

EFFECTS OF MATHEMATICAL GAMES ON SENIOR SECONDARY STUDENTS' ACADEMIC PERFORMANCE IN MATHEMATICS IN EJIGBO, OSUN STATE, NIGERIA

Kesan Permainan Matematik Keatas Prestasi Akademik Pelajar Sekolah Menengah Atas di Ejigbo, Negeri Osun, Nigeria

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Abstract

The secondary school system of education in Nigeria assumes the role of training and producing students for tertiary institutions and manpower for national development and world of work. The general poor academic performance of students in Mathematics has become a source of great concern to all the stakeholders in education particularly the Mathematics educators, parents and the government. Educational Game is one of the strategies that have been found to enhance the attitude and academic achievement of students in many subjects including Mathematics. But many Mathematics teachers lack the knowledge of the role of Mathematical Games. The study therefore, examined the effects of Mathematical Games on senior secondary students' academic performance in Mathematics in Ejigbo, Osun State, Nigeria. The researchers adopted a quasi-experimental research design and used simple random sampling technique to select two senior secondary schools for the study. A total of 73 students (32 experimental and 41 control groups) were involved in the study. The experimental group was exposed to Mathematical Games during the teaching of Mathematics for a period of three weeks while the control group was not exposed to Mathematical Games. Mathematics Performance Test (MPT) was used for data collection on students' academic performance. The findings of the study revealed that the use of Mathematical Games has a significant positive effect on the academic performance of the students in Mathematics; the use of Mathematical Games was beneficial to students irrespective of their gender and scoring ability. It was recommended among other things that government should provide Mathematical Games for secondary school students and Mathematics teachers should incorporate the use of Mathematical Games into the teaching and learning of Mathematics.

Keywords: Games, Academic performance, Secondary school, Mathematics, Instructional Game

Abstrak

Sistem pendidikan sekolah menengah di Nigeria memainkan peranan untuk pelatihan dan melahirkan pelajar untuk institusi pengajian tinggi dan tenaga kerja untuk pembangunan negara dan dunia kerja. Prestasi akademik pelajar yang lemah dalam Matematik telah menjadi sumber keprihatinan yang besar kepada semua pihak berkepentingan dalam pendidikan terutamanya pendidik matematik, ibu bapa dan kerajaan. Permainan Pendidikan merupakan salah satu strategi yang didapati telah meningkatkan sikap dan pencapaian akademik

pelajar dalam banyak mata pelajaran termasuk Matematik. Namun, ramai guru-guru Matematik kekurangan pengetahuan tentang peranan Permainan Matematik. Oleh itu, kajian ini mengkaji kesan Permainan Matematik ke atas prestasi akademik pelajar sekolah menengah dalam Matematik di Ejigbo, Osun State, Nigeria. Para penyelidik menggunakan reka bentuk penyelidikan separa eksperimen dan menggunakan teknik persampelan rawak mudah untuk memilih dua sekolah menengah untuk kajian. Seramai 73 pelajar (32 orang dalam kumpulan eksperimen dan 41 orang dalam kumpulan kawalan) terlibat dalam kajian ini. Kumpulan eksperimen terdedah kepada Permainan Matematik semasa pengajaran Matematik untuk tempoh tiga minggu manakala kumpulan kawalan tidak terdedah kepada Permainan Matematik. Ujian Prestasi Matematik (MPT) digunakan untuk pengumpulan data mengenai prestasi akademik pelajar. Dapatan kajian menunjukkan bahawa penggunaan Permainan Matematik mempunyai kesan positif yang ketara terhadap prestasi akademik pelajar dalam Matematik; penggunaan Permainan Matematik memberi manfaat kepada pelajar tanpa mengira jantina dan keupayaan pemarkahan mereka. Adalah disyorkan antara lain kerajaan perlu menyediakan Permainan Matematik kepada pelajar sekolah menengah dan guru Matematik perlu menggabungkan penggunaan Permainan Matematik ke dalam pengajaran dan pembelajaran Matematik.

Kata kunci: permainan, prestasi akademik, sekolah menengah, matematik

1.0 INTRODUCTION

The secondary school system of education in Nigeria is responsible for training and producing students for tertiary institutions and developing manpower for national development and world of work. The general poor academic performance of students in Mathematics has become a source of great concern to all the stakeholders in education particularly the Mathematics educators, parents and the government, (Akanmu, (2013)). Making the teaching and learning of Mathematics at this level more interesting and captivating through the use of different instructional strategy and media is therefore required for a better achievement in the subject.

The competence gained in the study of Mathematics is widely used in all spheres of human life. Mathematics plays a key role in shaping how individuals deal with the various spheres of private, social, and civil life (Mensah, Okyere & Kuranchie, 2013). This justifies the compulsion of the study of the subject by all students at both primary and secondary education in Nigeria. Mathematics is a core subject at these levels of education. It is regrettable, therefore, that in the contemporary times many students struggle with Mathematics and perform abysmally low in external examinations. Studies carried out by researchers (Adeniyi, 2012; Fajemidagba, Salman & Ayinla, 2012) revealed that the senior secondary school students' performance in SSCE Mathematics examinations for years have remained worrisome and not encouraging. Candidates are reported to exhibit poor understanding of Mathematical concepts and are unable to form the appropriate Mathematical models which could be tackled with the requisite skills (WAEC Chief Examiner's Report, 2007).

With the relationship of the indispensability of Mathematics in the survival of the society and the educational system, Mathematics educators have been concerned with the ways in which students can learn Mathematics effectively and with utmost interest and better achievement. Hence effort is now on how to use mathematical games to harness the students' intellectual power since we are now in the technological age whereby students from both primary and secondary levels of education are being carried attracted to technology-based games.

Instructional games are structured and interactive activities governed with a set of rules for the purpose of engaging two or more students in a game designed to achieve a set of instructional objectives. Instructional games have the ability to stimulate people to learn concepts that are ordinarily abstract or difficult. Games are usually played by people of all ages. It has the ability to increase social interaction among people and is a good strategy for learning new skills or concepts. Playing games require a winner which makes the participants to employ different tactics, strategies and initiative to stand the chance of winning the game. (Abonyi & Okoli, 2014)

A mathematical game is a type of play that follows a set of rules, aims at definite goal or outcome, and involves competition against other players or against barriers imposed by the nature of the game itself (Abonyi, Maduagwuna & Ugama, 2014). A game is regarded as 'mathematical game when the players can perceive and/or influence the course of the game on the basis of mathematical considerations (Abonyi, Maduagwuna & Ugama, 2014). Examples of Mathematical games include; Geoboard games which is used for learning geometric concepts, ludo game which can aid the learning of probability, Coordinate game for learning coordinates and cartesian plain, Card game for learning number concept and coin game which is also for probability. (Nekang, 2018)

Mathematical games may be used to introduce concepts as a prelude to explicit teaching or practice skills or consolidate a concept after explicit teaching. Educational games do lead to improved learning (Okigbo & Agu, 2010). Some researchers have evaluated the effectiveness of Mathematical games and gave reasons for the use of games. Among them are the powerful motivation, involvement, and the development of positive attitudes in learning have long been recognized as being essential and necessary, Games are also valuable for encouraging social skill, for stimulating discussions, helping the development of understanding, for developing strategies, for learning new concepts, reinforcing skills and concepts as an aid to symbolization and logic (Victor, Adeleye & Tinovimbanashe (2017); Okigbo & Agu, 2010). Games help to reduce the level of abstraction involved in teaching and learning a concept in Mathematics, capture the learner's interest and provide environment for active participation of the students (Moursund, (2017); Nekang, (2018); (Okigbo & Agu, 2010; Russell, 2000).

Abonyi, Maduagwuna and Ugama (2014) investigated the effect of mathematical game on students' achievement in quadratic expression. The study employed a non-equivalent control group quasi-experimental design. Three research questions and three hypotheses guided the study. The result revealed that the mathematical game approach is superior to the conventional method in facilitating students' achievement in Mathematics. The study also revealed that although with mathematical game approach males showed higher achievement than the females, the difference in the mean achievement of males and females taught using the method is not statistically significant. Also, Okigbo and Agu (2010) examined the effects of mathematical game and instructional analogy on students' achievement in junior secondary school Mathematics. A total of 246 Junior Secondary Two (JS2) Mathematics students were involved in the study. A 3×2 factorial design was adopted in the research. From the findings, it was observed that both game and analogy enhanced students' achievement in Mathematics, a non-significant difference existed between the achievement of male and female Mathematics students taught with either game or analogy. Therefore, the study investigates the effects of the use of mathematical games on students' academic performance in Ejigbo, Osun State, Nigeria.

The effect of gender on students' performance in Mathematics and science is still a major point of debate among education researchers. This is due to the

conflicting nature of result from researches that focus on gender and Mathematics. Adeniyi (2012) investigated the influence the Personalized System of Instruction on students' academic performance in Mathematics in indices and logarithms based on gender. The result revealed that there was no statistically significant difference in the performance of male and female students taught Mathematics using PSI. While Akanmu (2013) carried out a research on the influence of gender on senior school students' performance in Mathematics when taught using guided discovery method. The result revealed that there was no significant difference between the posttest means scores of both the male and female students since both male and female students significantly benefitted from the treatment.

Achievement refers to the level of an individual's attainment on learning tasks. It is a measure of how much an individual has accomplished after a course of instruction or training. Fajemidagba, Salman and Ayinla (2012) carried out a research on the effect of teachers' instructional strategy pattern on senior school students' academic performance in Mathematics word problem in Ondo, Nigeria. The findings of the study indicated a significant difference in the performance of students exposed to instructional strategy pattern at the three different levels of low, medium and high in simultaneous equations. While Adeniyi (2012) reported that all the three categories of scoring level benefitted from the study with the low scorers benefitting most; followed by the average scorers and high scorers respectively. The researcher concluded that Personalized System of Instruction can be used to teach all the three categories of scoring level of students effectively.

2.0 STATEMENT OF THE PROBLEM

Records of secondary school students' achievement in External examinations in Nigeria such as West Africa Council Examination (WAEC), National Examination Council (NECO) and the like showed that more than half of the students who sit for these examinations have been performing below expectation (Adeniyi and Akinoso (2019); & Akanmu, (2013)). Therefore, this study sought to assess the effects of mathematical games on students' academic performance in selected public secondary schools in Ejigbo, Osun State, Nigeria.

3.0 RESEARCH QUESTIONS

The study addressed the following research questions:

- a) Is there any difference in the academic performance of students exposed to Mathematical games and those who were not exposed to Mathematical games?
- b) Is there any difference in the academic performance of students exposed to Mathematical games based on gender?
- c) Is there any difference in the academic performance of students exposed to Mathematical games based on score level?

4.0 RESEARCH HYPOTHESES

The following research hypotheses were formulated and tested in this study:

HO₁: There is no significant difference in the academic performance of students exposed to Mathematical games and those who were not exposed to Mathematical games.

HO₂: There is no significant difference in the academic performance of students exposed to Mathematical games based on gender.

HO₃: There is no significant difference in the academic performance of students exposed to Mathematical games based on score levels.

5.0 METHODOLOGY

The researchers adopted a quasi-experimental type of the posttest, non-randomized, non-equivalent, control group design. It was designed to carry out the research in a classroom setting where classes were intact. The study involved pretest and posttest treatments. The design was to determine the effect of the use of Mathematical games on academic performance of senior secondary school students. Random sampling technique was used to select two co-education senior secondary schools from the population for the study. The sample for this study was seventy-three (73) senior secondary school II students from the selected schools (41 for the control group and 32 for the experimental group).

One instrument entitled Mathematics Performance Test (MPT) was utilized for the collection of data. The MPT had reliability coefficients of 0.84 while the instrument was validated by two Mathematics educators in Osun State. The selected schools were grouped into two: control and experimental group. The experimental group were exposed to the use of Mathematics games as an advance organizer while the control group was not.

The data collected was subjected to statistical analysis. Thus, t-test was used to test hypotheses 1 and 2, while hypothesis 3 was tested using ANCOVA at 0.05 level of significance.

6.0 RESULTS

6.1 Research Question One:

Is there any difference in the academic performance of students exposed to Mathematical games and those who were not exposed to Mathematical games?

Table 1: Mean Gain Scores of Students' Performance of both Experimental and Control Groups

Group	Group Statistic	Pretest	Posttest	Mean Gain Scores	Difference
Control	N	41	41	4.34	6.32
	Mean	46.293	50.634		
	Std Dev.	6.627	7.217		
Experimental	N	32	32	10.66	
	Mean	48.563	59.219		
	Std Dev.	6.329	9.004		

Table 1 shows the mean gain scores of students that participated in the performance tests in Mathematics. The mean gain score of students taught Mathematics using Mathematical games was 10.66, while the mean gain score of students in the control group was 4.34. The mean gain score of the experimental group was 6.32 higher than that of the control group. Further analysis was conducted to test whether the difference in the means was statistically significant; this was shown in table 2.

6.2 Research Hypothesis One:

There is no significant difference in the academic performance of students exposed to Mathematical games and those who were not exposed to Mathematical games in Mathematics.

Table 2: Independent Samples t-test of the experimental and the control groups

Group	N	Mean	Standard Deviation	Df	Mean Difference	t-value	Sig.
Control	41	50.634	7.217	71	8.585	4.523	0.000
Experimental	32	59.219	9.004				

Table 2 shows the independent sample t-test, the t-test value is 4.523, degree of freedom = 71, and p-value = 0.000 was obtained. Since the p-value is less than 0.05 level of significance, the mean of posttest scores of experimental group = 59.219 is statistically greater than the mean of posttest scores of control group = 50.634. Therefore, it is thus claimed that a significant difference existed in the performance of senior school students taught Mathematics using Mathematical games and their counterpart in the control group. This showed that the use of Mathematical games provided for the experimental group had significant impact on their academic performance.

6.3 Research Question Two:

Is there any difference in the academic performance of male and female students exposed to Mathematical games?

Table 3: Mean Gain Scores of male and female Students' exposed to Mathematical games

Group	Group Statistic	Pretest	Posttest	Mean Gain Scores	Difference
Male	N	18	18	9.61	2.39
	Mean	48.222	57.833		
	Std Dev.	6.431	8.985		
Female	N	14	14	12.00	
	Mean	49.000	61.000		
	Std Dev.	6.409	9.038		

Table 3 shows the mean gain scores of students that participated in the performance tests in Mathematics based on gender. The mean gain score of male students taught Mathematics using Mathematical games was 9.61, while the mean gain score of the female students was 12.00. The mean gain score of the female students exposed to Mathematical games was 2.39 higher than that of the male students. Further analysis was conducted to test whether the difference in the means was statistically significant; this was shown in table 4.

6.4 Research Hypothesis Two:

There is no significant difference in the academic performance of male and female students exposed to Mathematical games.

Table 4: Independent Samples t-test of male and female students' Mathematical games

Group	N	Mean	Standard Deviation	Df	Mean Difference	t-value	Sig.
Male	18	57.833	8.985	30	3.167	0.986	0.332
Female	14	61.000	9.038				

Table 4 shows the independent sample t-test, the t-test value is 0.986, degree of freedom = 30, and p-value = 0.332. Since the p-value is greater than 0.05 level of

significance, this means that the mean of posttest scores of male students (57.8333) is not statistically less than the mean of posttest scores of the female students (61.000) when exposed to Mathematical games. Therefore, it is thus claimed that no significant difference exists in the performance of male and female students taught Mathematics using Mathematical games. This showed that the use of Mathematical games was beneficial to both male and female students.

6.5 Research Question Three:

Is there any difference in the academic performance of students exposed to Mathematical games based on scoring levels?

Table 5: Mean Gains Scores of Students' Taught Mathematics After Been Exposed to Mathematical Games Based on Scoring Levels

Group	Group Statistic	Pre-test	Post-test	Mean Gain Score	Difference
Low	N	10	10	12.90	2.77
	Mean	41.600	54.500		
	SD	3.373	6.205		
Medium	N	15	15	10.13	1.56
	Mean	49.067	59.200		
	SD	2.251	7.476		
High	N	7	7	8.57	
	Mean	57.429	66.000		
	SD	2.225	11.832		

Table 5 shows the pretest and posttest scores of the students taught Mathematics using Mathematical games based on scoring levels. The mean gain score of low scoring students was 12.90, medium scoring students was 10.13 and high scoring students was 8.57 respectively. The low scoring students had the highest mean gain score followed by the medium scoring students and the high scoring students had the least mean gain score. Further analysis was conducted to test whether the difference among the means was statistically significant or not; this was shown in Table 6.

6.6 Research Hypothesis Three:

There is no significant difference in the academic performance of students exposed to Mathematical games based on scoring levels.

Table 6: ANCOVA of Students' Performance After Been Exposed to Mathematical Games Based on Scoring Levels

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	545.143a	3	181.714	2.585	.073
Intercept	272.543	1	272.543	3.877	.059
Group	79.964	2	39.982	.569	.573
Error	1968.326	28	70.297		
Total	114733.000	32			
Corrected Total	2513.469	31			

a. R Squared = .217 (Adjusted R Squared = .133)

Table 6 shows the analysis of covariance table containing the source of variations, sum of squares, degree of freedom, mean squares, *F*-test values and corresponding *p*-values. From the table $F(2, 31) = 70.297$ at $p = 0.573$, since the *p*-value is greater than 0.05 level of significance, the null hypothesis was not rejected

(there is no significant difference in the performance of students exposed to Mathematical games based on scoring levels). Therefore, the three scoring levels students benefitted from the study respectively.

7.0 DISCUSSION

The findings of the study indicated that the use of Mathematical games in school significantly improved students' performance in Mathematics. This finding corresponds with the findings of Moursund, (2017); Nekang ,(2018); Abonyi, Maduagwuna and Ugama (2014) and Okigbo and Agu, (2010) that had worked on the effect of Mathematical games on students' academic performance and found it to be effective at improving students' academic performance in Mathematics.

The result of the study revealed that both male and female students benefitted from the use of Mathematical games. This implies both male and female students benefitted from the study equally since there is no significant difference in their posttest mean gain scores. The findings were in agreement with the findings of Abonyi, Maduagwuna and Ugama (2014), Akanmu (2013), Adeniyi (2012) and Okigbo and Agu (2010) who reported in their various research works that there was no significant difference in the performance of male and female students when exposed to various instructional strategies in Mathematics. The researchers concluded that gender has nothing to do with students' academic performance.

The study also revealed that all the three categories of scoring level benefitted from the study with the low scoring students benefiting most with 12.90 mean gain score, followed by the medium scoring students with 10.13 mean gain score and high scoring students with 8.57 mean gain score respectively. These findings conform with the findings of Akanmu (2013), Adeniyi (2012), and Fajemidagba et al (2012) who reported that participants within the three categorized scoring level benefitted from their various studies. This implies that the use of Mathematical games can enhance students' academic performance in Mathematics regardless of the students' scoring level.

8.0 CONCLUSION

The findings of the study revealed that the use of Mathematical games in the teaching and learning process enhances students' performance in Mathematics significantly. It can be concluded that provision of Mathematical games for students improved students' performance in Mathematics. Also, the findings from this study revealed that the use of Mathematical games is beneficial to both male and female students when properly carried out. That is, both male and female students can perform better in Mathematics when exposed to the use of Mathematical games that will stimulate their interests in the subject.

It could also be concluded from the study that the use of Mathematical games could be used to improve the academic performance of all the three categories of score level of students since the result of the study showed that all categories benefitted significantly from the study.

9.0 RECOMMENDATIONS

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

- a) Government should provide various Mathematical games to all secondary schools for effective teaching and learning of Mathematics

- b) Mathematics teachers should incorporate the use of Mathematical games into their lessons in order to improve students' academic performance in Mathematics.

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