

## **Pupils' Perception on Gamification of Mathematics as a Tool for Technological Growth and Development in Kaduna State**

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### **Abstract**

*The importance of Mathematics as a foundational subject for developing the creative technological ability of people has since been established, though this is hampered by the phobia of the subject and the archaic methods of teaching in Nigeria. Studies of educational computer games have experienced sporadic growth globally with numerous learning benefits as games have become a favoured activity of youths today. This paper assessed pupils' perception of adopting a digital educational game as a supplementary educational tool in studying Mathematics in Kaduna North and South Senatorial zones. Primary school pupils' outlook using four constructs namely motivation of the pupils, their attitudes, their cognitive development, and their expectations were discussed. The game requirements were generated from actual pupils with a sample size of 420 respondents. Data obtained were analyzed and represented using percentages, mean scores, and standard deviation. The results indicated that pupils' opinions about gamification of Mathematics are mostly positive, which suggested that the game could be adopted as a supplementary learning tool in improving cognitive reasoning amongst pupils for technological growth and development.*

**Keywords:** Games; Gamification; Perception; Mathematics; Tool.

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### **Introduction**

The importance of mathematics as a course of study can never be overemphasized. The subject was established to develop competent people who can apply mathematical knowledge in solving everyday problems in life. It is also relevant to decision-making. The first National Mathematics Curricula for primary and

secondary schools used in Nigeria were developed in 1979. There was, however, a revision of the secondary school curriculum in 1986 to make provision for the 6-3-3-4 (6 years of primary, 3 years of junior secondary, 3 years of senior secondary, 4 years of tertiary) system of education (Okafor & Anaduaka, 2013). However, the Universal Basic Education (UBE) program was launched as a replacement for this system in Nigeria. UBE consists of a 9-3-4 system and involves 6 years of primary school and 3 years of junior secondary school adding up to a total of 9 years of uninterrupted schooling.

The introduction of the Universal Basic Education (UBE) was a move by the Nigerian Government to strive to attain the Millennium Development Goals and achieve the critical targets of the National Economic Empowerment and Development Strategies (NEEDS) which include value orientation, poverty eradication, job creation, wealth generation and empowering the citizens through education.

It has therefore become necessary that the existing curricula for primary and junior secondary school be reviewed and updated to fit into the 9-year Basic Education Program. Hence, in 2007, Nigeria adopted a New National Mathematics Curriculum for Basic Education. To make the curriculum responsive to the needs of the Nigerian child and the needs of the nation, issues relating to value orientation, peace and dialogue, human rights education, population, and family life education, drug abuse, environmental degradation, entrepreneurial and ICT skills were infused into the relevant curriculum contents. Also included were quantitative reasoning problems as well as topics like transactions in the home and offices, computer applications, use of measures of central tendency to analyze information on drug abuse, HIV/AIDS, and to show the importance of voting (Okafor & Anaduaka, 2013).

Mathematics is not a subject to joke with by any person or nation that wants to be productive and achieve scientific/technological development. Every individual requires the knowledge of mathematics to function effectively in the world today, irrespective of his/her job or profession. People encounter many demands for mathematical proficiency daily. To be able to manage ingredients for her recipes, the homemaker needs mathematic skills. She also needs to prepare her family's budget for food and other items that would be needed in the house. All these circumstances require ample mathematical knowledge for wise decisions to be made.

Nurses or medical personnel have a lot to do with mixing ingredients of different strengths as medication. They, therefore, need knowledge of different sizes, volumes, weights, and capacities of bottles. Businessmen and women also need to make predictions about fast-selling goods to purchase and decide on price cuts for slow-moving items. The carpenter, painter, driver, bricklayers, gardeners, and even farmers must put up with a lot of mathematical processing and quantitative situations. The value of mathematics in all fields of learning such as engineering, medicine, architecture, agriculture, etc., can also not be overemphasized. That is why Mathematics, called Arithmetic, as a subject is being taught right from the start of a child's educational pursuit in nursery school.

Mathematics is a very important subject as it encourages the habit of self-reliance and assists learners to think and solve problems themselves (Harbor-Peters, 2001). Commenting on the importance of Mathematics, Kravitz (2013) stated that it is the one skill everyone needs to master in life. Mathematics taught at the lower levels of the Nigerian educational system helps to build reasonable, thoughtful, and productive citizens. Emphasis on sound mathematical knowledge for pupils in primary and secondary schools ensures technological growth and economic development (Anaduaka, 2010). Pictorial representation of information like games is an interesting way of comprehending any information or task. According to Pivec & Keaney (2007) game-based learning can be applied as a close substitute to traditional classroom learning. When students' attention and efforts are directed into a game, there is hardly any distinction between work and play, making tasks carried out under the guise of games more tolerable and pleasurable. According to Fromme (2003) pupils have anticipated high interest in using games as one of their learning activities.

This paper studied pupils' perception of using educational games to study mathematics. The objective is to improve technological development in Kaduna North and South senatorial zones from the basic grade level as mathematics is a must for technological growth and development.

Science, Technology, Engineering, and Mathematics (STEM) is one of the key points to the future of innovation, economic competitiveness, and leadership in any nation. Studies have shown that STEM education has a direct relationship to a nation's future in many ways. It affects a nation's future not only in the areas of changing economy, leadership, and competitiveness, but also in global awareness, national security interests, unity, and cohesion of the country (The National

Commission on Mathematics and Science, 2000; Langdon et al., 2011). Despite this fact, several research studies have shown that there are various learning difficulties among pupils of all ages. Also, the existing methods of teaching Mathematics are at the very best, monotonous. Mathematics is usually taught in classrooms, with facts, figures, and rules written down in learners' notebooks. Many pupils find it difficult to study Mathematics, because they cannot easily digest facts and figures in written form (Chau, 2005). Furthermore, at the secondary school level, most students tend to believe that understanding Mathematics is reserved for a selected few. The mass failure in Mathematics at the higher education level and the frequency of examination malpractice are enough proofs of this dilemma. One of the most bedevilling consequences of mathematics anxieties is that it can lead to a negative attitude towards the subject, as well as negative self-perception about one's mathematics abilities (Ashcraft, 2002).

Even though mathematics as a subject is being taught right from the start of a child's educational pursuit, many pupils, nonetheless, have zero or little interest in the subject and most Nigerian school children dread mathematics. Most mathematics lessons in Nigeria are teacher-centred, not learner-centred. The subject is usually taught in classrooms, with facts, figures, and rules written down in learners' notebooks. For most of these students, pictorial representation of information is the only interesting way of understanding any information or data. Computer-aided software like games is graphically oriented to enhance problem solving.

With the proposal of a mathematics game, learning should now be meaningful to pupils as they would be actively involved in developing a suitable game based on their preferences through conducted surveys. From the requirement analysis generated, pupils should now get to think accurately in images and pictures, which would ultimately lead to early enhancement of learners' creativity.

The paper is organized into several parts. After the introduction, section two deals with literature review while the third section addresses the method used for the research. The findings are presented in section four while section five discusses the results and conclusion of the paper.

## **Literature Review**

A game is a physical or mental competition carried out by predetermined rules with the intention of entertaining or rewarding the players (Zyda, 2005). Generally, educational computer games combine game design principles and learning theories to integrate learning content of a specific subject matter. Pivec and Pivec (2008)

defined them as programs that allow collaborative learning, produce new ideas as well as exchange information via simplifying problems and resolving tasks. The reintroduction of amusement has led to the appearance of the concept of edutainment (Prensky, 2001; Gee, 2007).

The introduction of new technologies and tools in society has created a need for interactive content that can make the most of the potential that technological advances offer. There is a general notion that students' interest in various subjects would be enhanced by the joy and vast experience gained during playing games. Prensky (2003) observed that games are generally designed to balance subject matter with gameplay. Games also allow players to apply subject matter to real-world experiences. He added that video games are not the enemy, but the best opportunity we must engage our kids in real-life learning experiences (Prensky, 2003).

There is relative interest in specific games for education, professional training, healthcare, advertising, public policy, and social change (Noemi, 2004). Although professional games can be entertaining, their main purpose being to train or educate users; they may have other purposes such as marketing or advertising (Sawyer, 2002). Examples of such content are educational games (Noemi et al., 2014).

Many studies have reported on the use of commercial computer games for Mathematics, or the development of games developed for a specific subject. As indicated by these studies, computer games can increase students' math achievement and performance, and promote a positive outlook toward Mathematics. For instance, in a recent study, Pareto et al. (2011) created a teachable-agent arithmetic game that aims in training basic arithmetic skills. The game was evaluated in a study with 153 participants, consisting of 3<sup>rd</sup> and 5<sup>th</sup> grade students. The results indicated that the game helped students improve their math performance and self-efficacy beliefs. Ahmad and Latih (2010) described the development of an educational math game on fractions for primary school pupils. Similarly, Lee (2009) reported on the creation and evaluation of an educational game on fractions and mentions noting that it improved students' understanding and performance.

## **Methodology**

The questionnaire approach was adopted in the collection of data for the research. Questionnaires with 4 constructs including pupils' motivation, their attitudes, their cognitive development, and their expectations were distributed about learning using

games. These questionnaires were designed with structured questions set in a predetermined. The questions were close-ended because the researcher already has a clear understanding of the requirements for gamification of Mathematics. Also, structured questionnaires are credible, reliable and straightforward to conduct and analyze, especially given the nature of the respondents who are pupils that require assistance and guidance in conducting the analysis. The questionnaire items were adopted and modified from Ibrahim et al. (2011). Each questionnaire included 18 questions focused on young pupils (boys and girls) in Grades 4 and 5, aged between 7-13 years old. The number “1” was assigned to ‘strongly disagree’ and 5 to ‘strongly agree’ in the questionnaire options. 420 participants were recruited from the various local governments of Kaduna North and Kaduna Central senatorial zones. Kaduna State is known as the “Centre of Learning” and is characterized by several educational institutions to support this claim. Institutions in Kaduna metropolis include Kaduna State Univeristy, Nuhu Bamalli Polytechnic, College of Education Gidan Waya and even federal establishments like the Ahmadu Bello University Zaria, The Kaduna Polytechnic and the Nigeria Defence Academy. Kaduna State is a multi-cultural and multi-ethnic state with a population of more than 60 ethnic groups. The respondents, who were recruited from various private and public primary schools across Kaduna Senatorial zones, were accorded their due respect irrespective of their ages, and their privacy was maintained by the Data Protection Act 1998. Their rights were duly explained to them. The data were analyzed using quantitative analysis where the table was simplified into 3 points for better readability. SPSS 23.0 was used for the analysis.

**Table 1: Unbundling the Questionnaire**

<b>Section A: Background Questions</b>		
a.	Age in years	This refers to the age range of the earners which is between 7-13 years old.
b.	Sex	The pupils recruited included both young boys and girls.
c.	Grade	The pupils were of Grades 4 and 5 of Upper Primary schools.

**Table 2: Pupils' Motivation**

PUPILS' MOTIVATION						
No.	Statement	Agree	Not sure	Disagree	Mean	Standard Deviation
1.	Learning Mathematics is interesting	This seeks to determine the pupils' perception about the subject "Mathematics".				
2.	I prefer using games in classes to rote learning	This seeks to discover the experience of learners in playing games in classes in addition to rote learning.				
3.	I am very interested in using games for studying in the future.	This seeks to find out the interest of learners in using games in the near future.				
4.	The use of digital games will make Mathematics more interesting	This seeks to discover how much the pupils believe the use of digital games will make the subject, Mathematics more interesting.				

**Table 3: Pupils' Attitude**

No.	Statement	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
1.	I learn better in groups	This question seeks to investigate the social collaborative learning style of learners.				
2.	I prefer learning according to my pace.	This question seeks to find out the strength of the pupils.				
3.	I learn better using practice method than parrot learning.	This question seeks to know the individual learning style of the pupils.				
4.	I have played games on computer or mobile phone before	This question seeks to investigate the experience of the pupils with games.				
5.	I have played educational games based on a learning curriculum before.	This question seeks to find out the experience o the pupils with educational games that are based on a particular curriculum.				

6.	I have played computer games in school before.	This question seeks to find out the socio-economic background of the pupils' schools.
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**Table 4: Pupils' Cognitive Development**

No.	Statement	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
1.	Computer games make me think better.	This question intends to find out the impact of games for learning in pupils.				
2.	Solving Mathematics problems is interesting.	This question intends to address the interest of the learners in Mathematics.				
3.	I enjoy competing against other pupils.	This question seeks to determine the social competitive learning style of pupils.				
4.	It is fun playing games.	This question seeks to determine the love for games by learners.				

**Table 5: Pupils' Expectations**

No.	Statement	Strongly agree	Agree	Not sure	Disagree	Strongly disagree
1.	I wish to play games with cartoon characters.	This question seeks to determine the level of need for customization of games by pupils.				
2.	I wish to have more opportunities to learn using games.	This question seeks to determine the level of interest of gamification by pupils.				
3.	I would love to learn other subjects in future with games.	This question seeks to investigate the future learning style of other subjects by learners.				
4.	I wish these games will be available online for easy access.	This question seeks to find out the exposure of the learners to online learning.				

**Results**

In this section, the findings from the questionnaires received are presented. The results from the questionnaires are illustrated using percentages, mean and standard deviations. The reliability statistics of all 18 items used is Cronbach's Alpha with the value of 0.970.

**Table 6: Pupils' Motivation**

PUPILS' MOTIVATION						
No.	Statement	Agree	Not sure	Disagree	Mean	Standard Deviation
1.	Learning Mathematics is interesting	58%	19%	13%	2.00	1.200
2.	I prefer using games in classes to rote learning	67%	20%	13%	4.05	0.865
3.	I am very interested in using games for studying in the future.	57%	15%	28%	2.50	1.400
4.	The use of digital games will make Mathematics more interesting	77%	10%	22%	2.40	1.500

Table 6 shows pupils' motivation in learning to use games. The noticeable finding from this construct is that 77% of the pupils believed that using games will make Mathematics more interesting while 10% of them were not sure about it. This shows that pupils are encouraged by the idea of using educational games for their learning with more than 70% of them accepting that games make the subject more interesting. 67% of pupils prefer doing their exercises using games as compared to the traditional exercise (books or paper) way of doing exercises given by teachers in class. From the table, 78% of the pupils believe that using games for learning

was very beneficial to them. More than 50% of them enjoy Mathematics as a subject.

**Table 7: Pupils' Attitude towards using games**

PUPILS' ATTITUDE						
No.	Statement	Agree	Not sure	Disagree	Mean	Standard Deviation
1.	I study better in groups	77%	12%	11%	1.90	1.400
2.	I prefer learning according to my pace.	88%	8%	4%	1.90	2.000
3.	I learn better using the practice method than parrot learning.	77%	16%	7%	1.80	1.000
4.	I have played games on a computer or mobile phone before	90%	4%	6%	1.60	0.900
5.	I have played educational games based on a learning curriculum before.	62%	25%	13%	2.20	1.100
6.	I have played computer games in school before.	66%	11%	23%	2.40	1.600

Table 7 shows the pupil's attitude in using games. Almost 80% of the pupils agree that they study better in groups. They also agree that by using games, they can study at their own pace (88%). This can help pupils to understand the subject content in the way that they prefer without any pressure from their surroundings, nor including pressure from friends or teachers. 62% of the pupils agreed that the content of the educational game they have played before matches the syllabus of the subject.

**Table 8: Pupils' Cognitive Development**

PUPILS' COGNITIVE DEVELOPMENT						
No.	Statement	Agree	Not sure	Disagree	Mean	Standard Deviation
1.	Digital computer games make me think better.	60%	19%	21%	2.50	1.500
2.	Solving Mathematics problems is interesting.	77%	10%	13%	1.90	1.200
3.	I enjoy competing against other pupils.	84%	6%	10%	1.70	1.400
4.	It is fun playing games.	82%	5%	13%	1.80	1.100

Table 8 discusses pupils' cognitive development by using games. 60% of the pupils agree that generally, games help them to think better. Furthermore, they believe they will find it more interesting to learn Mathematics by playing games (77%). More than 80% of them enjoy competing against each other. Findings of this factor show that pupils predicted that playing educational games would be a fun-filled and engaging activity that would help them think critically.

**Table 9: Pupils' Expectations**

PUPILS' EXPECTATION						
No.	Statement	Agree	Not sure	Disagree	Mean	Standard Deviation
1.	I wish to play games with cartoon characters.	81%	2%	17%	4.05	0.669
2.	I wish to have more opportunities to learn using games.	64%	22%	14%	2.80	5.100
3.	I would love to learn other subjects in the future with games.	67%	17%	14%	4.10	2.600

4.	I wish these games will be available online.	77%	15%	8%	4.05	0.805
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The final construct is pupils' expectation in utilizing games for their learning (refer to table 9 above). This portion is to know what the pupils' view is regarding learning with games. 64% of the pupils wish that they were provided more time to use games as learning approaches. Expectedly, 81% of the pupils prefer to use customized educational games with cartoon characters to generic games developed for no specific audience. Similarly, 67% of them would like to use educational games to learn other subjects. 77% of the pupils prefer the games to be online for ease of access.

### **Discussion**

This paper presented the perception of pupils on using gamification to aid in learning Mathematics. The results inferred in our study showed that opinions about gamification were mostly positive, and the respondents consider games to be useful learning tools, regardless of their age and gender. This shows that the use of games can be adopted in critical problem-solving subjects like Mathematics. These findings conform to the study conducted by Zaharin et al. (2021) that the student's perception of learning two topics in Mathematics, perimeter, and area is very high. The study also indicated that pupils have high interest in using games as one of their learning activities. They have shown great interest in using games in solving Mathematical problems, and games have been proven to generate greater enthusiasm for the subject. This indicated that games might be suitable for certain subjects, for example, subjects that enjoy low motivation among students. This is an indication that pupils' learning styles and preferences have changed, and educators must adapt to the preferences of the new generation of learners.

Based on pupils' expectations, we are highly encouraged to further and expand the study. The pupils have exhibited great interest in using games for learning, so an evaluation of the improvement of Mathematical skills before and after the implementation of games using a larger sample size is necessary.

### **Conclusion and Recommendations**

This paper deals with the perception of pupils about teaching Mathematics using games. Games are popular and can achieve learning objectives. A major push for this gamification is that many students encounter a lot of difficulties while learning Mathematics. We also identified the reasons for the fear of the subject by many pupils which include lack of motivation for the subject, lack of confidence and the

insufficient practice by the learners. We then proffered solutions of varying the methods of teaching the subject in order to enhance the interest of the learners and make the subject view the subject as a source of enjoyment, not a chore. As a background for the study, the researcher(s) decided to use structured questionnaires with four constructs (motivation, attitude, cognitive development, and expectations) to determine the respondents' present perception of Mathematics and future requirements on the subject's gamification. It can be concluded that gamification is ideal to be conducted as a concurrent method of teaching and learning Mathematics since pupils' interest in learning can be improved. Accordingly, this will increase their creative technological abilities.

Based on the findings of this study, the following recommendations were made:

1. Educational games should be used as a complementary learning tool of various subjects especially Mathematics in the nearest future to make the classes more interesting and comprehensible.
2. Customized games with popular cartoon characters should be incorporated into learning to make studies more enjoyable.
3. The educational games can be hosted online to make them more accessible to a larger number of learners.

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