

META-ANALYSIS OF RESEARCH FINDINGS ON EFFECT OF GAMES ON SECONDARY SCHOOL STUDENTS' MATHEMATICS ACHIEVEMENT IN NIGERIA

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Abstract

It is evident that a lot of inconsistencies exist among research reports on the effect of games on mathematics achievement of secondary school students in Nigeria. This study was to integrate the results of the previous studies on games and mathematics achievement carried out in different parts of Nigeria, in order to arrive at a generalized conclusion. This study was guided by three research questions and one research hypothesis. The population of the study consisted of all the previous research reports on games and mathematics achievement in Nigeria. The purposive and snowball sampling techniques were used to gather the studies that constituted the sample. In all, twenty-six studies which included journal articles, Ph.D theses, M.Ed, B.Ed and PGDE projects, were integrated. Data was collected using a validated and reliable coding instrument designed for the study. In data analysis, descriptive statistics, statistical transformations and effect sizes were used to answer the research questions, while Winer combined test was used to test the hypothesis. The result of this study revealed that the accumulated results of the previous studies showed a positive and statistically significant effect of games on secondary school students' mathematics achievement. The findings of the study also revealed that games have moderate effect on mathematics achievement in secondary schools. The study has implications for curriculum planners and teachers. Based on the implications and findings, it was recommended

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that workshops should be organized on the use of game facilities for the improvement of mathematics teaching and learning in our schools

Key Words: Mathematics, Students, Games, Achievement, Meta-Analysi

Introduction

Mathematics plays very important roles in our daily lives. Today, mathematics is an inevitable part of Science and it is used in almost every field, be it Natural Science, Engineering, Arts or Economics (Haneefa, 2008). Kaye (2009), pointed out that learning to think in mathematical terms is an essential part of becoming a liberally educated person. Professional bodies like the National Mathematical Centre (NMC), Nigerian Mathematical Society (NMS), Mathematics Association of Nigeria (MAN), etc are really working hard to see to the improvement of mathematics teaching and learning in Nigeria.

The National Mathematical Centre (NMC) Abuja, in September 1990, set up a programme, called Mathematical Sciences Education Programme, whose central mandate is the improvement of the teaching and learning of mathematics at all levels of our educational system nationwide. A report from the NMC revealed that since the commencement of this programme, many activities have been carried out which have to a great extent popularized the teaching and learning of mathematics in Nigeria (www.nmcabuja.com).

The various benefits accruing from mathematics has led to considering ways and means of ensuring its effective teaching and learning in schools. Based on this background, mathematics educators have been, and are still researching on how pupils' achievement in mathematics can be improved. Some of such researches have their focus on the effect of game method of teaching on mathematics achievement while some others are concerned about the effect of some other teaching methods. According to Motladi (2006), instructional games are softwares designed to increase motivation to learning by adding game rules and/or competition to learning activities. They are also learning tools used during teaching and learning.

Researchers have made so much effort to determine the effect of games on Secondary school students' mathematics achievement in different parts of Nigeria. Such studies on the effect of games on students' mathematics achievement include the works of Okpala (2004), Okigbo and Okeke (2010) and Ihesia (2011). The results of these studies indicate a significant effect of games on students' mathematics achievement. Other studies carried out by Iko (1999), Oboh (2005) and Nwosu (2004), have results which show non-significant effect of games on students' mathematics achievement. There are so many other research reports on the effect of games on mathematics achievement in Secondary schools. Each of these studies differs in one way or the other. These studies also, are in bits in journals and research reports. The results of many of these studies are conflicting, and no effort has been made to integrate these results to arrive at a general conclusion. Therefore, the problem of this study is the lack of consensus in the findings of the previous studies. Therefore, there is need to put them together, and to see what the integrated result would be like. The only quantitative and objective way of doing this, is through meta-analysis.

Meta-analysis is a statistical procedure through which the results of several independent studies considered to be combinable are integrated. In the words of Erika and Harris (2007), the term meta-analysis, first coined by Gene Glass in 1976, refers to a statistical technique used to synthesize data from separate comparable studies in order to obtain a quantitative summary of research addressing common question. It is a quantitative statistical analysis of several separate but similar experiments or studies in order to test the pooled data for statistical significance. A meta-analysis is an analytical technique designed to summarize the results of multiple studies. It is a study in which the results of other studies, all published on the same topic, are combined so as to obtain a cumulative result.

Meta-analysis techniques have been used to integrate studies in different fields, and have yielded reasonable, objective and generalized conclusions despite the divergent findings. It is expected that same result will be obtained if meta-analysis is applied to other situations such as this study.

Purpose of the Study

The purpose of this study was to establish a generalized pattern of effect of games on students' mathematics achievement in Nigeria. Specifically, this study sought to determine the:

1. Results of the previous studies on games and students' mathematics achievement in Secondary schools.
2. Effect size for each of the studies examined.
3. Mean effect size of all the studies examined.

Research Questions

1. What are the results of previous studies on games and students' mathematics achievement in Secondary schools?
2. What is the effect size for each of the studies examined?
3. What is the mean effect size of all the studies examined?

Research Hypothesis

H₀₁: The overall effect of games on Secondary school students' mathematics achievement is non-significant.

Method

Metal-analysis design was used for this study. This study was carried out in Nigeria. It examined the reports of research works carried out in different parts of Nigeria. The population of this study consisted of all published and unpublished research reports on games and secondary school students' achievement in mathematics. The purposive and snowball sampling techniques were adopted by the researcher, based on some criteria for inclusion of studies. A sample of twenty-six (26) studies which meet up with the study inclusion criteria were finally collected and used for the study.

A tabular coding instrument was adapted from Ajaur (2006) and used for data collection. The coding instrument was made of columns for pieces of information such as serial number, author's name, year of study, area of study, type of publication, level of students, sample size, statistical methods used, result of analysis and effect size.

The instrument was face validated by three experts in Measurement and Evaluation, who confirmed its appropriateness for the study. A sample of six articles was given to two experts in Measurement and Evaluation to make their ratings, after which the inter-rater reliability was calculated and the value of 0.95 obtained.

The researchers and other research assistants personally visited some libraries and Higher institutions in different parts of Nigeria to collect studies that meet the study inclusion criteria. This was to ensure that the data collected are representative of the country. The relevant information from the studies gathered were coded into the coding instrument.

The data collected were analyzed using effect size, descriptive statistics, statistical transformations, averaged weighted Z and Winer Combined test.

Results

The results of the study are presented in accordance with the research questions and hypothesis.

Research Question One

- What are the results of the previous studies on games and students' mathematics achievement in Secondary schools?

Data from the previous studies were coded and the results were summarized. The table below shows the summary of the results according to number and percentage of significant and non-significant findings, and according to the direction of effect.

Table 1: Summary of results of the previous studies examined

Statistically significant results				Statistically non-significant results			
Positive		Negative		Positive		Negative	
Number	%age	Number	%age	Number	%age	Number	%age
18	69.23	1	3.85	6	23.07	1	3.85

Positive means the treatment group performed better than the control group while negative means that the control group performed better than the treatment group. Therefore, from the table above, among the twenty-six studies examined, eighteen (69.23%) of the studies found statistically significant effect of games in the positive direction, one (3.85) found statistically significant effect in the negative direction, six (23.07%) found statistically non-significant effect in the positive direction, while one (3.85) found statistically non-significant effect in the negative direction.

Research Question Two

- What is the effect size for each of the studies examined?

The effect size for each of the studies was calculated and interpreted into large, medium or small, based on Cohen's (2005) guideline for effect size interpretation. The results are summarized according to the quality of their effect sizes in the table below.

Table 2: Distribution of studies examined based on quality of effect size

Quality of effect size	Number	Percentage
Large	13	50
Medium	5	19.23%
Small	8	30.77%
Total	26	100%

Of the twenty-six studies examined, thirteen (50%) show a high effect (large effect size) of games on students' mathematics achievement, five (19.23%) show a moderate effect (medium effect size), while eight (30.77%) show a low effect (small effect size).

Research Question Three

What is the mean effect size of all the studies examined?

Table 3: Mean effect size associated with all the studies examined

Number of cases	$\sum(N-3)$	\sum weighted	Average Zr	r value of	d value of r	Quality of effect	Percentage of variance
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	Z	average	size
		Zr	
26	4256	1084.978	0.240
		0.235	0.484
			Medium
			5.52

Table 3 shows that the computed mean effect size for all the twenty-six findings integrated is 0.484 (in terms of d) or 0.235 (in terms of r). Based on the Cohen's interpretation of effect sizes (d), this value represents a medium effect size and is significant. This indicates that the mean size of effect of games on secondary school students' mathematics achievement is moderate, positive and significant. The table also shows that the percentage variance in students' mathematics achievement attributable to the use of games is 5.52 percent ($100r^2$).

Hypothesis

H_0 : The overall effect of games on Secondary school students' mathematics achievement is non-significant.

Table 4: Summary table of the Winer combined test for all studies examined

$\sum t$	$\sum\{(df/(df-2))\}$	Z-calculated	Z-critical
91.628	26.413	17.829	1.96

From the table, the calculated value of Z is 17.829 while the critical value of Z at 0.05 level of significance is 1.96. Since the calculated value is greater than the critical value, it implies that accumulated results of the previous studies on games and students' mathematics achievement show that the null hypothesis common to the studies is rejected. This means that the overall effect of games on students' mathematics achievement is significant.

Discussion

The analysis indicates that the number and percentage of statistically significant findings are more than those of non-significant findings. For both significant and non-significant cases, the number and percentage of positive findings are quite higher than negative findings. The magnitude of the effect of games on students' mathematics achievement varies among the

studies examined. Out of the twenty-six effect sizes, thirteen are large, five are medium and eight are small. The number and percentage of large effect sizes are the highest, followed by small effect sizes, and then moderate effect sizes. The mean effect size represents a medium effect, which implies that the strength of the effect of games on students' mathematics achievement is moderate. From the hypothesis tested at 0.05 level of significance, the accumulated results indicate that the overall effect of games on students mathematics achievement is significant. These agree with the findings of Mosugu (2003) and some other researchers. In all, the analysis shows the fact that games have a significant effect on Secondary school students' mathematics achievement, and that this effect is positive and moderate.

This is in agreement with the findings of Akinsola and Animashum (2007), Egana (2010) and Okigbo (2013) who found that games have positive and significant effect on achievement to mathematics. This finding, however, contradicts the findings of Nwosu (2004) who found that games have non-significant effect on achievement in mathematics. Similarly, this is not in agreement with the findings of Kolawale (2009) which stated that games have negative effect on pupils achievement in mathematics.

In all, the results of the examined studies showed that Secondary schools contributed the highest number of both significant and non-significant results than the primary schools. This could be that, of all the examined studies, the number of studies that use secondary schools was more than those that used primary schools

The data on table 2 showed that the magnitude of effect of games on mathematics achievement varies among the studies. In all, studies carried out in the Secondary schools showed the higher number of large, medium and small effect. This may be attributed to a higher number of studies carried out in the secondary schools. However, studies carried out in the primary schools showed a higher percentage of large and small effect sizes, while studies carried out in the secondary school showed a higher percentage of medium effect size.

This meta-analysis revealed that the accumulated results of primary studies showed that games generally, have positive and statistically significant effect on pupils' achievement in

mathematics. This is also the case with the secondary schools. This implies that the use of games in the teaching and learning of mathematics enhances pupils' achievement in mathematics.

Conclusion and Recommendation

The results of this study reveal that the game method of teaching is significantly more effective than the conventional teaching method.

Based on the results and implications of the findings, the teachers should be sensitized and trained on the effective use of games in mathematics teaching and learning. This could be achieved through organizing workshops and inviting resource persons, by the government and by the school heads from time to time.

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