Effect of Game-Based Learning on Academic Performance of Pupils in Numeracy in Ekiti Local Government Area, Kwara State

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Abstract

Poor performance in numeracy at the primary schools might be as a result of inadequacies and inappropriate use of classroom practices by the teachers. Therefore, the researchers investigated effect of game-based learning on academic performance of pupils in numeracy in Ekiti Local Government Area, Kwara State. This study adopted the pre-test post-test Quasi-experimental research design. Stratified random sampling technique was used to select four schools (2 public and 2 private). Numeracy Performance Achievement Test (NPAT) was used for data collection. The reliability level of the items was established using test re-test method and analysed with Pearson Product Moment Correlation (PPMC) yielding reliability coefficient of 0.83. Data collected was analysed using Analysis of Covariance (ANCOVA) at 0.05 significance level. The study established a significant effect of game-based learning on the academic performance of pupils in numeracy ($F_{(1; 91)}$ =15.800; P<0.05). It was concluded that game-based learning ease the understanding of learners in numeracy than the conventional method of teaching and learning. Therefore, teachers should be educated through seminars and workshops on the effectiveness of Game-based Learning on pupils' academic performance in numeracy.

Keywords: Numeracy, Game-based learning, Gender and School-type

Introduction

Numeracy is the competence and skills needed by pupils in order to contend with all challenges of life and understanding of information presented mathematically. Mathematics is the basis in today's systematic life. Without numerical and mathematical proof, one may not be able to make any conclusion on many matters in daily life. One may be aware that mathematics plays a crucial role in economic and social development of a Nation because it is the bedrock for science and technology. Engaging in any profession one may not succeed without having numeracy skills (Mehraj, 2014). This view may justify why the Federal Republic of Nigeria (2013) in her National Policy on Education defined primary education as the education given in an institution to children aged 6 to 11 plus. The National Policy went further to explain that the rest of Nigeria education system is built upon primary education and is the key to the success or failure

of the whole system. This can best be done by checking how the primary school system is expected to actualize its goals of inculcating permanent literacy and numeracy, ability to communicate effectively, to lay a sound basis for scientific and reflective thinking, give Nigerian children the opportunities for developing manipulative skills that will enable them function effectively in the society within the limits of the child's capacity; and Provide the child with basic tools for further educational advancement, including preparation for trades and crafts of the locality, among others (FRN,2013)

Thus, any Nigerian child at primary school level is taught basic numerical and language skills. The skills acquired enable the child to effectively communicate and transact in the society (Anekwe, 2018). The foundation for children's numeracy is established in the early years. Numeracy learning builds curiosity and enthusiasm of children naturally from their experience. Numeracy at primary school level, if appropriately connected to a child's world, helps in getting children ready for school.

However, poor academic performance in numeracy was evident during the inter-schools quiz competition in Ekiti Local Government Area of Kwara State when pupils found it difficult to answer some of the numeracy questions in common entrance examination (2017 and 2018) where 40% of the pupils scored 50 marks and above while 60% scored below 50 marks (Yusuf, 2019).This was also evident during Nigeria Mathematics and Science Olympiad (2020) held at Omu-aran, Irepodun Local Government Area, Kwara state where 90% of the participants failed the mathematics aspect of the competition due to their low level of knowledge acquisition of numeracy skills from primary school and Junior Secondary School respectively (Saadu, Obafemi & Yusuf, 2020). This has been attributed to the inability of the pupils to learn, unlearn, and re-learn and the inadequacies in parental efforts to make pupils read at their various homes in order to master and discover new things in themselves different from what they have been taught and exposed to in school (Yusuf, 2019). This is without prejudice to the fact that the teacher is a major influential agent with principles and practices consider in teaching and learning processes in the classroom where both teaching and learning depend on the abilities of the teacher to drive home lessons with the appropriate use of strategies and instructional resources especially in numeracy (Yusuf, 2019)

One of the determining factors of pupils' performance in numeracy is the quality of principles and practices employed by the teacher (Adeyemi, 2002). The traditional pedagogical practices, which are confined to conveying information using telling, reading, and memorising, and the teacher adopting the "fountain of knowledge" approach, have failed to cope with the problems of Numeracy and scientific related knowledge subjects needed for development (Kohle, 2002). Appropriate pedagogical approaches need to be sought in passing the message of Numeracy and other related science subjects across to learners such as game-based learning instruction

Game is an activity that is voluntary and enjoyable, separate from the real world, uncertain, unproductive in that the activity does not produce any goods of external

value, and governed by rules (Caillois, 1961). Learning mathematics presents various challenges for many children due to the difficult and often tedious nature of the subject (Sedig, 2007). However, Video games have been used to promote children's mathematics achievement in various domains including problem-solving and algebra skills (Abramovich, 2010), strategic and reasoning abilities (Bottino, Ferlino, Ott, & Tavella, 2007), critical geometry skills (Yang & Chen, 2010), and arithmetic procedures (Moreno & Duran, 2004). Nevertheless, the National Mathematics Advisory Panel (NMAP, 2008) and others (Martinez-Garza, Clark, & Nelson, 2013; Pellegrino & Hilton, 2012; Young et al., 2012) do not provide a direct recommendation for using games as a potentially useful tool in introducing and teaching specific subject-matter to specific populations (NMAP, 2008) due to the limited number of rigorous studies exploring effects of game-based learning on mathematics skills development.

Beserra, Nussbaum, Zeni, Rodriguez, and Wurman (2014) examined third grade students' arithmetic performance in game-based and traditional classroom conditions in three different countries (Brazil, Chile, and Costa Rica). The authors found that game-based learning was more effective than a traditional classroom approach. Conversely, several studies did not show positive benefits of using video games in a mathematical classroom. For instance, Ferguson (2014) found that traditional instruction was more effective than game-based instruction for high school Algebra 1 students. Swearingen's (2011) research showed that both game-based and traditional instructional approaches were equally beneficial for teaching high school mathematics. Moreover, not only did different research teams that used different games for promoting distinct learning outcomes report mixed results, some findings by the same researchers who used the same mathematics video games were inconsistent (Ke,2008, Ke,2008, Ke,2008, Ke & Grabowski, 2007).

Papastergiou (2009) conducted research in a secondary school on a sample of 88 pupils, 47 in group A who used computer games in learning, and 41 in control group B without computer games. The research analysis indicated that teaching with computer games was more efficient in promoting pupils' knowledge. In their study Kebritcki and Hirumi (2010) looked into the effects of computer games on pupils' mathematical achievements and motivation. They also examined the effects of prior math knowledge, computer skills and knowledge of English on achievements and motivation. The results indicated a significant improvement of achievements and motivation of pupils who played computer games both in ordinary classrooms and computer labs when compared to the pupils who played games only in computer labs. Prior knowledge, skills and knowledge of English did not have a significant role in achievements or motivation. During an eight-weeks research in which 10-year-olds created their own games, Robertson and Howells (2008) study emphasised the importance of the teacher's role. To them, the teacher has to be a good organiser and leader, while providing help and support and directing pupils in their active work. Since the process of game design also

involved game playing (because of testing), pupils developed better meta-cognitive skills and decision-making skills which is a result identical to results of researches dealing with positive impacts of games on learning numeracy.

Adigun, Onihunwa, Irunokhai, Sada, and Adesina (2015) investigated the effects of gender on the academic performance in Computer Studies in secondary schools in New Bussa, Borgu Local Government of Niger State and the results showed that boys did better more than girls. However, male students' performance diverges more around average when compared to the female students. Yusuf (2019), also carried out research on effects of think-pair-share and problem-solving strategies on numeracy academic performance of pupils in Ekiti Local Government Area, kwara state. Findings from the study, found that there was no significant different between the numeracy academic performances of pupils based on gender and school-type respectively. Obafemi (2017), researched on the effects of jigsaw teaching method on pupils' academic achievement in social studies in Ilorin West Local Government Area of Kwara state. The study result also revealed that there was no significant effects of school-type and gender on the pupils' performance. This also formed part of the motives of this study to also investigate whether or not there would be significant difference in the academic performance of male and female pupils in numeracy using game-based learning

Yusuf and Adigun (2010) investigated the influence of school type, sex and location on students' academic performance in Ekiti State secondary schools. The findings from the study revealed that school type, sex and location had no significance contribution on students' academic performance. Onekutu (2002) perused the difference in the academic achievement of students in both private and public secondary schools in Akwa Ibom State. The findings of this study showed that students in private secondary schools performed better in Social Studies than those in public schools.

From the reviewed researches, it is evident that school type influence academic performance of learners, but there was a controversy on the influence. Some researches revealed that public school students do better than private school students while others revealed that private school students do better than public school students. This is one of the rationales for the inclusion of the variable of the school-type in this study in order to establish if there would be significant different in academic performance of public and private pupils in numeracy using game-based learning as a strategy to present the instruction.

Statement of the Problem

Numeracy skills are needed by learners in order to contend with all challenges of life and understanding of information presented mathematically. One may also be aware that mathematics plays a crucial role in economic and social development of a nation because it is the bedrock for science and technology. Numeracy, in primary schools

today, is the world-beater of all sciences and the keystone of civilization. Engaging in any profession one may not succeed without having numeracy skills. Despite of this, learners across all the categories of education still find it difficult to understand the concept of numeracy which usually leads to poor academic performance. The poor academic performance in Numeracy was also evident during the inter-schools quiz competition where pupils found it difficult to answer some of the numeracy questions in the last two years common entrance examination (2017 and 2018) where 40% of the pupils scored 50 marks and above while 60% scored below 50 marks. This was also evident during Nigeria Mathematics and Science Olympiad held at Omu-aran Irepodun Local Government Area, Kwara state where 90% of the participants failed the mathematics aspect of the competition due to their low level of knowledge acquisition of numeracy skills from primary school. Based on this reason, the researchers investigated the effects of game-based learning on academic performance of pupils in Ekiti Local Government Area, Kwara state.

Based on the stated problem, the following research questions were used to direct this study.

1. There is no main effect of game-based learning method on pupils' performance in numeracy in Ekiti Local Government Area of Kwara State.

2. There is no main effect of gender on pupils' performance in numeracy in Ekiti Local Government Area of Kwara State.

3. There is no main effect of school type on pupils' performance in numeracy in Ekiti Local Government Area of Kwara State.

4. There is no interaction effect of:
   a. game-based learning method and gender;
   b. game-based learning method and school-type;
   c. gender and school-type on pupils' numeracy academic performance in Ekiti Local Government Area of Kwara State.

5: There is no interaction effect of game-based learning method, gender and school-type on pupils' performance in numeracy in Ekiti Local Government Area of Kwara State.

Methodology

The pre-test post-test quasi experimental research design was adopted while stratified sampling technique was used to select 4 schools (2 public and 2 private). A Numeracy Performance Test developed based on some topics selected from the curriculum which pupils were exposed to. This test was used to obtain pre-test and post-test scores administered to both experimental and control groups. The instrument was validated by the numeracy teachers of the selected schools and some lecturers in the department of Early

Childhood and Primary Education. The reliability of the items were established using test-retest given within two weeks interval and was analysed using Pearson Product Moment Correlation (PPMC) and it yielded reliability coefficient of 0.83.

The procedure adopted was to give the pre-test developed based on the topics chosen to the pupils before the treatment began. After this, those in the experimental group were taught the selected topics using game-based learning strategy and control group were taught the same topics using traditional method. After the teaching and learning exercises, the test was administered to the two groups again. Data collected was analysed using Analysis of Covariance (ANCOVA) at 0.05 level of significance.

Results

Research Question 1: There is no significant main effect of game-based learning on academic performance of pupils in numeracy in Ekiti Local Government Area of Kwara State.

Table 1: **Summary of Analysis of Co-variance (ANCOVA) on the effect of game-based learning on pupils' Numeracy academic performance in Ekiti Local Government Area of Kwara State**

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	12019.955[a]	8	1502.494	3.935	.000
Intercept	9879.106	1	9879.106	25.871	.000
Pretest	86.405	1	86.405	.226	.635
Game Based Learning	6033.442	1	6033.442	15.800	.000
Gender	1005.719	1	1005.719	2.634	.108
School-type	661.122	1	661.122	1.731	.192
Game Based * Gender	353.698	1	353.698	.926	.338
Game Based * School-type	21.698	1	21.698	.057	.812
Gender * School-type	18.573	1	18.573	.049	.826
Game Based * Gender * School-type	82.332	1	82.332	.216	.644
Error	34749.045	91	381.858		
Total	359250.000	100			
Corrected Total	46769.000	99			

Table 1 shows the result of the analysis of effect of game-based learning on academic performance in numeracy by the pupils used. The reveals that was significant main effect of game-based learning on the academic performance of pupils in numeracy $(F (1; 91) = 15.800; P < 0.05)$. Thus, the hypothesis was rejected in the light of the result since the significant level (.000) was less than the 0.05. This implies that the use of game-based teaching-learning process while teaching numeracy can enhance the pupils' performance in numeracy in Ekiti Local Government Area, Kwara State.

Table 2:   **Summary of Bonferroni's Post Hoc pairwise Comparison of the scores within the two Groups**

Treatment	Mean Score	Experimental	Control Group
Game-Based Learning Method	65.042	*	
Traditional Method	47.714		*

Table 2 reveals that that those taught with game-based Learning performed significantly better than those taught with traditional method because the mean of 65.04 by those in the experimental group is higher than mean of 47.71 generated by those in the control group.

Research Question 2: There is no significant main effect of gender on academic performance of pupils in numeracy in Ekiti Local Government Area of Kwara State.

Information from Table 1 showed the effect of gender on academic performance in numeracy. The result indicates that there was no significant main effect of gender on the pupils' performance in numeracy ($F_{(1; 91)}$ =2.634; P>0.05). Thus, the hypothesis was not rejected in the light of the result since the significant level (.108) was greater than the 0.05. This implies that gender had no effect on academic performance of pupils in numeracy in Ekiti Local Government Area, Kwara State

Research Question 3: There is no significant main effect of school type on academic performance of pupils in numeracy in Ekiti Local Government Area of Kwara State.

Table 1 also showed that there is no significant effect of school-type on the pupils' performance in numeracy ($F_{(1; 91)}$ =1.731; P>0.05). Thus, the hypothesis was not rejected in the light of the result since the significant level of 0.192 generated by gender was greater than the 0.05. This implies that school-type had no significant effect on academic performance of pupils in numeracy in Ekiti Local Government Area, Kwara State

Research Questions 4a, b and c: There is no significant interaction effect of game-based learning and gender, game-based learning and school-type as well as gender and school-type on pupils' performance in numeracy in Ekiti Local Government Area, Kwara State.

Information emanating from Table 1 shows that there is no interaction effect of game-based learning and gender ($F_{(1; 91)}$ =.926; P = 0.338 < 0.05, game-based learning and school-type ($F_{(1; 91)}$ =.057; P= (.812) < 0.05) as well as gender and school-type ($F_{(1; 91)}$ =.049; P=(.826) < 0.05) on pupils' performance in numeracy in Ekiti Local Government Area, Kwara State. Thus, the hypothesis was not rejected in the light that

the significant level of game-based learning and gender, game-based learning and school-type as well as gender and school-type on pupils' performance in numeracy in Ekiti Local Government Area, Kwara State were greater than the 0.05. This implies that the combination of these variables had no significant interaction effect on academic performance of pupils in numeracy in Ekiti Local Government Area, Kwara State.

Research Question 5: There is no significant interaction effect of game-based learning, gender and school-type on pupils' performance in numeracy in Ekiti Local Government Area of Kwara State.

Table 1 reveals that there is no significant the interaction effect of game-based learning, gender and school-type on pupils' performance in numeracy ($F_{(1; 91)}$ =.216; P>0.05). Thus, the hypothesis was not rejected in the light of the result since the significant level (.644) was greater than the 0.05. This implies that game-based learning, gender and school-type had no significant effect on pupils' performance in numeracy in Ekiti Local Government Area, Kwara State

Discussion

One of the results of the study revealed that, there was significant effect of game-based learning on the academic performance of pupils in numeracy in Ekiti Local Government Area, Kwara state. The findings of this study support Beserra et al (2014) who examined third grade students' arithmetic performance in game-based and traditional classroom conditions in three different countries (Brazil, Chile, and Costa Rica). The authors found that game-based learning was more effective than a traditional classroom approach. This was also concurred with the findings of Papastergiou (2009) whose findings indicated that teaching with computer games was more efficient in promoting pupils' knowledge.

Further, the result collaborates with Kebritcki and Hirumi (2010) which looked into the effects of computer games on pupils' mathematical achievements and motivation. They also examined the effects of prior math knowledge, computer skills and knowledge of English on achievements and motivation. The results indicated a significant improvement of achievements of pupils who played computer games. The pupils who played games both in ordinary classrooms and computer laboratories had better motivation when compared with the pupils who played games only in computer laboratories. Also, the results analysis of a geography lesson in which computer games were used (Tüzün,Soylu, Yavuz,2009) indicated a significant difference in easier learning and increased motivation as well as greater independence of pupils who played computer games during learning. Burguillo (2010) observed that a combination of game playing and friendly competition resulted in pupils' strong motivation and helped increase learning effectiveness and achievements. From the above discussion, it was

deduced that learners can perform significantly well in all subjects especially in numeracy and other science related subjects if teacher make use of appropriate principle and practice in the classroom and appropriate pedagogy like game-based learning in dissemination of instruction

Against the findings of this study, Costabile, De Angeli, Roselli, Lanzilotti, & Plantamura, 2003; Gelman, (2010) and Jones, (2011) submitted that several studies did not show positive benefits of using video games in a mathematical classroom. For instance, Ferguson (2014) found that traditional instruction was more effective than game-based instruction for high school Algebra 1 students. Swearingen's (2011) who revealed that both game-based and traditional instructional approaches were equally beneficial for teaching high school mathematics. Moreover, not only did different research teams that used different games for promoting distinct learning outcomes report mixed results, some findings by the same researchers who used the same mathematics video games were inconsistent.

One of the findings from this study stated that there was no significant effect of gender on the academic performance of pupils in numeracy. This was in agreement with the findings of Yusuf (2019), who carried out research on effects of think-pair-share and problem-solving strategies on numeracy academic performance of pupils in Ekiti Local Government Area, kwara state. Findings from the study, found that there was no significant different between the numeracy academic performances of pupils based on gender and school-type respectively. And also, Saadu, Obafemi and Yusuf (2020), researched on the effects of personalised learning on pupils' numeracy academic performance in Ekiti Local Government Area of Kwara state and found that there was no significant main effect of gender on the academic performance of pupils in numeracy.

In contrary, Adigun, Onihunwa, Irunokhai, Sada, and Adesina (2015) investigated the effects of gender on the academic performance in Computer Studies in secondary schools in New Bussa, Borgu Local Government of Niger State. The results found that boys do better more than girl. However, male students' performance diverges more around average equate to the female students. Literature indicates that the role played by boy and girl in Mathematics education is multifarious (Maccoby, 1998 &Fennema, 2000). Their findings showed a lot of differences in Mathematics connected to gender over the past decades. Fenemma (2000) investigated into gender differences in mathematics performance among secondary school students in Bureti Sub-County, Kericho County Kenya. The findings of the study showed that there was a significant difference in performance based on gender because male students out-performed the female students in Mathematics.

Another finding also stated that there was no significant effect of school-type on the academic performance of pupils in numeracy. This was against the submission of Onekutu (2002) who perused into the difference in the academic achievement of

students in both private and public secondary schools in Akwa Ibom State. The findings of this study showed that students in private secondary schools performed better in Social Studies than those in public schools. Yusuf (2019) and Saadu, Obafemi and Yusuf (2020), submitted that there was no significant effect of school-type of academic performance of pupils in numeracy in Ekiti Local Government Area, Kwara state. This connotes that, the pupils' performance in subjects especially in numeracy does not based on school-type stereo-type it depends on the ability of the pupils and strategy used by the teacher used during the teaching and learning process to disseminate better understanding of the subject matter

Based on the above discussion, it was pertinently and clearly stated that game-based learning can ease he understanding of the learners in numeracy than the conventional method of teaching and learning.

Recommendations

In the light of this conclusion, the following recommendations were made:

Teachers should be educated through seminars and workshops on the effectiveness of Game-based Learning on pupils' performance in numeracy.

Curriculum developer in Numeracy such as, Federal and State Ministries of Education, school proprietors and NERDC should incorporate game-based learning into the Numeracy curriculum as one of the innovative strategies that would be used to teach numeracy concepts and other related science subjects in schools.

Learners' academic performance should not be determined based on their gender and school type because, the two factors have been discovered not to be strong factors that hinder learners' academic performance it depends on the principles and practices and pedagogy like game-based learning employed by the teacher

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