**EFFECTS OF GAME BASED LEARNING ON JUNIOR SECONDARY SCHOOL STUDENT’S ACHIEVEMENT IN MATHEMATICS IN ENUGU EAST LGA ENUGU STATE**

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**UGWUOMU – NIKE, ENUGU STATE**

**JULY, 2018**

**TITLE PAGE**

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**A RESEARCH WORK SUBMITTED TO THE DEPARTMENT OF SCIENCE AND VOCATIONAL EDUCATION, FACULTY OF EDUCATION, GODFREY OKOYE UNIVERSITY IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR AWARD OF B.Sc (MATHEMATICS EDUCATION)**

**SUPERVISOR’S NAME;MR. E. OZOMADU**

**CERTIFICATION**

Johnson Amarachi Rebecca a student in the Department of Science and Vocational Education (Mathematics Education) Faculty of Education with Registration Number U16∕EDU∕MAT∕007 has satisfactorily completed the requirement for Award of Degree in B.Sc.(Mathematics Education). This project is original and has not to the best of my knowledge been submitted or presented elsewhere.

……………………………….. …………………..

**Johnson Amarachi Rebecca Date**

**APPROVAL**

This is to certify that this research work "Effects of game based learning on junior secondary school student’s achievement in mathematics in Enugu East Local Government Area” by Johnson Amarachi Rebecca in the Department of Science and Vocational Education has been examined and approved as meeting the requirements for the award of Bachelor of Science B.Sc (mathematics Education) degree in Education (Mathematics Education), Faculty of Education, Godfrey Okoye University, Enugu State.

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**(External Examiner) Date**

**DEDICATION**

This research work is unconditionally dedicated to God Almighty in whose grace and favour I was able to write this project.

**ACKNOWLEDGMENT**

A special thanks and gratitude goes to the Almighty God for his kindness, faithfulness and love upon me for his immense blessing, graces and protection upon the cause of my studies. My deep appreciation goes to someone I call daddy in the person of Rev.Fr. Prof. Christian Anieke who saw me through this citadel of learning may God reward you for everything. I will not forget my role model and daddy number two in the person of Mr. Eric Mbaeze for his love and support through my studies may God reward you. My appreciation goes also to my supervisor Mr Ozomadu for his contributions and sense of direction throughout the period of this work. It is necessary to acknowledge the Head of Department, science and vocational Education, Professor Agwagah and my lecturers; professor Ochor, Dr. Ugwunnadi, Dr. Abibaku, Mr. Benson, Mr. Anieche, Dr. Anabanti, Rev. Father Wobodo, and Mr. and Mrs. Ezeugorie for their immense contribution in my academic endeavors, may God bless you all.

It is highly necessary to acknowledge my source into this world my parents Mr and Mrs. Johnson Abia and siblings; I am highly indebted to my ambitious family, because without their mutual understanding, this brain would not have come into existence.

To my friends and course mates; Egah Deborah, Nnadika Peace, Ezievuo Chiwendu, Nzekwe Ujunwa, Lemchi Chiamaka and Chukwu Augustine, I say thank you all for everything.

At this juncture, I must not fail to relay my unalloyed thanks to the students of the Faculty of Education.

**Abstract**

The topic of the study is ‘Effects of game based learning on junior secondary school student’s achievement in mathematics in Enugu east local government area of Enugu state. The purpose of the study was to determine the effects of game based learning on junior secondary school student’s achievement in mathematics. The work was a pre-test post-test control group quasi experimental research design. The researcher formulated two research questions and two hypotheses that guided the study. The researcher used mathematics achievement test as an instrument for data collection. The reliability of the instrument was 0.79 using Richard Kuderson formula 20 and the instrument was validated by three research experts. The population of the study was 950 and a sample size of 280 was obtained using the Taro Yamane’s simplified formula in the four selected Government secondary schools in Enugu East local Government Area of Enugu state. The Data collected was analyzed using mean, standard deviation for the research questions and t-test for the hypotheses analysis. The study revealed that game based learning is an interactive form of learning that gives learners the opportunity to work in group competitively and at the same time learn mathematics in a fun filled way. Results also show that male students perform better than their female counterparts when exposed to game based learning approach. The following recommendation was made, teachers should be trained on ways of using game based learning approach in the classroom and Educational planners should implement it in the school curriculum among others.

**TABLE OF CONTENTS**

Cover page\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ i

Title page\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ii

Certification\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ iii

Approval\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ iv

Dedication\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_v

Aknowledgement\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ vi

Abstract\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ vii

Table of content\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_viii-ix

**Chapter one: Introduction**

Background of the study\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 1-4

Statement of the problem\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 4-5

Purpose of the study\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 5

Scope of the study\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 5

Significance of the study\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 5

Research questions\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 6

Research hypothesis\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 6

**Chapter Two: Review of related literature**

Conceptual framework\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 7-20

Theoretical framework\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 20-26

Empirical framework\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 26-30

Summary of literature review\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 30

**Chapter Three: Research Methods**

Design of the study\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 31

Area of the study\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_31

Population of study\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 31

Sample and sampling techniques\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 32

Instrument for data collection\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 33

Reliability of the instrument\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 33

validity of the instrument\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 34

Methods of data collection\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 34

Methods of data analysis\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 34

**Chapter Four: Data Analysis and Presentation**

Results\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_35-38

**Chapter Five: Discussion, Implication, Recommendation and Summary of Findings**

Discussion of findings\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 39-40

Summary \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 40

Implication of the study\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 40

Recommendations\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 40-41

Limitations of the study\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 41

Suggestions for further study\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 41

References\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 42-50

Appendixes\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ 51-60

**CHAPTER ONE**

**INTRODUCTION**

**Background to the study**

Since the inception of formal education in Nigeria, mathematics, in one form or the other has been placed as a core course in the school curriculum right from nursery level up to secondary level of the education system. This is in recognition of its immense contribution to individual’s capacity building and nation’s advancement in science and technology and over all development. The actualization of the vision 20:2020 hinges on qualitative and functional mathematics education (Gbolagade and Sangoniyi, 2013). These researchers averred the above in a bid to establish the importance of mathematics to the Nigerian students.

The value of mathematics to any developing country is not debatable and this is why the supremacy of mathematics over every other subject is extolled by the national policy on Education (FRN, 2004), when it stated that mathematics should be made a core subject at the primary and secondary school levels as earlier mentioned. There is hardly any area of human endeavor devoid of mathematics and its application. Among the present day application of mathematics are the building of models to eliminate or bound recessions and inflations, selecting portfolio of stocks, plan industrial capabilities, plan transportation networks, study the nature of competition and the effects of business rivalry, investigate economic growth, population growth and formulate models( Lassa, 2012). Kekere (2008) noted that mathematics is the foundation of any meaningful scientific endeavor and any nation that needs development in science and technology should have a strong mathematics for its youths.

Mathematics remains a service provider for all disciplines and its contributes immensely in deciding directions of activities such as economy, banking, market transactions, industrial functions, research, leadership, legal jurisprudence, engineering and others too many to mention ( Salman,2005; Odili, 2006; Umar and Aliyu, 2006, Ugwuanyi and Agwagah, 2014). The development of any nation is dependent on its improved mathematics education which establishes bases for technological advancement. Thus, science is the bedrock that provides the spring board for the growth of technology and mathematics is the gate to the science (Aguele and Usman, 2007). The petinent virtue of mathematics in contributing to the development of mankind calls for its improved teaching and learning.

Despite its robustness and utilitarian value, mathematics remains one subject in the school curriculum where majority of learners have shown negative interest and attitude and achieved poorly in internal and external Examinations (Ezeugo and Agwagah, 2000; Unonyang, 2009; Iweka, Onwuka and Moseri, 2010; WAEC, 2010-2016). The falling standards in mathematics education have become so discussed and researched in recent times (Adetula, 2005;Adeyanji, 2009); indeed the performance in mathematics has become so deplorable all over the country that there is a consensus of opinion about the poor state of secondary school students’ achievement in mathematics (Adebule, 2004; Adesemowo, 2005; Asikhia, 2012). The situation has degenerated to a level that calls for a close look at all the critical factors in teaching and learning of mathematics. Improving student attitudes is not an insignificantly frivolous achievement because negative attitudes about mathematics if not changed in schools, may reverberate to the next generation of students as some of the students who in our classes struggle with or even hate mathematics will soon be in the classroom teaching other school students mathematics and passing along the same attitudes. It is imperative, therefore, that these attitudes be changed now. Among such factors are improved instructional techniques such as the use of game based learning as against the conventional method which is widely used in schools today. Game based learning is a relatively young concept if compared to the traditional learning procedure and with the interesting novelty of engaging interactivity (Breuer & Bente, 2009).

Over the years, researchers have been mandated with the task of unveiling many of such improved techniques aimed at proffering solution to the problem of poor achievement in mathematics. Even though the problem still persists, there seems to be growing evidence( Galadima and Okogbenin, 2012; Ukpebor and Omole, 2012) that the use of games in instruction can produce better achievement and generate more favorable attitude in mathematics than the use of conventional method.

Besides being an emerging research Game-based learning (GBL) has also been widely discussed in the educational sector in the 21st century. There are several studies indicating that game based learning is not only a motivating educational idea, but also a didactic concept that if carefully implemented could be an alternative with better outcomes than with conventional methods (Malone & Lepper 1987; Gee 2003; Prensky 2001). Since achievement is a means of finding out how learners perform in various subjects, the researcher decided to use game based learning to find out if it will improve student’s performance in mathematics

There are many methods that are familiar; game based learning is one of such methods. Agwagah (2011) defines a game as “a situation in which two or more participants confront one another in pursuit of certain objectives. From this definition one may look at game as an activity involving two or more persons operating under some rules with the objective of winning or payoff. So a game must produce a winner and a loser. They stimulate mathematical thinking and also generate excitement and spirit of competition. It deals with the use of games in teaching and learning environment. It uses competitive exercises, either putting the students against each other or getting them to challenge themselves in other to motivate them to learn better.

Today, we are confronted with the reality of the dearth of games in our schools (Agwagah, 2011) in addition to the fact that teachers have deficiency in the construction and use of games. The issue of updating teachers in the construction and use of game based learning of mathematics and their popularization in schools present a huge challenge to mathematics teachers. Plato (Gutek, 2005) maintained that knowledge occurs only in the mind of the person seeking it, and it is the teacher who should create the right environment for such learning. Since there is dearth of mathematical games in schools, in addition to the challenge posed to the teachers in the construction and use of games, one way of tackling this challenge is to start from the basics of identifying some mathematics concepts in some readily available games and how these concepts can be taught using such games. This attempt will open the eyes of the mathematics teachers to the reality of mathematics in games just as in other endeavors of humanity.

However, since mathematics is practical in nature, it is pertinent to device games which will give a positive result to the study. It is against the backdrop that the researcher intends to investigate the effect of game based learning on junior secondary school students’ achievement in mathematics. The study may assist in improving the students’ achievement in mathematics which could enhance their abilities to improve their leadership qualities and service to humanity.

**Statement of the problem**

Mathematics is the science of patterns and layouts. It is also a universal language written with symbols and shapes that involves information processing( editing, analyzing, interpreting and sharing), producing, predicting and solving problem (MEB 2009) but the rate at which students fail mathematics is alarming and has been a bone of contention in the Nigerian Educational system. Some of the reasons for this failure may be lack of interest from the students, unqualified and non-dedicated teachers in the subject, phobia of the subject by students and constant changing of mathematics teachers in schools. As a result the researcher deemed it fit to conduct this study titled ‘Effects of game based learning on junior secondary school student’s achievement in mathematics. Since games are fun filled and enjoyable, the researcher picks some games to study and they include geoboard game and ludo or dice game among others. Will these games bring a turnaround in the achievement of students in mathematics?

**Purpose of the study**

The purpose of the study is to find out the effects of game based learning on junior secondary school students’ achievement in mathematics in Enugu East Local Government Area of Enugu state.

Specifically, the study intends:

1. To determine the effects of game based learning on junior secondary school students’ achievement in mathematics.
2. To find if there will be difference in male and female student’s achievement in mathematics when using game based learning.

**Scope of the study**

This study is restricted to public secondary schools in Enugu East Local Government Area of Enugu state. The study also limited its scope to the effects of game based learning on junior secondary school students’ achievement in mathematics.

**Significance of the study**

This study will be of great value to the researcher as it serves as an achievement and reference material.

It will give the government new ideas on things to include in the mathematics curriculum during curriculum innovation.

It will expose the students to better and more interesting ways of learning mathematics which will lead to development of interest in the subject.

It will enable the teachers to discover a new and improved teaching technique in mathematics which is game based learning.

The researcher is of the view that this study will enable school authorities to make resources needed for the use of games in teaching mathematics available for better learning of the subject.

**Research questions**

The following research questions were formulated to guide the study in order to achieve its objectives

1. What is the difference in the mean achievement score of students taught mathematics with game based learning approach and those taught with conventional methods?

2. What is the difference in the mean achievement score of male and female students taught mathematics with game based learning approach?

**Research Hypothesis**

The following hypothesis at 0.05 level of significance guided the study

1. There is no significant difference between the mean achievement scores of students taught mathematics with game based learning approach and those taught with conventional methods.
2. There is no significant difference between the mean achievement score of male and female students taught mathematics with game based learning approach.

**CHAPTER TWO**

**REVIEW OF RELATED LITERATURE**

This chapter will be divided into the following headings:

1. Conceptual framework

2. Theoretical framework

3. Empirical study

4. Summary of literature review

**Conceptual framework**

**The concept of Game based learning**

Aristotle (Gutek, 2005) stated that education was to enable humans to live socially, politically, and economically in the world. All people according to Aristotle have the power to reason and knowledge comes from one’s senses carrying information to the brain. The purpose of education is to cultivate human excellence by developing rationality and forming human character which game based learning can do.

Game Based Learning is an interactive activity that has as its foundation and tenet that games, by their very nature, increase learning through positive emotional experience. Games do not merely entertain; rather, they can deepen connections and allow for greater learning.According to Shaffer, Halverson, Squire and Gee (2005) game based learning is a type of play that has defined learning outcomes. Generally, game based learning is designed to balance subject matter with game play and ability of the players to retain and apply said subject matter to the real world. It describes an approach of teaching where students explore relevant aspects of game in a learning context designed by teachers. Teachers and students collaborate in order to add depth and perspective to the experience of playing game. Good game based learning applications can draw us into virtual environment, we work towards a goal, choosing actions and experiencing the consequences of those actions along the way. We make mistakes in a risk free setting and through experimentation we actively learn and practice the right to do things. This keeps us highly engaged in practicing behavior and thought processes that we can easily transfer from the stimulation of environment to real life.

Game based learning can also be defined as lessons which are competitive, interactive and allow the learner to have fun while gaining knowledge. The best game based learning procedure has three main elements namely:

1. Competition- the competitive elements help to provide motivation in conventional learning methods.
2. Engagement- playing games is engaging and it springs out curiosity and imagination in the learners. They also learn a lot within a short period of time.
3. Immediate feedbacks and rewards- this is vital to keep the learners interested and coming back for more as well as helping the learning process. These rewards might be as simple as letting them know they are correct, giving them points or even descriptive feedback expanding their knowledge.

Game based learning offer many advantages when done properly as it allows students to interact with multiple learning scenarios that are tailored to meet the pace at which they learn. Scoring on these games can be standardized to allow comparisons between students and feedback can be instantaneous.

According to Trybus (2009), game based learning has many positive aspects. It is cost effective, has low physical risk or liability to the learner, has standardized assessments for student-to-student comparisons, is highly engaging, has a learning pace tailored to the individual needs of the students, affords immediate feedback responses for students’ mistakes and can easily transfer learning to a real-world environment. With game based learning, our teaching and learning of mathematics structure may improve for good.

Game based learning can offer students the opportunity to enhance their current knowledge when teachers provide the right learning environment relevant to the curriculum being learned. It provides students with opportunities to reason through the use of their senses (touching, seeing, and hearing) as well as opportunities to develop rational thought and character through interactions with others, even in a virtual setting.

In the application of game based learning in the classroom, the teachers or educators should consider the following factors:

1. Which game best integrates into the existing curriculum, Harris (2006).
2. Which game meets the objectives of the topics being taught, MacKenty (2006).

Depending on the type of game that is played, there are clear benefits to supplementing games as active learning components in the classroom. According to Franklin, Peat and Lewis (2003), when students work cooperatively on a game activity, it fosters group cooperation and typically creates a high level of student involvement that makes them useful tools for effective teaching and learning. Research suggests that use of game based learning is an effective means of improving students’ attitudes towards mathematics. Although much of the research on the effects of game based learning of mathematics is inconclusive at this point as observed by Fletcher and Tobias (2006), there is strong evidence that appropriately designed educational games do have the potential to enhance student’s learning of mathematics (Klawe, 1998; Bragg, 2007). Through the introduction of challenging tasks that are meaningful for students and facilitate their interest in exploration, educational games can help focus mathematics instruction on conceptual understanding and problem-solving and not on recipes and formal derivations, which become secondary in importance. Through game based learning, students can build valuable skills such as strategic thinking, planning, communication, the application of numbers, negotiating skills, group decision-making and data-handling, Kirriemuir and McFarlane, (2004).

There are different types of game based learning of mathematics such as:

**Computer games or digital game based learning:**

This is the use of digital games to spark competition, engage learners, and challenge and motivate learners (Teed, 2012). Prensky (2001) defined six key structural elements of digital games necessary for learning engagement: (a) rules; (b) goals and objectives; (c) outcomes and feedback; (d) conflict, competition, challenge, or opposition; (e) interaction; and (f) a storyline.

According to Bloom (2009), ‘The underlying principles of video game design parallel the learning process’ Game design must meet the needs of the learner by being relevant to the learner, understanding the educational needs of the learner, appealing to various types of learners, being user-friendly, and being easily played (Moschini, 2006). Teed (2012) stated that a continuous challenge, an interesting storyline, flexibility, immediacy, useful rewards, and the combination of fun and being realistic define a good game.

Today’s students may be disconnected from school but technologically connected to social media such as Facebook and Twitter (Prensky, 2001). Subsequently, today’s technology offers students opportunities in an abundance of information and research through the Internet, tools to analyze information and data, tools to create various types of multimedia, and a variety of collaboration tools. Digital games have become a popular source of learning various strategies and acquiring new knowledge (Gros, 2007). Digital games create a virtual world that promotes necessary social and community skills and can create real-life simulations for learning. Previous game studies noted various aspects of games that make them engaging and appealing to both male and female students. These characteristics include; the feeling of working toward a goal, the possibility of attaining spectacular successes, the ability to solve problem, collaborate with others, to socialize, an interesting story line and other characteristics (Johnson, Smith, Willis, Levine, and Haywood, 2011). Tarng and Tsai (2010) claimed that digital game based learning is motivational for students, involves active participation for students, simulates real situations, is used to aid current teaching practices, and promotes problem solving.

Examples of computer games for learning mathematics includes include; Bizz buzz game, spread of rumour game, hypothesis test bingo game, jeopardy, the dimension M game, NIU- torcs for numerical methods etc.

The diagram below shows some learners and their facilitator in a digital game based learning environment.



Some of the educational benefits of digital game use identified by Mitchell and Savill-Smith (2004) were the following:

1. Computer games are valuable tools in enhancing learning.

2. They are means of encouraging learners who may lack interest or confidence.

3. Computer games can reduce training time and instructor load.

4. They enhance knowledge acquisition and retention.

5. They allow manipulation of objects, supporting development towards levels of proficiency.

6. Computer games are particularly effective when designed to address a specific problem or to teach a certain skill.

7. Such games are relevant to specific learning activities and goals.

8. They can be used to facilitate tasks appropriate to learners’ level of maturity in the skill.

9. They are designed to enhance specific learning outcomes such as recall of factual content or as the basis for active involvement and discussion.

10. They are good vehicles for embedding curriculum content such as math and science concepts that may be hard to visualize or manipulate with concrete materials.

11. Computer games enhance creative and other forms of critical thoughts.

12. They have the potential to support cognitive processing and the development of strategic skills.

13. They can encourage greater academic, social, and computer literacy skills.

We also have the manual game based learning, some of the mathematical games includes; ludo, okwe (Igbo) or Ayo (Yoruba), number games and puzzles, coordinate games, spinner game, dienes block, probability kit, quadratic equation box game, number line game, geo-board game ( Ezike and Obodo, 1991), geometrical games, position marker game, card game, identifactor game , Dikeohamatics games and many others. These games have a lot of advantages such as:

1. Creating an avenue for recreation and enjoyment and at the same time stimulate mathematical thinking. Most games require trial and error at first before the correct methods are discovered. Such trial and error require deep concentration and skill.
2. Ascertaining the previous experience students have and the extent to which concepts have developed.
3. Reinforcing what has been taught in class for example properties of geometrical shapes.
4. Serving as motivating factor especially for students who are slow learners and below average. The games can provide a close situation where they feel they are controlling the whole situation. The joy and freedom therein could lead them to derive mathematical knowledge and love for the subject.
5. Leading to creativity and discovery as a result of the kind of concentration and skill needed in mathematical games.
6. Helping to satisfy the love of meeting challenges. For instance in playing a game, a player thinks of his moves and also anticipates the moves of his opponent as well.
7. Releasing tension, clearing boredom and providing an environment where the students can develop their skills and acquire more knowledge. Games and mathematics are related because each has rules which involve experiences, drills and practical applications.
8. It is learner centered.

In the application of game based learning in the classroom, the teachers or educators should consider the following factors:

1. Which game best integrates into the existing curriculum, Harris (2006).
2. Which game meets the objectives of the topics being taught, MacKenty (2006).

Depending on the type of game that is played, there are clear benefits to supplementing games as active learning components in the classroom. According to Franklin, Peat and Lewis (2003), when students work cooperatively on a game activity, it foster group cooperation and typically create a high level of student involvement that makes them useful tools for effective teaching and learning. Research suggests that use of game based learning is an effective means of improving students’ attitudes towards mathematics. Although much of the research on the effects of game based learning of mathematics is inconclusive at this point as observed by Fletcher and Tobias (2006), there is strong evidence that appropriately designed educational games do have the potential to enhance student’s learning of mathematics (Klawe, 1998; Bragg, 2007; McGivern 2007; Simpson, 2006). Through the introduction of challenging tasks that are meaningful for students and facilitate their interest in exploration, educational games can help focus mathematics instruction on conceptual understanding and problem-solving and not on recipes and formal derivations, which become secondary in importance. Through use of educational games, students can build valuable skills such as strategic thinking, planning, communication, the application of numbers, negotiating skills, group decision-making and data-handling, Kirriemuir & McFarlane, (2004).

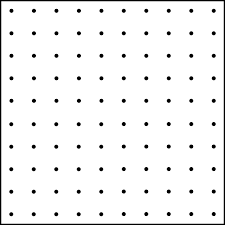
**How to play some of the manual mathematics games**

**The Geoboard game**

A geoboard is a wooden graph board with pins or nails at each point where the horizontal and vertical lines cross each other, Obodo (1991). It was invented in the 1950s by an Egytian mathematician Caled Gattegno (1988-1991). As a learning tool, it provides a means to act upon the world and can be used as a cognitive scaffold that facilitates the extention of knowledge, Perkins and Solomon (2001). The geoboard can be used to play many games for varied and specific mathematical activities such as:

1. Representing geometric patterns; by using a rubber band, students can represent different geometric patterns and shapes such as rectangles, squares, triangles, polygons, parallelogram, trapezia etc.
2. Demonstrating symmetry; the rubber bands are used on the geoboard to show lines of symmetry, for instance it can be used to show that a square has four lines of symmetry and a rectangle has two
3. Showing angles; with the use of rubber bands the geoboard can be used to show alternate angle, obtuse angle, right angle, reflex angles etc
4. Representing histogram and bar chart; different rubber bands can be used in plotting histograms and bar charts on the geoboard. The x and y axis are clearly marked out and scales indicated
5. Representing and describing coordinate points; the points (0,1), (1,1), (4,2) etc can be represented on the geoboard. Each nail or pin on the geoboard represents a point which can be described with the aid of the x and y axis and an appropriate scale indicated on the geoboard.

A diagram of the geoboard is drawn below

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**How to play**

**Geoboard game for identifying and differentiating polygons**

Materials needed: geoboard, rubber bands, paper and pencil or pen.

Procedure: player A uses a rubber band to form a scalene triangle( a triangle with no side equal), he scores one point; then player B identifies the shape formed and scores one point. Player B describes the properties of the scalene triangle and scores one point for each correct property.

Now, player B forms a square for example and scores a point. Player A identifies and describes the properties then gets a point for each correct property. Bonus points are given to who answers the opponent’s questions. They continue with the game for other shapes, for instance, equilateral triangle, trapezium, rectangle, kite, parallelogram, pentagon, hexagon, heptagon, octagon, nonagon decagon etc. if one has formed a shape, the other is not allowed to repeat it. The player with the highest score wins.

**Geoboard game for describing and locating coordinate points**

Player A indicates the X and Y axis in the geoboard using two rubber bands. He points at any pin or nail on the geoboard and asks player B to describe the point, say, (1,2) and write it down on paper. Player B points at another pin and asks player A to describe the point, say (3,2). Each scores one point. The game continues this way till the teacher stops them and the one with more points wins.

**The geoboard game for angles**

Player A uses a rubber band to form a shape PQORS on the geoboard. He points at angle P for instance, then asks player B to show an equal angle to P with reasons. Then player B points at angle x and asks player A to show an equal angle to x giving reasons. Both players score a point each for showing equal angles and giving correct reasons. They continue this way till the time for the game is over.

Based on observation, the geoboard has the potential to develop students understanding of mathematics especially in areas like Geometry, angles, coordinates etc. This learning can be more interesting when students are guided by their teachers to work with their hands on the geoboard, the learners find it difficult to forget such moments and also it enables them remember what has been taught by the use of geoboard. For this reason, Geoboards should not be forgotten in our mathematics classes.

**The coordinate game for Cartesian plane and coordinates**

Number of players: 2 or 4

Materials: 2 dice (different colours), a graph board or lattice, a ludo or die cup.

Objective: to locate and plot coordinates of points on a plane

Procedure: player A marks the X and Y axis on the board, he shakes thoroughly the ludo cup containing the two dice and throws it on the board. The two dice may be scattered in different positions on the lattice thereby giving two points let’s say C and D, the positions are marked by x. 0 is the origin. Player B describes coordinates of C (-1.5,-1.5) and D (1, 1.5) and scores one point for each correct one. If he fails, the other player gets a bonus mark if he gets it right.

The other player plays his turn and they continue like that till the time allotted for the game is over and the teacher stops it, then the player or players with the highest score wins

**The concept of Mathematics**

The word "mathematics" comes from the Greek ‘máthema’ which means "science, knowledge. Today, the term refers to a specific body of knowledge that is the deductive study of quantity, structure, space, and change.

According to the advanced learners’ dictionary, mathematics is the study of numbers, equations, functions, geometric shapes and their relationships. Some branches of mathematics are characterized by the use of strict proofs based on axions. Some of its major subdivisions are arithmetic, algebra, geometry and calculus. Wikipidia (2018) viewed Mathematics as the abstract science of numbers, quantity, and space either as abstract concept (pure mathematics) or as applied to other disciplines such as physics and engineering (applied mathematics). Mathematics is an academic discipline that requires and permits social construction of knowledge as well as thinking and reasoning skills (Cantoral and Farfan, 2003). It is a universal and symbolic language for all cultures and civilizations. The language of mathematics enables human beings to think about, record and communicate ideas concerning the elements and the relationships of quantity. The term mathematics encompasses more than the term arithmetic. Students who discover some of the structure of mathematics are often impressed by its beauty, they note the lack of contradictions and they see how a new technique can be derived from one that has already been learnt because mathematics comprises of related concepts.

Despite the indispensability of mathematics in the development of humanity it has witnessed a persistent failure in both internal and external examinations. This failure is attributed to perceived difficulties in mathematics by students and poor teaching methods by mathematics teachers, Azuka (2008). Several researchers and educators also agree that there is prevalence of poor achievement in mathematics among school students. They include Obodo (2004), Kurumeh (2009), Lefouque (2011), WEAC (2010), to mention but a few. This poor achievement adversely affects both male and female students’ interest in mathematics. Some researchers have shown significant improvement of students’ achievement in mathematics to innovative learning such as game based learning approaches in the teaching and learning of mathematics (Gillispie, 2008; Aronowitz, 2009; Kebritchi, Hirumi and Bai 2010; Kim and Chang 2010; Abdullahi, Bakar, Ali, Faye, Hassan, Amar and Yaacob, 2011 and Miller, 2011). Others researchers like Baumert and Schnabel (2001) have their study and findings showing established sex difference in favor of boys in mathematics achievement. However there are other reported studies which do not support the findings above. Chipman’s (2002) study shows that remarkable female students have done well in mathematics as compared to the male counterpart.

On gender related achievement reports, quit a number of studies established gender equality in mathematics achievement after exposing both sexes to mathematics teaching and learning (Halai, 2008 and Achor, Imoko and Ajai, 2010). Consequently on gender parity or disparity in mathematics achievement, further investigation on gender issue relating to mathematics achievement exposing students to innovative teaching approaches like the use of game based learning in the teaching and learning of mathematics would be useful to set the students on course early in life and prepare them for the challenges of the current modern technological societies. Mathematics as a science subject is a key to innovation and power in today’s world, hence its improvement to enhance ability to succeed in the global economic development of a nation is highly imperative (Earls and Holbrook, 2007). Mathematics which provides the bedrock and foundation for creative thinking and cognitive development should be emphasized early in academic life of the nation’s citizenry.

Game based learning of mathematics has to do with the use of games in creating a relatively permanent change in performance of learners in mathematics.

**The concept of Academic achievement**

According to the advanced learner’s dictionary, achievement refers to something accomplished, especially by superior ability, special effort, great courage etc. it is the quality and quantity of a student’s work. There are different kinds of tests that can be used to measure students achievement such as: the standardized test and the teacher made test. In this study, the teacher made test (mathematics achievement test) will be used.

Academic achievement is the performance of students based on the evaluation given by teachers or instructors after teaching and learning has taken place. Based on this research, it is the score of students after the mathematics achievement tests have been administered by the researcher to the students.

**Theoretical framework**

Patanella (2011) stated that ‘Learning refers to changes in behavior and cognition as a result of experience’. The beliefs in this study are built upon some theories, and forms of learning associated with game based learning and mathematics that are outlined within this literature review. These include; the Howard Gardners’ theory, constructivism theory, Piaget’s cognitive development theory and social learning theory.

**Piaget’s Cognitive Development Theory (1970)**

Jean Piaget’s cognitive development theory focuses on the intellectual growth and development of children biologically (Jansen, 2011). The four stages of Piaget’s theory are sensory motor, preoperational, concrete, and formal. Each of the four phases contains specific identifiers of childhood development based on the age of the child, regardless of intelligence (Jansen, 2011). Children also tend to move from one stage to the next through organization and adaptation. Piaget’s last period of development, the formal operational stage, ranges from age 11 to adulthood. This stage specifically describes the abilities and capabilities of high school students. At this phase of development, adolescents “engage in abstract thinking, using skills such as deductive and hypothetical reasoning” (Jansen, 2011). Adolescents at this stage learn and begin to solve complex problems through cautious and systematic processes, share and propose their own ideas and as well as go through the process of evaluating their opinion being proposed (Jansen, 2011). Moreover, they learn to form their own identity as well as how to relate to others (Jansen, 2011). Game based learning can provide students with opportunities for problem solving and collaborative interactions with others. Piaget (as cited in Jansen, 2011) maintained that children go through three stages of maintaining a balanced equilibrium: adaptation, assimilation, and accommodation. Adaptation is when a child learns to adapt to his or her surroundings. Assimilation is when a child incorporates newly learned ideas into existing knowledge. Accommodation is when a child modifies existing knowledge to accommodate newly learned knowledge and understanding. Humans organize their worlds into systems. Disequilibrium happens when humans are unable to fit information into one of their systems. When disequilibrium occurs, humans either assimilate this new information into an existing system or accommodate by changing the system to fit the new information (Atherton, 2011). Because students are accustomed to technology at this age anyway, they can readily adapt to the use of game based learning, assimilate to a method of learning that fits their lifestyle and accommodate their knowledge of technology to acquire new knowledge in mathematics and other disciplines.

**Constructivism**

This is a philosophical viewpoint about the nature of knowledge. There are many flavors of constructivism, but one prominent theorist known for his constructivist view is Jean Piaget, who focused on how humans make meaning in relation to the interaction between their experiences and ideas. His views tended to focus on human development in relation to what is occurring with an individual as distinct from development influenced by other persons.

Constructivism is a learning theory in which learners construct or build their own knowledge for themselves based on their own experiences (Hein, 1991). Interaction and experience create understanding for people, even those with varying abilities and interests (Champion, 2008). Connolly, Stansfield, and Hainey (2007) addressed two types of constructivism, cognitive and social.

1. Cognitive constructivism pertains to the active learning process of an individual based on current and past knowledge.
2. Social constructivism is based on an individual’s learning through cultural experiences and interactions with others (Connolly et al., 2007).

The constructivist theory holds that learners construct knowledge by understanding and expertise. Constructivism contradicts the idea that learning is the transmission of content to a passive receiver. Instead, it views learning as an active process, always based on the learner’s current understanding or intellectual ability. A learner does not come to a classroom with a mind that is tabula rasa, a blank slate. Each learner arrives at a learning “site” with some preexisting level of understanding (Brown, 2005).

Simon (1995) explained that because constructivism is not a teaching method but a teaching perspective, educators need to provide students the means to investigate and explore mathematics using a constructivist purpose by designing tasks that utilizes structures, provide a set of guidelines and stimulate thoughts for students. Thus, the role of the teacher is that of a facilitator who provides the learning tasks and enquiry for students to construct their own knowlwdge (Lerman, 1989; Simon, 1995). Game based learning readily provides constructive learning experiences because it actively engages the learner and allows collaborative interactions.

**Social Learning Theory**

A psychologist Albert Bandura(1977) integrated theories and came up with four requirements for learning such as; observation(environmental), retention (cognitive), reproduction (cognitive), and motivation (both). This integrative approach to learning was called social learning theory.

Social learning theory focuses on the learning that occurs within a social context. Learning takes place in natural contexts and in everyday situations and is relative to the environment (Dede, 2005). Social learning theory considers that people learn from one another, including such concepts as observational learning, imitation, and modeling (Ormrod, 1999). Social learning theory is the belief that humans are unique in thier abilities to symbolize experiences, to develop forethought about consequences for our actions, to learn vicariously through the actions of others, to be able to change our behaviors through self-regulation, and to self-reflect(Bozack, 2011).

Social cognitive learning theory is often seen as an alternative to Piaget’s cognitive development theory. This theory states that people learn best by observing and being exposed to other people and information (Bozack, 2011, Hammer, 2011). Learning takes place in real situations that are meaningful to the learner. Learning is culturally biased and dependent upon interactions with other people and contexts (Tarng and Tsai, 2010). Bozack (2011) claimed that, “People are both products and producers of their environments and social systems.

Again, according to (Bozack, 2011), Self-efficacy is a major component of social learning theory. It is a person’s belief about his or her abilities to do something but can change over time and with experience. Game based learning is conducive to meeting the needs of students through a social learning perspective because it allows for social interactions with others in a method that is already natural to students (e.g., the use of technology).

**Howard Gardner’s Theory**

Gardner’s Theory of Multiple Intelligences is one of the most significant developments in learning theories to come out of the last quarter of the 20th century. The foundation of this theory is that we all employ different strategies for learning, and that these strategies relate to internal strengths and capabilities that can be classified into eight categories, which Gardner called “intelligences”. Gardner proposes eight primary forms of intelligence:

1. Linguistic
2. Musical
3. logical-mathematical
4. spatial
5. body-kinesthetic
6. intrapersonal (e.g., insight)
7. interpersonal (e.g., social skills) and
8. Naturalistic (sensitivity to natural phenomena, and classification skills). The implication of this theory is that learning can become more effective if we focus on and develop instruction for these intelligences. Generally speaking, assessment should include more than one ‘intelligence’ as each is more than simply a content domain; it is also a learning modality. Cultural differences play a key role, as each culture tends to value and emphasize particular intelligences in favor of others.

**Gardner’s Eight Intelligences**

Connecting Gardner’s ideas with the design of games is particularly effortless, as almost everyone is evident in almost every successful game in fact, it could be argued that one of the features of games that make them so engaging is that they address each one of these forms, providing game players with a particularly rich experience, where each player has an opportunity to take advantage of her own particular strengths.

**1) Linguistic:** Linguistic intelligence coincides nicely with Gagné’s Verbal Information category, and thus what was said there also applies here. Games often include written and spoken elements – for game play, as well as for direction and help.

**2) Musical:** Virtually all games include sound to enhance play – there are sound-effects, both diegetic and non-diegetic, as well as music to set the mood or provide feedback about game states. In some cases musical scores for games are as sophisticated as they are for film.

**3) Logical-mathematical:** Strategy is one of the key elements in play. The extent to which this intelligence is exercised depends heavily on the genre and specific game played.

**4) Spatial:** Games are of course highly visual, providing a rich and colourful 2- or 3-dimensional environment, which is always at least partially under the player’s control in terms of what is visible. It is quite common for example, to be shown multiple simultaneous first and third person views which not only tap into one’s spatial intelligence, but at the same time actively help players learn to use these views in their game play.

**5) Kinesthetic:** Although games cannot yet place their players physically in the game, most games do require players to ‘place themselves’ virtually in the game in one way or another and all involve movement and action

**6) Intrapersonal:** Strategy is one of the key elements in play – once again this is a key element in games.

**7) Interpersonal:** Many of the most popular games include multi-player modes, many online games massively so.

**8) Naturalistic:** Games with naturalistic themes are common – whether they include purely realistic flora and fauna, purely fantastical ones or some combination of the two. Any game that creates a world with geography and a variety of inhabitants require classification, as well as naturalistic skills and understandings.

**Gardner’s Seven Levers of Change**

An appropriate place to conclude this paper is with Gardner, who describes seven levers of change in his recent book on the art and science of changing minds. This paper argues that all seven levers must be fully utilized in order to effect real change in the attitudes of educational Institutions towards the use of games for learning. The establishment of a clear connection between best practices in game design and current learning theories is one more strategy that can be adopted to support the use of games as valuable tools for learning. Gardner’s levers includes: rational reasoning, resonance, representational redescription, resources and rewards, real world events and resistances. This connection needs to be made explicit, both for the benefit of teachers currently in the classroom, and for the benefit of the academics who ultimately create the programs and curricula that are used to train the next generations of teachers.

1. **Rational Reasoning:** Logically outline the pros and cons of the use of games for learning.

2. **Research:** Present data and relevant cases to support the argument.

3. **Resonance:** Create connections between desirable facets of education and those elements already embodied in games.

4. **Representational Redescription:** Make your point in many different ways.

5. **Resources and Rewards:** Use rewards as incentives to convince someone to adopt your view; make it easy to agree.

6. **Real World Events:** Use events from society at large to make your point.

7. **Resistances:** Understand the factors that cause people to reject your view. Such insights can make it easier for you to change their minds.

**Empirical framework**

According to Udele (2014) when he embarked on the project topic ‘Eradicating mathematics phobia in schools’ using a descriptive survey design, a sample size of 300 senior secondary school students chosen randomly from three schools, a well structured questionnaire as instrument for data collection, frequency count of the data collected was used to answer the research questions, while the chi- square test statistics was used to test the hypothesis at 0.05 level of significance. The result showed that teachers’ factors such as ineffective teaching methods, not giving attention to the students’ opinion, not using instructional materials etc can cause mathematics phobia in students. Again not providing opportunities for the students to practicalize theoretical concepts is also discovered as one of the reasons for the mathematics phobia in students among the useful suggestions given was anything which will make the students understand mathematics both at home and in schools should be doggedly pursued.

The cited work above was carried out on senior secondary school students and suggested that anything that will improve teaching and learning of mathematics should be employed in schools but the current study is carried out on junior secondary school students and in furtherance of the cited work, suggested that game based learning of mathematics should be given a chance in our secondary schools to see if it will yield better results in students’ mathematics achievement.

Chun , Iwen and Gwo-Jen (2014) conducted a research on Effects of digital game-based learning on students’ self efficacy, motivation, anxiety, and achievements in learning mathematics .To evaluate the effectiveness of the proposed approach, an experiment was carried out on an elementary school mathematics course with quasi-experimental research design and particularly a pretest post test was used, they also used questionnaire as instrument for data collection and ANCOVA for data analysis, a total of 69 pupils in three classes were selected as the research subjects. One class was assigned to be experimental group A, another class was experimental group B, and the third was the control group. Each group consisted of 23 students. In the experimental process, the three groups took pre-tests, had experimental instruction, and then took post-tests. The experimental results show that the game based e-book learning model effectively promoted the students’ learning achievement, self-efficacy, and motivation of mathematics. Therefore game based learning should be encouraged in schools.

The cited work above was carried out on elementary schools but this current study was carried out on junior secondary school students and went further to include manual mathematics games like the geoboard game.

Akande M.T.(2017) carried out a quasi-experimental research design of pre-test and post-test control group on the topic; ‘Effects of Mathematical games on the academic achievement of senior secondary school students in Nasarawa state’. The sample size of 123 senior secondary school students drawn from two selected schools out of five secondary schools was used for the study. The instrument for data collection was a teacher made Algebra Achievement Test. The instrument was subjected to three experts’ judgment for validation. The reliability coefficient was obtained for the AAT. The findings revealed that the students taught with the use of games had a greater mean score than their counterparts taught without the use of games and also female students had higher mean score than the male students, thus the hypothesis show that gender had influence on students’ achievement. Based on the findings, it was recommended among others that teachers should use games to introduce new concepts in engaging students in the teaching and learning mathematics in the classrooms.

The above work was conducted on senior secondary school students in SSI classes of two selected schools in Nassarawa state while the current work was conducted on junior secondary school students in JSS 2 classes of four selected schools in Enugu East local government of Enugu state.

Chia-Li, Ting-Kuang and Chun-Yen (2014) conducted a quasi experimental design using pretest and post test on the topic ‘The Effects of Game-Based Learning and anticipation of a test on the learning outcomes of 10th Grade Geology students’. The study examines whether a role play game with embedded geological contents and students’ anticipation of an upcoming posttest significantly affect high school students’ achievements and attitudes toward geology. The population of the study was comprised of 202 high school students, 103 males and 99 females. ANCOVA was used as a statistical tool on the posttest scores with students’ pretest scores as the covariates. The results indicated that: there was no statistically significant interaction effect between role play games and anticipation of posttest on students’ learning outcomes; and there was no statistically significant main effect for role play games on students’ learning outcomes. In conclusion, game based learning has positive effects because it serves as a reinforcement to help students both retain their content knowledge and develop a positive attitude towards geology.

In relation to the above study which was carried out in the field of Geology, the current study was carried out in the field of mathematics.

Imoko and Isa (2015) embarked on a quasi experimental research using the pre test and post test on Impact of computer games on pupil’s achievement in mathematics in primary school’. The sample of the study consisted of 374 primary four pupils, two research questions and two hypotheses were used for the study. Mathematics achievement test with a reliability of 0.80 was used as instrument for data collection. Mean and standard deviation were used to answer the research questions, while analysis of covariance (ANCOVA) was used to test the hypotheses. The analysis of the data showed that the use of computer games learning approach improved significantly pupil’s achievement in mathematics but there are little or no computer games available in our schools. It was therefore recommended that computer games as a learning approach should be included in mathematics Education curriculum. Programmed text materials should be produced to enable pupils to learn mathematics using computer games and government should provide computers for the games. In line to the above work cited was conducted on primary school pupils, while the current study was conducted on junior secondary school students and the researcher included manual games like the geoboard game which can be played when the computer games are not available.

Mohammed, Abu Bakar, Ali, Ibrahima and Hasan (2014) conducted a causal comparative research to investigate the impact of video games in children’s learning of mathematics. The analysis was done using data from pretest and post test to find the mean, t tests and ANOVA test result with a sample size of 100 selected randomly from two primary schools.

The finding revealed that video games as a supplementary activity to classroom learning brings significant and positive effect on learners understanding of mathematics, therefore it was recommended that stakeholders, curriculum planners and Government should consider the possibility of including video games in primary school mathematics curriculum for effective teaching and learning of the subject.

In relation to the above cited work, the researcher extended the currents work to junior secondary school students in Enugu east local government area of Enugu state.

**Summary of literature review**

This chapter is divided into conceptual framework, theoretical framework and empirical study

In the conceptual framework concepts of game based learning, mathematics and achievement were defined and explained.

The theoretical framework followed suit and the following theories were used; constructivism, Howard Gardner’s theory of intelligence, Jean Piaget’s cognitive development theory and the social learning theory.

The researcher cited some already existing works in relation to the current work by the following researchers; Udele (2014), Imoko and Isa (2014), Akande M.T.(2017), Mohammed, Abu Bakar, Ali, Ibrahima and Hassan (2014), Chai-Li,Ting kwang and Chun-Yen. From the cited works, it is evident that game based learning plays an important role in improving student’s achievement in mathematics and geology.

**CHAPTER THREE**

**RESEARCH METHOD**

This chapter gives the details of the research method employed in the study. The chapter present and define the research design, population of the study, area of the study, sample and sampling techniques, research instruments and procedure for data collection and analysis.

**Research design**

Grooves (2005) define research design as a “Blueprint for conducting a study with maximum control over factors that may interfere with the volatility of the findings”. The study adopted a quasi experimental research design particularly pre-test post-test control group. The design was used because the researcher was interested in studying the cause and the effects and in manipulating the independent variable (game based learning) in order to observe its effect on the dependent variable (academic achievement).

**Area of the study**

The study was carried out in all the government secondary schools in Enugu East Local Government Area of Enugu state which are ten in number. Enugu east is one of the 17 local government areas in Enugu state. The reason for the choice of the area was because it is very populated and results obtained can serve as reference for other areas. Another reason is because students perform poorly in mathematics in the area therefore the researcher wants to find out if game based learning will improve student’s achievement in mathematics.

**Population of the study**

The population of this study was the ten government secondary schools in Enugu East local government area of Enugu state comprising of 12,270 students. This data was gotten from the statistical unit of the Post Primary School Management Board (PPSMB) in Enugu state.

**Sample and sampling techniques**

The sample size was 280 which was obtained from the junior section of four selected schools (Abakpa girls secondary school, St. Patrick secondary school Emene, Announciation secondary school Nkwo Nike and Umuchigbo secondary school) out of the ten schools with a population of 950 students and its sampling technique was achieved using Taro Yamane’s simplified formula:

n = N

1+N× (e) 2

Where:

n = the samples size.

N = the finite population size.

e = the acceptance sampling error∕ margin of error.

95 = percent confidence level.

P = 5

1 = Unity (constant)

N= 950

e = 0.05

n = 950

1+950 × (0.05)2

n = 950

1+950 × (0.0025)

n = 950

1+4.425

n = 950

5.425

n = 280

Therefore the sample size is 280.

**Instrument for data collection**

The instrument used for data collection for the study was a teacher made test called Mathematics Achievement Test (MAT) which comprises of ten questions comprising of 9 objectives and 1 essay. MAT is the achievement test that measures the competencies of the students including knowledge and skill in solving problems involving topics such as; plane shapes and angles. The game used for the study was ‘Geo-board game’. This is a mathematical used for game identifying plane shapes, angles, co-ordinate points and differentiating polygons.

**Reliability of instrument**

The researcher used Kuder-Richardson formula 20 to establish the internal consistency reliability of 0.79.

**Validity of instrument**

The instrument after construction was given to two research experts and a mathematics educationist for critique and this ensured its face and content validity as the corrections made were implemented.

**Method for data collection**

The researcher sought the permission of the principals of the four schools to allow their school to be used for the study. The researcher also was assisted by the mathematics teachers in the schools as they were helpful throughout the activity. The assistants administered the first test (pre-test) to the two groups respectively before teaching, and then the researcher collected their work after writing and started teaching using the Geo-board game. At the end of two successful lessons respectively with each group, the researcher administered another test (post test) to each of the groups. The teaching lasted for a week. Students in the experimental group were taught plane shapes and angles by the researcher with game while those in the control group were taught plane shapes and angles without the use of game. This was done in order to find out the effects of game based learning on students’ achievement in mathematics.

Extraneous variables such as students lack of cooperation was controlled as the researcher was introduced to the students as an under graduate carrying out research to find a solution to the study problem. With this explanation the students gave their maximum cooperation throughout the activity.

**Method of data analysis**

The datacollected for the study was analyzed using mean and standard deviation for the research questions and t-test for the research hypothesis.

**CHAPTER FOUR**

**RESULTS**

In this chapter the researcher analyzed, presented and interpreted the data collected for the study according to the research questions and hypothesis. The results are presented as follows:

**Research question 1**

What is the difference in the mean achievement score of students taught mathematics with game based learning approach and those taught with conventional method?

**Table 1; Shows the Mean score and standard deviation of the pre test of the two groups**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Group | Number of students | Mean score | Standard deviation | Mean gain |
| Experimental | 100 | 30.0 | 7.18 | 7.0 |
| Control | 110 | 23.0 | 5.0 |

The table above shows the effects of game based learning on the control and experimental group before teaching took place (pre-test). The experimental group had a mean score of 30.0 and a standard deviation of 7.18 while the control group had a mean score of 23.0 and a standard deviation of 5.0. the difference in the mean scores is 7.0 which appears high.

**Table 2; mean and standard deviation on the post-test of the two groups**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Groups | Number of students | Mean score | Standard deviation | Mean gain |
| Experimental | 100 | 33.0 | 9.01 | 9.0 |
| Control | 110 | 24.0 | 5.9 |

The table above indicates that at the end of the experiment or after teaching (post test) the experimental group had a mean score of 33.0 and a standard deviation of 9.01 while the control group had a mean score of 24.0 and a standard deviation of 5.9. There was a mean gain of 9.0 which is also high.

**Research question 2**

What is the difference in the mean achievement score of male and female students taught mathematics with game based learning approach?

**Table 3; shows the mean, standard deviation of the male and female students in the pre-test**

|  |  |  |  |
| --- | --- | --- | --- |
| Gender | Number of students | Mean score | Standard deviation |
| Male | 40 | 32.01 | 8.01 |
| Female | 50 | 29.56 | 6.90 |

In table 3, the male students had a mean score of 32.01 and a standard deviation of 8.01 and the female students had a mean score of 29.56 and a standard deviation of 6.90 all in the pre-test. A mean gain of 2.45 was obtained also.

**Table 4; shows the mean and standard deviation on post test of the male and female students**

|  |  |  |  |
| --- | --- | --- | --- |
| Gender | Number of students | Mean score | Standard deviation |
| Male | 40 | 34.0 | 9.10 |
| Female | 50 | 30.0 | 7.09 |

The table above shows that the female students had a mean score of 30.0 and a standard deviation of 7.09 in the post test while the male students had a mean score of 34.0 and a standard deviation of 9.10. There was a mean gain of 4.0.

**Research hypothesis 1**

There is no significant difference between the mean achievement score of students taught mathematics with game based learning approach and those taught with conventional methods.

**Decision rule**; reject hypothesis if t-calculated is greater than t-critical then accept if it is the other way round.

**Level of significance;** 0.05

**Table 5; t-test of the post test on the mean achievement scores between the experimental and control groups**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Group | mean | Standard  Deviation | Number | Degree of freedom | t-cal | t-tab |
| Experimental | 33.0 | 9.01 | 100 | 208 | 12.01 | 1.96 |
| Control | 24.0 | 5.9 | 110 |

From the table, the calculated t of 12.01 is greater than the table value of 1.96; hence there is a significant difference between the mean achievement scores of students taught mathematics with game and those taught without game. The implication is to reject the null hypothesis of no significant difference.

**Research hypothesis 2**

There is no significant difference between the mean achievement score of male and female students taught mathematics with game based learning approach.

**Decision rule**; reject hypothesis if t-calculated is greater than t-tabulated then accept if it is the other way round.

**Level of significance;** 0.05

**Table 6;t-test showing male and female students’ achievement scores taught mathematics using game based learning approach**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Gender | Number | Mean | Standard  deviation | Degree of freedom | t-cal | t-tab |
| Male | 40 | 34.0 | 9.10 | 88 | 5.90 | 1.98 |
| Female | 50 | 30.0 | 7.09 |

From the table above, the t-calculated = 5.90 is greater than the t-tabulated=1.98 at 0.05 level of significance and degree of freedom of 88. Therefore, the null hypothesis was rejected. Thus, male students perform better than their female counterparts when taught mathematics with game based learning approach.

**Summary of findings**

The summary of this study as obtained from the analysis of the data is as follows;

1. There was a significant difference in the performance of students taught plane shapes and angles using game (geo-board game) and those taught using the conventional method of method and the difference was in favor of those taught with game(geo-baord game).
2. There was a significant difference between male and female students taught mathematics with game (geo-board game) in favor of boys.

**CHAPTER FIVE**

**DISCUSSION, IMPLICATION, RECOMMENDATION AND SUMMARY OF THE STUDY**

This chapter deals with the discussion of findings and conclusions based on the findings drawn from the study. It also shows some recommendations and

suggestions for further studies.

**Discussion of findings**

The findings in regards to the mean scores of students taught mathematics using game based learning approach was higher than the mean achievement of students taught using conventional approach. The result was further confirmed by the hypothesis analyzed using t-test and ANOVA which revealed that game based learning plays a significant role on student’s achievement in mathematics, hence students who were taught using games performed better than those taught without games. In other words, the teaching of mathematics should go by practical approaches of the game based type where there will be supply of concrete and experimental basis for the students to proceed to abstract reasoning. This finding tends to support the research of Aburime (2003), where students who were exposed to practical activities proved to perform better than their counterparts who were not exposed to practical activities. It also agrees with those of Imoko and Isa (2015); Chai-li, Ting-Kuang and Chen-Yen ( 2014); Chun,Iwen and Gwo-Jen (2014); Mohammed, Abu Bakar, Ali, Ibrahima and Hassan (2014) that the use of games in teaching and learning improves learners achievement.

Furthermore, results in respect of mean achievement scores in terms of gender that of male students is higher than that of the female students who were both exposed to game based approach. The observed difference is statistically significant as this was tested using the null hypothesis of no significant difference between male and female students exposed to game based learning approach. This implies that the male students perform better than the female students when game based learning approach is used. This is in line with the research findings of Baumert and Schnabel (2001) which shows an established sex difference in favor of boys in mathematics achievement.

**Summary**

The study investigated the effects of game based learning on junior secondary school student’s achievement in mathematics in Enugu East local government area of Enugu state. The result of the study indicates a significant difference in the two teaching methods employed, in favor of game based learning; in addition, there was gender influence in favor of boys. It can be deduced therefore that game based learning is effective in teaching and learning of mathematics. Therefore, if given the chance in our secondary schools game based learning may be a means of improving learners’ achievement in mathematics for the attainment of vision 20;2020 in our nation at large.

**Educational Implication of the study**

It has been discovered from the study that game based learning is of immense importance to the teaching and learning of mathematics in junior secondary schools, therefore, mathematics teachers should ensure that they use games to teach mathematics so as to achieve a better results from students. If the computer games are not available, they should use the available manual games like the geoboard game, equation box etc which can be made locally.

Likewise, educational administrators should endeavor to encourage mathematics teachers to adopt the use of games in teaching of the subject.

**Recommendations**

Taking into consideration, the importance of the study with the view that it could be used outside the area of study, the researcher has deemed it necessary to give the following recommendations:

The importance of game based learning of mathematics should be considered in teachers training institutions.

1. Game based learning approach should be incorporated in the mathematics curriculum teacher’s training schools.
2. Teachers should be dynamic in the type of game they employ in the process of teaching depending on the topic and concept.
3. Adequate supervision to ensure the use and understanding of game based learning approach should be ensured by the appropriate bodies concerned.
4. Educational administrators should organize seminars and workshops for secondary school teachers from time to time in order to update their knowledge on game based learning.
5. School authorities should not be too rigid to accept new and improved ways of learning mathematics
6. The government should build mathematics laboratories and equip them with game based learning materials both digital and manual. They should also send supervisors to inspect the proper use and management of these laboratory materials

**Limitations of the study**

The researcher encountered a major limitation which was unavailability of mathematical game materials in the selected schools. In fact there was nothing like using games in teaching mathematics at all. As a result, the researcher had to construct a geo-board to aid the study.

**Suggestions for further studies**

1. The extent to which game based learning is used for effective teaching and learning of mathematics in junior secondary schools.
2. The effects of the socio economic status of parents on student’s mathematics achievement in secondary schools.

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**Appendix A**

Department of Science and Vocational Education,

Godfrey Okoye University,

Ugwuomu Nike Enugu,

Enugu state,

April 2018.

Dear respondent,

A LETTER OF INTRODUCTION

I am a student of the above mentioned institution. I am carrying out a research on the "Effects of game based learning on junior secondary school student’s mathematics achievement in Enugu East Local Government Area of Enugu state.

The enclosed test is purely a research tool designed for a Bachelor of Science Education (B.Sc.) project to be submitted to the Department of Science and Vocational Education, Faculty of Education, Godfrey Okoye University Ugwuomu - Nike Enugu. You have been randomly selected to answer.

Your responses to the test are highly confidential. It is purely for academic purpose and as such your cooperation is highly solicited, Thanks.

Yours faithfully

Johnson

Amarachi R.

**Appendix B**

Validator’s Letter

Godfrey Okoye University

Thinkers Corner, Enugu

20th of June 2018

Sir\Madam

A LETTER OF REQUEST FOR RESEARCH INSTRUMENT VALIDATION

I Johnson Amarachi a 400 level student of the above mentioned institution studying Mathematics Education humbly request that you validate my instrument for data collection on the topic; Effects of game based learning on junior secondary school student’s mathematics achievement.

The focus is to ensure its face and content validity and for clarity, a document showing the purpose of the research, chosen topics for the test, research questions and hypothesis is attached to the instrument.

Thanks in anticipation.

Yours faithfully

Johnson Amarachi

Researcher

**Appendix C**

**Teacher made mathematics achievement test**

Time allowed: 25 minutes

Name:-----------------------------------------------------

Group:----------------------------------------------------

Class: JSS 2

Instruction: answer all questions

1. All four sided figures are generally called ---------------------------------
2. Octagons B. Triangles C. Quadrilaterals D. none of the above
3. The area of the following figure

10cm

5cm

1. 15cm2 B. 30cm2 C. 5cm2 D. 50cm2 3.What shape is this?

1. Decagon. B. pentagon C. Hexagon D. Heptagon
2. The following are plane shapes except
3. Hexagon B. Cube C. Rectangle D. Circle
4. Reflex angle is between 1800 and 3600. Yes / No
5. An angle less than 900 is called
6. An acute angle B. An obtuse angle C. A reflex angle D. A and B
7. When two angles each other they are regarded as ----
8. Adjacent angles B. Complimentary angles C. Opposite angles D. None of the above
9. a right angled triangle is also regarded as angle----
10. 600 B. 1800 C. 450 D. 900
11. The perimeter of an equilateral triangle with sides 9cm is----
12. 81cm B. 27cm C. 18cm D. 12cm
13. Mention five types of angles you know.

**Appendix D**

VALIDATION REPORT

TOPIC:

THE EFFECTS OF GAME BASED LEARNING ON JUNIOR SECONDARY SCHOOL STUDENT’S ACHIEVEMENT IN MATHEMATICS

This is to certify that---------------------------------------------------------------------------------------------- validated the following instrument and made the following observations;

1.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6.\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

After the amendment(s) I consider the instrument fit for the study for which it was designed.

Signed\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Appendix E**

**Analysis of research hypotheses**

**Hypothesis 1**

t-test calculation

\_ \_

t= X1 +X2

( X21 + X22)(1 + 1)

( N1+N2-2) (N1 N2)

t= 33-24

(536 + 761) (1 +1)

(100+110-2) (100 110)

t= 12.01(calculated t)

**Degree of freedom**= N1+N2-2

100+110-2=208

**Level of significance**= 0.05

t-tabulated= 1.96

**Hypothesis 2**

t-test calculation

\_ \_

t= X1 +X2

( X21 + X22)(1 + 1)

( N1+N2-2) (N1 N2)

t= 34-30

( 574 +236) (1 + 1)

( 40+50 ) (40 50)

t=5.90

**Degree of freedom**= N1 + N2-2

40+50-2=88

**Level of significance**= 0.05

t-tabulated= 1.98

Appendix E

STUDENTS POPULATION FOR 2017\2018 ACCADEMIC SESSION IN ENUGU EAST LOCAL GOVERNMENT AREA OF ENUGU STATE

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Name of schools | Number of students in JSS 1 | Number of students in JSS 2 | Number of students in JSS 3 | Number of students in SS 1 | Number of students in SS 2 |  |
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