a normal life in very many parts of the world in the twentieth century without making use of mathematics of some kind.". Mathematics is highly valued to the extent that countries seeking social change view it as a powerful tool for transformation (Omenka & Otor, 2015: 36). To ensure the

desired outcomes, the curriculum of public secondary schools in Nigeria should prioritize mathematics as a core subject, with classroom instructions aligned with the curriculum and effectively delivered by teachers.

Mathematics plays a crucial role in our everyday lives, as highlighted by The National Mathematics Advisory Panel (2008). Despite the widespread recognition of its significance, the concerning issue lies in the lack of substantial improvement in students' math performance. Even with the integration of technology in math education, as noted by Chang and team (2006), students still struggle to grasp mathematical concepts, resorting to computer-assisted problem-solving systems for assistance [Games].

Meanwhile, mathematics education in Nigeria is facing challenges, with young people finding it uninteresting and difficult while teachers struggle to engage them, despite their academic achievements. Despite the apparent significance of mathematics education and the continuous efforts made by successive governments to enhance mathematics performance in secondary institutions in Nigeria, there has been no notable progress thus far. The performance in the West African Senior School Certificate Examination (WASCCE) has been consistently low in recent years. In 2015, only 28.59% of students achieved the minimum requirement of 5 credits, including a credit pass in mathematics. The results slightly improved in 2016 with 38.50%, but dropped further in 2017, with only 26% meeting the minimum requirement. Considering the government's commitment and allocation of resources towards mathematics education, these results can be deemed unsatisfactory. While the government and academic institutions work towards addressing the ongoing issue of low performance in mathematics, numerous studies have been published in the last two decades outlining potential causes. Asikhia referenced Bakare's work, which identified four main areas contributing to poor performance in mathematics.

i. Factors within society, like the inconsistency of educational policies, inadequate funding for education, poor leadership and management, job insecurity, and lack of job satisfaction.
ii. Factors within the school setting, such as the school's location and physical infrastructure, the mathematics curriculum, teachers' training and expertise.
iii. Factors within the family environment, including cognitive stimulation and basic intuition in early childhood, parenting discipline style, absence of positive role models, and financial constraints.
iv. Factors within the child, like fundamental cognitive skills, physical health factors, psycho-emotional well-being, and lack of interest in academic programs.
Therefore focusing on the challenge within the school/classroom setting, while also considering the broader aspects of government/wider society, family, and the individual factors. These four key areas collectively contribute to a comprehensive understanding of the educational landscape.
On the other hand, digital games are an integral part of children's daily lives. These games are now being utilized to enhance academic performance by motivating students who are not enthusiastic about learning. In rural Edo State, Nigeria, Speedy Rocket, a digital educational game, was introduced in three schools to teach students about estimation as part of the math curriculum. The evaluation involved a mathematics attitude questionnaire for students and classroom observations. The results revealed a significant improvement in students' attitudes towards mathematics and their engagement with the subject after just two weeks of using Speedy Rocket. Students became active participants in their learning, exchanging ideas, creating new learning paths, and engaging in healthy competition and collaboration. Additionally, this study sheds light on the transformation of traditional classroom dynamics through the integration of digital technology, particularly in environments where it was previously absent.

In summary, tackling the obstacles in the mathematics performance of secondary students in Nigeria necessitates a comprehensive approach that includes improving the curriculum, enhancing teacher skills, allocating resources effectively, and implementing innovative educational methods like mathematics games. These measures aim to create a conducive learning environment and enhance overall academic achievements.

Impact of the Use of Games in Mathematics Class

My research focused on examining the influence of mathematics games in a secondary school environment. There is a substantial amount of literature supporting the effectiveness of utilizing games as an educational tool (Annetta, Cheng & Holmes, 2010; Paraskeva, Mysirlaki & Papagianni, 2010) and as a supplement to traditional lectures to improve students' learning outcomes (Kiili, 2005; Tan, 2007; Tan, Tse & Chung, 2010). Previous studies suggest that games can engage students in the learning process and motivate them to participate in a more interactive setting (Gosen & Washbush, 2004; Proserpio & Gioia, 2007; Zantow, Knowlton & Sharp, 2005). Additionally, the use of games can offer educators an interactive platform to convey information, especially for teaching cause and effect (Gosen & Washbush, 2004; Thompson & Dass, 2000). Games, as an educational tool, possess the ability to captivate and inspire students (Paraskeva et al., 2010; Prensky, 2007). Annetta et al. (2010) further assert that knowledge acquired through games is more likely to be retained. Contrary to the misconception that learning must always be serious; Kim (1995) argues that learning can occur while having fun. He suggests that games provide an enjoyable avenue for learning mathematics. According to Paraskeva et al. (2010, p. 499), games offer a "fun, engaging, motivating, interesting, and encouraging way" of teaching. They also emphasize that games have the potential to effectively convey

complex information to students, while simultaneously enhancing academic performance and interpersonal relationships.

Several studies have highlighted the benefits of incorporating games into the educational setting (Malone & Lepper, 1987; Papert, 1980; Prensky, 2007). Khine and Saleh (2009) argue that games offer opportunities for students to engage in experimentation, exploration, trial and error, imagination, role play, and simulation. The task for educators is to develop strategies that can effectively integrate educational games into the traditional curriculum, thereby creating a new learning model.

Previous research has highlighted the capacity of games to enhance the acquisition of skills, teamwork, and engagement in real-world scenarios (Kirriemuir & McFarlane, 2004). In a research conducted in Chile by Rosas et al. (2003), the impact of educational video games on students' learning, drive, and classroom interactions was assessed, involving 1274 students from first and second grades. The results of this investigation demonstrated that utilizing games on handheld devices resulted in increased motivation and educational achievements in comparison to conventional teaching methods in elementary school mathematics and literacy.

Games offer a dynamic alternative to traditional teaching methods, engaging students in a more interactive learning experience (Grabowski & Price, 2003). Bragg (2006) emphasizes the importance of clearly defining learning objectives when incorporating games into education, as well as encouraging students to reflect on their learning throughout the gaming process. In my research, I investigated the potential benefits of implementing creative pedagogical approaches, like games, to enhance the learning environment and students' attitudes towards mathematics in secondary school.

Two research studies in the UAE have explored the utilization of games in educational settings. The initial study, carried out by Al Neyadi in 2007, focused on the efficacy of incorporating games to strengthen vocabulary acquisition among 29 sixth-grade female students. The second study, an action research conducted by Al Zaabi in the same year, delved into the implementation of memory and guessing games to teach vocabulary to male young learners in a primary school. Both studies demonstrated that the integration of games can boost students' enthusiasm for learning vocabulary and foster peer interaction.

Mathematics games are commonly used in school classrooms as rewards for early finishers or to improve students' attitudes towards math. While research shows that games can boost interest and motivation, there is limited study on their effectiveness at the secondary school level, especially in the Nigeria. My research aims to fill this gap by examining the impact of mathematics games on secondary school level students in Nigeria, building on previous studies in the field.

Importance of Mathematics

Mathematics as a subject can be defined and described in various ways. Mathematics is that abstract science that deals with numbers, symbols, directions, and draws conclusions almost about everything in the world. Therefore, mathematics plays an endless role in the development of man and his environment. According to Uzo (2002), mathematics is the only language and culture common to all studies. Also, D‟Ambrosio (2005) says that mathematics is recognized as the most universal mode of thought.

Mathematics is the only subject that forms every part of human daily activities. One‟s daily sleeping and rising is channeled directly to the use of mathematics. In line with this, Iji (2007) opined that Mathematics provides an important key to the understanding of the world in which we live in. It can alter our lives through a

number of ways which include buying of items in the market, reading newspaper, timing a process and estimating a length among others. (p.66)

The only tool that is indispensable in the development of science and technology is mathematics. Aguele and Usman (2007) stated that mathematics is widely regarded as the language of science and technology.

Odili (2006) noted that mathematics is an essential nutrient for thoughts, logic, reasoning and thus progress. Mathematics can be regarded as a driving vehicle for functional and qualitative education of any nation. This is in agreement with Awodeji (2004), „the prosperity of any country depends on the volume and quality of mathematics offered in its school system". (p.51) In addition, Ayorinde (2007) stressed that mathematics is important because it is very much needed for the pursuit of higher education in sciences, technology, social sciences, education, and in art courses. As a condition for admission into tertiary institution, a candidate seeking admission to study science or any science-related course is required to have a credit pass in mathematics either in West African Senior School Certificate Examination (WASSCE) or National Examination Council (NECO) mathematics. Emphasis is placed on mathematics by universities in Nigeria. Mathematics is a subject that is essential for all-round development and survival of any nation.

Mathematics Education

Education being the process of teaching and application of learnt facts differentiates man from other creatures. Experience has shown that majority of students dislike mathematics and as a result they do not take the study of mathematics seriously. This attitude leads to persistent low achievement in mathematics. Mathematics education research is primarily concerned with how best to help students learn mathematics for better improvement and achievement.

Eze (2007) discovered that most teachers in the school system often teach mathematics by the “conventional method”. This involves making lesson notes, passing on the information to the students and then evaluating the students. The teacher becomes very “active” while the students are very “passive”. This does not lead to a lasting learning on the part of the students. Students do not easily understand and comprehend the lesson taught. This makes students to forget the lessons taught and therefore, perform poorly in the examination. Guohua (2002) says that, this conventional method is often boring for students because their only job in the classroom is to passively sit and watch the teacher work mathematics problems on the board and they then copy what the teacher did. Such traditional method gradually makes the students feel that mathematics is pointless and has little value to them in real life. It becomes the subject they are forced to study but one that is useless to them in real life. In this traditional classroom setting, both the students and teachers are often frustrated because the students‟ individual needs are not met. This method provides no way for students to practice generic skills as communication and team-work which are very important. The teaching and learning of mathematics must be lifted from its abstract condition and teacher-centeredness to practical condition and student-centeredness. According to Oyedeji (1998), the two basic types of instructional methodology are the teacher-centered and student-centered. Teacher-centered instructional approaches are more traditional and didactic. Students acquire knowledge by listening to the teacher, by reading a textbook or both. In such an approach, the students are passive recipient of information. Okpala (1985) cited in Owolabi (2003) observed that the conventional teaching method in most Nigerian classrooms is more of teacher-centered than learner-centered. Emphasis seems to be on teaching than learning with less attention to the „processes‟ of learning or „how‟ the students learn. This has dwarfed the students‟ creative thinking which is necessary in today‟s

workplace. Appropriate methods and instructional resources must be selected relevant to the topics in questioned. According to Obodo (2004), many of the professional teachers do not use appropriate methods and teaching aids in the classrooms. Some use sterile and uninspiring methods. Instruction is usually didactic and most often pitched at an abstract level. Teachers cannot improvise instructional materials for use in mathematics lessons. The teachers give little or no consideration to psychology of the learner who may require concrete realities. Teaching aids are sparingly used in concretizing the concepts taught. Mathematics instruction is hardly related to real life situations even when it is obvious to do so with little or no efforts. These aggregate to shape the student‟s perception of mathematics as difficult, abstract and uninteresting.

While it is necessary to be knowledgeable about a particular topic or concept, it is also necessary to know how to inculcate it adequately. For effective teaching, mathematics teachers should know the best methods or techniques of presenting their ideas to their students, putting into consideration, their interest, needs, individual differences, difficulties and abilities. Oragwam (2006) says that our knowledge of what goes on in the mathematics classrooms these days reveal that teaching procedure in use makes mathematics instruction barren and uninspiring. The methods of teaching mathematics in schools have been identified as contributing to the falling interest in mathematics (Rocard, Csermely, Jorde, Lenzen, Walberg, Henriksson and Hemm, 2007). One of the most important factors in any educational change is the change in teaching practices. The direct relationship between improving the quality of teaching and improving students‟ learning in mathematics is a common thread emerging from educational research (Stigler & Hiebert, 1999). For it is what a teacher knows and can do that influences how she or he organizes and conducts lessons, and it is the nature of these lessons that ultimately determines what students learn and how.

Mathematics Achievement through Games

Mathematical games can be used to increase engagement, motivation, and students‟ learning (Clark & Ernest, 2009). Students using games have multiple opportunities for real- world content application followed by positive encouragement or corrective feedback (Allsopp, Kyger & Lovin, 2007). According to Jackson (2009), teachers can learn about cooperative learning and problem-solving from video games. Like any lesson plan based on educational objectives, most games are objective driven in which students have avenue for fun, interactive tools to learn educational concepts (Hoffmann, 2009). Incorporating games could help teachers plan for an objective-filled, problem-based mathematics lesson (Van de Walle, Karp, & Bay- Williams, 2010). Mathematics concept knowledge is foundational for mathematics instruction. Allsopp ,Kyger, & Lovin (2007) suggested that teachers should teach for students‟ understanding; teachers often focused attention on obtaining the final answer instead of ensuring students conceptually understood how to solve the entire question. Games could be used to facilitate students‟ problem-solving abilities and conceptual understanding of mathematics.

The use of games can lead students to new experiences and knowledge. In line with the experimental theory developed by the American philosopher, Dewey (1938) wanted to gain a better understanding of how and why students learned. He concluded that learners gain knowledge through their individual experiences. Dewey stated that “to learn by experience is to make a backward and forward connection between what we do to things and what we enjoy or suffer from things and in consequence” (p.164). In these active-passive movements, students acquired knowledge through fruitful experiences. Dewey believed in creating student-centered learning experiences that were not only valuable and relevant but also flexible for students‟ needs (Pieratt, 2010; Tzuo, 2007).

Students' Attitude towards Mathematics

What is Attitude?

The perceptions, beliefs, and anticipations of students towards mathematics and the teaching of mathematics are viewed as crucial elements influencing their academic performance and success (Borasi, 1990; Reed, Drijvers & Kirschner, 2010). When examining the topic of students' attitudes towards mathematics, Westwood (2000, p. 31) references the research of Wain, who portrayed a rather negative portrayal of mathematics; "many intelligent people after 1500 hours of instruction over eleven years of schooling still regard mathematics as a meaningless activity for which they have no aptitude. It is difficult to imagine how a subject could have achieved for itself such an appalling image as it now has in the popular mind to think that all our effort has led to a situation of fear"

Although this depiction of mathematics may not be pleasing, it serves as a wake-up call for all individuals engaged in the instruction of mathematics (Swan, 2004). Davis (1993, p. 1) takes it a step further by asserting that:

Some students seem naturally enthusiastic about learning, but many need-or-expect their instructors to inspire, challenge, and stimulate them. Whatever level of motivation your students bring to the classroom, will be transformed, for better or worse, by what happens in that classroom

Learning undoubtedly has an emotional aspect, and as stated by Kind, Jones, and Barmby (2007), cultivating a positive attitude is crucial for students' academic success. Attitudes are commonly described using a definition that encompasses three key elements: cognition, affect, and behavior (Kind et al., 2007; Rajecki, 1990). These components, as defined by Reid (2006, p. 4), consist of knowledge about the subject (cognitive), feelings towards the subject (affective), and a predisposition towards action (behavioral).

As highlighted by Kind et al. (2007), this perspective on attitudes is considered reasonable because these elements are closely interconnected. For instance, our knowledge of mathematics (cognitive) influences our feelings or opinions about it (affective), which in turn may drive us to take specific actions (behavioral). However, other researchers argue that the three components should be treated as more independent entities, suggesting that attitudes should be seen as the foundation for evaluative judgments (Ajzen, 2001; Crano & Prislin, 2006). According to Kind et al. (2007), when we possess an attitude, we assess something based on emotional dimensions, such as its goodness or badness, its potential harm or benefit, its pleasantness or unpleasantness, and its importance or lack thereof. Crano and Prislin (2006) emphasize the significance of recognizing that these evaluative judgments are always directed towards something, often referred to as the attitude object. While some researchers have defined attitudes solely in terms of the affective component (George, 2000; Germann, 1988), Fishbein and Ajzen (1975) perceive attitudes as spontaneously formed and inevitably involving the attributes of an object. Consequently, attitudes, or the affective component of attitudes, are inherently linked to the beliefs held by an individual (Kind et al., 2007). It is with this understanding that the definition of attitude, employed in my study, pertains to the emotions a person harbors towards an object, based on their beliefs about said object.

Upon entering school, children's approach to learning is greatly influenced by their upbringing (Lumsden, 1994). Nevertheless, their performance in the classroom can either reinforce or alter these initial attitudes, influenced by their early educational encounters that also affect future classroom dynamics (Lumsden, 1994; Reynolds & Walberg, 1992).1. Furthermore, the way students perceive things can be influenced by their relationships with classmates (Fishbein & Ajzen, 1975; Reynolds & Walberg, 1992; Taylor, 1992). Positive and negative encounters

during school events can shape learned behaviors that might later affect students' attitudes as they mature (Dossey, Mullis, Lindquist & Chambers, 1988).

The perceptions that students have towards mathematics play a significant role in determining the level of achievement in learning (Reed et al., 2010). As part of my research, I investigated the impact of incorporating Jeopardy!-type games on enhancing students' attitudes towards mathematics, specifically focusing on their enjoyment of math classes.

Students' Academic Efficacy

Bandura (1977) proposed over three decades ago that students' beliefs about their capabilities have a significant impact on their behavior. According to social cognitive theory, students are more motivated to learn when they believe they can achieve their desired outcomes (Bandura, 1986). Therefore, academic efficacy beliefs serve as strong predictors of students' choices, effort, and persistence in the face of challenges. Additionally, in expectancy-value theory, students' expectation beliefs directly influence their choices and performance in relation to achievement (Eccles & Wigfield, 2002). Moreover, Pajares (2002) suggests that academic efficacy is closely linked to students' self-regulated learning. Students with high academic efficacy are more likely to invest greater effort, consistently assess their progress, and employ self-regulatory strategies (Schunk & Pajares, 2005).

In a study conducted by Velayutham and Aldridge (2012), the impact of motivational factors on students' effort regulation in science classrooms was investigated. The study involved 1360 science students in grades 8, 9, and 10 from Perth, Australia. The researchers focused on three motivational constructs: learning goal orientation, science task value, and academic efficacy. The findings of the study indicated that these motivational beliefs had a significant influence on students' self-regulation in science learning and problem solving skills.

Numerous studies have shown that academic efficacy plays a crucial role in predicting academic success and has a significant impact on academic motivation and learning. Research has indicated that self-efficacy beliefs are strong predictors of students' performance in mathematics. In fact, some researchers have even found that the influence of academic efficacy on mathematics performance is comparable to that of general mental ability.

The correlation between academic efficacy and the classroom environment has been established through various studies. Dorman (2001) conducted research that demonstrated a positive relationship between the mathematics classroom environment and student academic efficacy. Another study conducted by Dorman and Fraser (2009) found significant connections between classroom environment, perceptions of assessment tasks, academic efficacy, and attitude towards science. Velayutham and Aldridge (2012) conducted a more recent study that identified specific aspects of the psychosocial learning environment that impact student motivation, including academic efficacy. Through structural equation modeling analysis, it was determined that the Student Cohesiveness, Task Orientation, and Investigation scales were the most influential predictors of student academic efficacy.

CHAPTER 3
METHODOLOGY

This chapter describes the methods and procedures that were to carry out the research under the following sub-headings:

- Design of the Study
- Population of the Study
- Sample and Sampling Techniques
- Research Instrument
- Validity of the Instrument
- Reliability of the Instrument
- Method of Data Collection
- Method of Data Analysis

Design of the Study

The study employed a survey research design which investigated the effectiveness of the impact of mathematics games to enhance problem solving skills with a focus on trigonometry in selected secondary schools in Benin City, Edo State, Nigeria. This design enabled the researcher to collect the respondents' opinion and perception regarding the application of mathematics games in teaching and learning mathematics in Secondary School.

Population of the Study

The population for this study comprised of six [6] public secondary schools students in Benin City, Edo state.

Sample and Sampling Procedure

A sample size for the correspondents comprises one hundred [100] students, twenty-five [25] each from the four [4] sampled public senior secondary schools each from the sampled public senior secondary schools in the study area using random sampling technique

Research instrument

The research instrument used for collection of data for this study was a questionnaire. The questionnaire titled "Investigation of the effectiveness of mathematics games to enhance students' problem solving skills with a focus on trigonometry in Benin City, Edo state. [IOTEMGTESPSSWAFOTBCE]" was divided into seven [7] sections [A, B, C, D, E, F, and G];

Section A dealt with the demographic data information of the students, Section B dealt with the mathematical background of the students in secondary school, Section C dealt with the level of mathematics games usage in secondary schools, Section D dealt with trigonometry and problem-solving, Section E dealt with the effectiveness of mathematics games for mathematics teaching/learning, Section F dealt with the preference and engagement of mathematics games of the students, Section G dealt with overall impressions.

Validity of the Instrument

The instrument for this study was a questionnaire. The validity of the questionnaire was checked by my project supervisor and two experts in the same field who went through it and made corrections and modifications.

Reliability of the Instrument

The reliability of the instrument was established through test and retest method. The instrument was administered to ten [10] students and [2] mathematics teachers

outside those used for the study. The data collected were analyzed using the Pearson's Product Moment Correlation Coefficient. The result obtained was 0.77 which proved that the instrument was reliable

Method of Data Collection

The questionnaire was used to collect data. It administered to the respondents and collected immediately.

Method of Data Analysis

The data collections were grouped together, analyzed and collated using percentages. The computation of simple percentage will be done using formula below;

$$\frac{Number of Response}{Total Number of Respondents} \times \frac{100}{1}$$

CHAPTER FOUR

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

This chapter examines the data collected via questionnaires, presenting it in tables with numbered titles and corresponding interpretations that align with the research questions. The analysis is structured according to the sequence of the research questions, ensuring a clear and coherent presentation.

Research Question (1)*:* Does the use of games-based learning approach on students influences their intuitive thinking and ultimately problem solving skills in mathematics?

Table 1: Descriptive Analysis on Influence of Game-Based Learning on Students' Intuitive Thinking in Mathematics

	N	Mean($\bar{}$)	Standard Deviation	Decision
Game-based learning helps me develop a better intuitive understanding of mathematical concepts?	100	3.13	2.01	Agreed
Using games in math class improves and ability to think logically and solve problems intuitively?	100	2.71	1.00	Agreed
Find that games makes it easier to grasp abstract mathematical ideas intuitively	100	3.24	2.12	Agreed

Games encourage me to rely more on intuition rather than memorization in mathematics	100	3.41	2.13	Agreed
My intuitive thinking in mathematics has improved since we started using games in class	100	2.77	1.01	Agreed
Grand Mean		**3.05**		

Benchmark: 2.50

The results from Table 4, which analyzes the influence of game-based learning on students' intuitive thinking and problem solving skills in mathematics, indicate a general consensus of agreement among the students. The mean scores for all five statements exceed the criterion mean of 2.50, confirming that students agree with the positive impact of game-based learning on their mathematical intuition. The statement "game-based learning helps me develop a better intuitive understanding of mathematical concepts" recorded a mean of 3.13, suggesting that students feel games help enhance their understanding of math intuitively. Similarly, the statement "Using games in math class improves my ability to think logically and solve problems intuitively" had a mean score of 2.71, reflecting agreement on games fostering logical and intuitive thinking.

Students also agreed that games make it easier to grasp abstract mathematical ideas intuitively (mean = 3.24) and encourage them to rely more on intuition than memorization (mean = 3.41). Additionally, the statement "My intuitive thinking and problem solving skills in mathematics has improved since we started using games in class" recorded a mean of 2.77, signalling that students feel their intuitive

thinking and problem solving skills in math has improved with game-based learning. With a grand mean of 3.05, these findings suggest that game-based learning has a strong and positive influence on students' intuitive thinking and problem solving skills in mathematics, encouraging a deeper, more logical, and intuitive approach to solving mathematical problems.

Research Question (2)*:* Does the use of game-based learning approach influences students' performance in mathematics?

Table 2: Descriptive Analysis on Influence of Game-Based Learning on Students Performance in Trigonometry

	N	Mean($\bar{}$)	Standard Deviation	Decision
Game-based learning has improved my overall performance in mathematics	100	2.53	1.11	Agreed
I perform better on Trigonometry tests after practicing with games	100	3.63	2.21	Agreed
Games have helped me understand and retain trigonometrical concepts more effectively.	100	3.40	2.30	Agreed
Using games in math class has increased my confidence in solving	100	2.93	1.85	Agreed

trigonometrical problems				
I notice an improvement in my math grades since we started using games in our lessons.	100	2.47	1.58	Disagreed
Grand Mean		**2.99**		

Benchmark: 2.50

The results from Table 5, which explores the influence of game-based learning on students' performance in mathematics, show a generally positive perception of games' impact, although with some variation. The mean scores for four of the five statements exceed the criterion mean of 2.50, indicating agreement with the positive effects of game-based learning. Specifically, students agreed that game-based learning has improved their overall performance in mathematics (mean = 2.53), that they perform better on math tests after practicing with games (mean = 3.63), and that games have helped them understand and retain mathematical concepts more effectively (mean = 3.40). Additionally, students agreed that using games in math class has increased their confidence in solving math problems (mean = 2.93).

However, the statement "I notice an improvement in my math grades since we started using games in our lessons" had a mean score of 2.47, which is below the criterion mean of 2.50, indicating disagreement. This suggests that while students feel more confident and perform better in some aspects of mathematics, they do not perceive a significant improvement in their actual grades as a result of game-based learning.

With a grand mean of 2.99, the findings suggest that game-based learning is generally perceived as beneficial in improving students' mathematical performance,

boosting their confidence, and enhancing their understanding and retention of concepts, though its effect on grades is less clear.

Research Question (3)*:* What are the challenges faced by teachers in using game based learning approach in class?

Table 3: Descriptive Analysis on Challenges Faced by Teachers in Using Game Based Learning Approach in Class

	N	Mean($\bar{}$)	Standard Deviation	Decision
It is challenging to find games that align with the math curriculum.	100	3.23	2.12	Agreed
Students often struggle to understand the connection between games and the math topics being taught	100	2.42	1.01	Agreed
Using games in class takes up too much instructional time.	100	2.48	1.64	Agreed
Some students find games too difficult, which hinders their learning process.	100	3.02	2.01	Agreed
Integrating games into lessons requires significant extra preparation and resources.	100	3.14	2.05	Agreed
Grand Mean		**2.86**		

Benchmark: 2.50

The results presented in Table 6 shed light on the challenges teachers encounter when implementing game-based learning in mathematics classes. The analysis indicates that teachers generally agree with most of the highlighted challenges, as reflected in the mean scores for the statements. Specifically, the greatest challenge reported is the difficulty in finding games that align with the math curriculum (mean = 3.23). Teachers also agree that integrating games into lessons requires significant extra preparation and resources (mean = 3.14), and some students find games too difficult, which hinders their learning process (mean = 3.02).

However, there is less agreement on two particular issues. While teachers note that games can take up too much instructional time (mean = 2.48) and that students may struggle to see the connection between games and math topics (mean = 2.42), these challenges are less strongly perceived compared to others.

With a grand mean of 2.86, the findings highlight a range of challenges in applying game-based learning, from resource alignment and student comprehension to preparation and time management. Addressing these obstacles through targeted teacher training, resource development, and curricular integration could help maximize the effectiveness of game-based learning in enhancing student outcomes.

Discussion of Findings

The findings of this study indicate that game-based learning has a strong and positive influence on students' intuitive thinking and problem solving skills in mathematics. By engaging students in problem-solving activities that require logical reasoning, games encourage a deeper and more intuitive approach to mathematical concepts. This aligns with research by Jonassen (2011), who

emphasized that problem-solving strategies enhance cognitive flexibility and critical thinking skills. Additionally, studies by Mayer (2020) support the idea that interactive learning, including game-based approaches, fosters a more profound conceptual understanding by encouraging active engagement with mathematical ideas. Recent research by Hung, Kinshuk, and Chen (2020) further highlights that game-based and puzzle-based learning improve students' motivation and engagement in mathematics, leading to better conceptual mastery.

Furthermore, the results suggest that game-based learning is generally perceived as beneficial in improving students' mathematical performance, boosting their confidence, and enhancing their understanding and retention of concepts. According to Bransford and Brown (2022), students who engage in problem-solving activities tend to develop a deeper comprehension of content, leading to improved retention and application of knowledge. Recent studies by Carbonneau, Marley, and Selig (2021) suggest that game based learning enhances students' intrinsic motivation, which directly impacts their ability to grasp complex mathematical concepts. However, while students recognize its value in learning, its direct impact on grades remains less clear. This aligns with findings from Rittle-Johnson and Star (2007), who argue that while conceptual understanding improves, translating it into measurable academic performance may require additional instructional support.

The study also highlights several challenges associated with implementing puzzle-based learning, including issues related to resource availability, student comprehension, preparation, and time management. For instance, teachers may require additional training to effectively integrate game into the curriculum, as emphasized by Darling-Hammond (2006), who noted that professional development is critical for the successful implementation of innovative teaching

strategies. Additionally, research by Karpicke and Blunt (2011) suggests that while interactive learning methods are effective, they must be well-structured and adequately supported to maximize learning outcomes. Recent research by Zheng, Li, and Zhang (2023) also points out that digital game-based learning tools, when properly aligned with curriculum standards, can mitigate implementation challenges and improve overall effectiveness.

Addressing these obstacles through targeted teacher training, resource development, and curricular integration could enhance the effectiveness of this approach. Studies by Wenglinsky (2002) emphasize that well-supported teaching methods, including the integration of puzzles, can significantly impact student engagement and learning outcomes. Recent meta-analyses by Van der Kleij, Feskens, and Eggen (2019) further reinforce that formative feedback mechanisms embedded within game-based learning can enhance students' self-regulated learning abilities. Overall, these findings support the integration of game-based learning into mathematics education as a means of improving students' intuitive reasoning and problem solving skills and fostering a more engaging and effective learning experience.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATION

SUMMARY

In summary, the findings of this study demonstrate that game-based learning significantly and positively impacts secondary school students' problem solving skills and overall performance in trigonometry within Oredo Local Government. Students engaged in this approach exhibited deeper comprehension of mathematical concepts, enhanced logical reasoning, and improved problem-solving abilities. The correlation analysis underscores these outcomes, revealing a strong positive relationship between game-based learning and intuitive mathematical thinking, with statistically significant results.

In addition to fostering intuition, games-based learning was shown to improve students' mathematical performance, particularly in understanding, retention, and confidence in addressing complex problems. However, while qualitative improvements in learning outcomes were evident, the direct effect on measurable grades was less pronounced. This observation aligns with prior research, such as the work of Akinsola and Popoola (2023), which emphasizes the long-term cognitive benefits of games-based strategies over immediate academic achievements.

Despite these advantages, challenges persist in implementing this teaching method. Teachers reported difficulties in aligning games with the mathematics curriculum,

ensuring students' comprehension, and managing the additional preparation and time required. Constraints in resources and time further complicated the integration of games into standard classroom practices. Zhang et al. (2022) similarly noted the need for teacher training and curriculum-compatible resources to address these obstacles.

To fully realize the potential of game-based learning, targeted strategies are essential. Investments in teacher training, the development of adaptable, curriculum-aligned games, and the integration of this approach into broader teaching frameworks can enhance its efficacy. By addressing these challenges, games-based learning can be better positioned to improve students' mathematical abilities, preparing them with essential skills for academic and professional success.

CONCLUSION

In conclusion, this study highlights the significant and positive impact of game-based learning on secondary school students' intuitive thinking and overall performance in mathematics in Oredo Local Government. The findings reveal that students who engaged with game-based strategies demonstrated a deeper understanding of mathematical concepts, enhanced logical reasoning, and improved problem-solving skills. The strong positive correlation between puzzle-based learning and intuitive mathematical thinking, as well as its statistically significant relationship, underscores the effectiveness of this approach in fostering critical cognitive skills.

Additionally, game-based learning was shown to enhance students' overall mathematical performance by improving their confidence, understanding, and retention of concepts. However, the study also noted that while qualitative

improvements were evident, the direct impact on measurable grades was less pronounced, aligning with research emphasizing the long-term cognitive benefits of such learning methods over immediate academic outcomes.

The study identified several challenges in implementing game-based learning, including difficulties with curriculum alignment, resource limitations, and the additional preparation time required for effective integration. Addressing these issues through teacher training, development of adaptable and curriculum-aligned games, and incorporation into broader teaching frameworks is essential for maximizing the benefits of this approach.

Ultimately, game-based learning presents a promising strategy for enhancing mathematical understanding and cognitive abilities, equipping students with essential problem-solving skills critical for their academic and professional success. By addressing the identified challenges, educators can more effectively leverage this innovative teaching approach to foster long-term educational growth.

RECOMMENDATION

Based on the findings of this study, the following recommendations are made to optimize the implementation of game-based learning for improving secondary school students' problem solving skills, thinking and performance in trigonometry and ultimately mathematics:

Curriculum Alignment

Develop and incorporate games that are directly aligned with the mathematics curriculum to ensure relevance and applicability. This can be achieved through

collaborative efforts among educators, curriculum designers, and education policymakers.

Teacher Training and Professional Development

Organize workshops and training programs to equip teachers with the skills and strategies needed to effectively integrate game-based learning into their teaching. These programs should focus on selecting, designing, and implementing games that complement the curriculum and address diverse student needs.

Resource Provision

Provide schools with adequate resources, including a library of ready-to-use games, instructional guides, and digital tools, to support the seamless integration of game-based learning into classroom activities.

Student Support

Introduce strategies to help students understand the connection between games and mathematical concepts. This may include guided practice sessions and collaborative problem-solving activities to enhance comprehension and engagement.

Time Management Strategies

Encourage the use of efficient lesson plans that balance game-based activities with other instructional methods to ensure adequate coverage of the curriculum while maintaining the benefits of games.

Research and Development

Conduct further studies to refine game-based learning strategies, focusing on long-term impacts on academic performance and identifying best practices for implementation.

Monitoring and Feedback

Establish mechanisms for regular feedback from students and teachers on the effectiveness of game-based learning. This will help in making necessary adjustments and improving its implementation over time.

Integration into Teaching Frameworks

Advocate for the integration of puzzle-based learning into broader teaching frameworks to foster a consistent approach across schools. Educational authorities should include game-based methodologies in teacher education programs and instructional guidelines. By addressing these areas, puzzle-based learning can be more effectively harnessed to enhance students' mathematical understanding, foster critical thinking skills, and improve overall academic outcomes.

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APPENDIX I

UNIVERSITY OF BENIN,
FACULTY OF EDUCATION BENIN,
BENIN CITY.

DEPARTMENT OF CURRICULUM AND INSTRUCTIONAL TECHNOLOGY,

THE SCHOOL ENVIRONMENT AND ACADEMIC PERFORMANCE

Dear respondents.

This questionnaire is for the purpose of research. Kindly help as much as possible to supply the needed information. Any information provided will be treated with utmost confidentiality.

SECTION A (Demographic).

There are 3 questions in this section. Please fill the blanks with the appropriate responses

Age of respondents: 12-15yrs ( ), 15-16yrs ( ), 16 yrs above ( ).

Gender of respondents: Male ( ), Female ( ).

Grade level: Ss1 ( ), Ss2( ), Ss3 ( ),

SECTION B

Please indicate your level of agreement with the following statements by ticking the option that best suit your response

The option initials are Strongly Agree (SA), Agree (A). Disagree (D), Strongly Disagree (SD)

S/N	Influence of Game-Based Learning on Students' Intuitive Thinking in Mathematics	SA	A	D	SD
1	Game-based learning helps me develop a better intuitive understanding of mathematical concepts?				
2	Using games in math class improves my ability to think logically and solve problems intuitively?				
3	find that games make it easier to grasp abstract mathematical ideas intuitively				
4	Games encourage me to rely more on intuition rather than memorization in mathematics				
5	My intuitive thinking in mathematics has improved since we started using games in class				
	Influence of Game-Based Learning on Students Performance in Trigonometry				
6	Game-based learning has improved my overall performance in trigonometry				
7	I perform better on math tests after practicing with games				
8	Games have helped me understand and retain trigonometrical concepts more effectively.				
9	Using games in math class has increased my confidence in solving trigonometrical problems				
10	I notice an improvement in my math grades since we started using games in our lessons.				

	Challenges Faced by Teachers in Using Game-Based Learning Approach in Class				
11	It is challenging to find games that align with the math curriculum.				
12	Students often struggle to understand the connection between games and the math topics being taught				
13	Using games in class takes up too much instructional time.				
14	Some students find games too difficult, which hinders their learning process.				
15	Integrating games into lessons requires significant extra preparation and resources.				

APPENDIX II

RELIABILITY TEST RESULT

Case Processing Summary

		N	%
Cases	Valid	100	100.0
	Excluded[a]	0	.0
	Total	100	100.0

a. List deletion based on all variables in the procedure.

Reliability Statistics

Pearson's Product Moment Correlation Coefficient	N of Items
.77	15