EFFECT OF MATHEMATICS GAMES ON SECONDARY SCHOOL STUDENTS' ATTITUDE TO MATHEMATICS

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Abstract
The study investigates the effect of incorporating Mathematics games in the teaching and learning of Mathematics on secondary school students' attitude to Mathematics. A sample of 180 SS2 students was selected from three schools using stratified random sampling technique. Three research questions and two hypotheses guided the study. Data collected using Mathematics Attitude questionnaire with Cronbach alpha reliability coefficient of 0.84 The research questions were analysed using percentage, and mean while the hypotheses were tested with Analysis of Covariance. Result among others showed that the use of Mathematics games enhanced the attitude of students to Mathematics. Furthermore result of analysis shows that gender is significant in influencing the effectiveness of Mathematics games in fostering positive attitude to Mathematics. The research recommends that the ministry of education should embark on awareness campaign to enlighten students and other stake holders on the merits and proper utilization of Mathematics games. Serving teachers should also be trained through seminars and workshops on the use of Mathematics games and encouraged to incorporate its use in their instruction.

Introduction

The subject Mathematics is acclaimed to be a universal and a very important tool in development of an individual in particular and the society in general. It is fundamental and indispensable in every aspect of human endeavour. Its relevance to science and technology cannot be over emphasised as it is a tool and language of science. Onuoha-Chidiebere (2015) noted that Mathematics is the foundation upon which technology is built. In this regard, advancement in science and technology is largely dependent on knowledge of Mathematics. She further noted that Mathematics is a systematic and dynamic field of knowledge that cuts across all spheres of life. It is versatile in nature in the sense that Mathematics can be applied in different subjects and occupations.

According to Wikipedia, the free encyclopaedia, Mathematics is the study of quantity, structure, space and change. Mathematics seeks out patterns, formulates new conjectures and establishes truth by rigorous deduction from

appropriately chosen axioms and definitions. Through the use of abstraction and logical reasoning, Mathematics evolved from counting, calculation, measurement and motion of physical objects, it stated. Hence Mathematics is essentially a process of thinking which involves building and applying abstract, logically connected networks of ideas. These ideas often arise from the need to solve problem in science, technology and everyday life problems.

The purpose of Mathematics classes in schools is to help students gain problem solving skills, reasoning to be able to make interconnections, generalization, establish communications and some other Mathematical skills, and to use these skills in order to solve problems they encounter in real life (Ucar, 2oo7; Gurefe & Kan, 2013) in Yasar (2016). Notably, the real target in the educational system is obtaining voluntary changes in the positive direction of individuals' behaviour from the education process.

Despite the notable benefits of Mathematics, students often think that Mathematical issues can either not be learned, or can only be learned with great difficulty (Yasar 2016). According to Baykul in Yasar (2016), many students have difficulties in Mathematics classes and this creates increased anxiety levels because they think that they cannot succeed in Mathematics, and therefore develop negative attitudes towards Mathematics classes. It has been widely known for a very long time that there is high-level relationship between Mathematical success levels and attitudes towards Mathematics (Yasar, 2016). Hence the issue of attitudinal changes of students in Mathematics classroom is an evergreen topic which cannot be wished away. Bauret-Puch as cited in Ijadele (2010) noted that a leaners attitude has been found to affect both his scholastic achievement and his education. For example, attitude towards a school subject which is a measure of the degree of the learners attraction to or repulsion from the subject-matter, influences every other thing connected with the subject, he noted. It influences the students' attendance at lessons, his behaviour towards all the learning activities in the subject and incidentally the person teaching him the subject matter. Attitude towards a school subject will therefore affect the students' achievement on the particular subject he concluded.

Bussinessdictionary.com defined attitude as predisposition or a tendency to respond positively or negatively towards a certain idea, object, person, or situation. Attitude influences an individual's choice of action, and responses to challenges, incentives and rewards-together called stimuli (Isaac, 2016). In another definition, Mkpa (2006) defined attitude as a stable long lasting but learned predisposition to respond to certain things in a certain way. According to Mkpa, attitude has a cognitive (belief), an affective (feeling) and a psychomotor aspect (action). Amoo and Rahmaan (2004) described attitude

as a state of readiness, a tendency to act or react in a certain way and in general, a learned disposition or tendency on the part of individual to respond positively or negatively to a situation or another person. They further stated that attitude toward Mathematics therefore deals with the beliefs, interests, perception, aspiration, practicing habits in dealing with Mathematics. Attitude plays a major role in the comprehensibility of Mathematics concept, they concluded. Also Archcraft (2002) declared that high Mathematics anxious individuals are characterized by a strong tendency to avoid Mathematics, which ultimately undercut their Mathematics competence and forecloses important career paths. He further stated that math anxiety disrupts cognitive processing by compromising ongoing activities in working memory.

The conceptions, attitudes and expectations of the students regarding Mathematics and Mathematics teaching have been suspected to be very significant factor underlying their school experience and achievement. The general conceptions may determine the way students approach Mathematics tasks, in many cases leading them into non-productive paths. In the words of Frank (1988) students have been found to hold a strong procedural and rule oriented view of Mathematics and to assume that Mathematical questions should be quickly solvable in just a few steps, the goal just being to get "right answers". For them, the role of the student is to receive Mathematical knowledge and to be able to demonstrate so; the role of the teacher is to transmit this knowledge and to ascertain that students acquire it. Such conceptions may prevent the students from understanding that there are alternative strategies and approaches to many Mathematical problems, different constructions due to different starting points, Frank stated. In consequence, they may miss significant aspects of Mathematical experience, including formulating their own questions, conjecturing relationships, and testing them. They may approach the tasks in the Mathematics class with a very narrow frame of mind that keeps them from developing personal methods and build confidence in dealing with Mathematical ideas, he asserted. Hence the aim and objectives of Mathematics classes as stated above tends to be defeated.

Many researchers have reported positive link between attitude and academic achievement (Akinsola & Olowajaije, 2008; Ifeanacho & Ifeanacho, 2015; Ihendinihu, 2014). Current pedagogy in Education advocates a shift from teacher centered to learner activity centered instructional approach or strategy. This is in line with current policy on education as FRN (2004:9) stated that "Educational activities shall be centered on the learner for maximum self-development and self-fulfilment" This requires learners to participate actively in the learning process. This calls for innovative strategies

that are activity oriented that can foster positive attitude of students towards Mathematics. It is therefore important to search for more, simple and interesting methods/ ways by which teachers could continually inspire positive attitude to Mathematics classrooms as the strategies adopted by the teacher during instruction will no doubt play a prominent role in influencing the attitude of the students towards the subject. One of such proposed strategies is the incorporation of games in the teaching and learning of Mathematics.

Nowadays it is a known fact that young persons are very fond of games. They have widespread interest in games. It is also clear that Mathematics phobia is prevalent among our young persons. Tizard cited in Renninger (2000) noted that interest need special consideration in child education, and remarked that the teacher cannot teach the students the same way since children's interest differ. Therefore any systematic effective lesson delivery according to Renninger must adopt approaches capable of capturing and sustaining students' interest and active participation. Since students are very interested in games, one will suspect that when games are incorporated into the teaching and learning of Mathematics, students' attitude to Mathematics could be changed in the positive direction. Hence games can be very productive learning activities. In line with this, National Mathematical Centre (2008) stated that amusement and pleasure ought to be combined with instruction in order to make the subject more interesting. Mathematics games are one of the strategies of the National Mathematical Centre (NMC) to improve the teaching and learning of Mathematics in the schools. Mathematics games are one of the most potent means of stimulating in Mathematics. In education play method is a veritable pedagogical process. In fact, the Montessori method is predicated on the efficacy of play as an effective learning strategy. Learning through play makes learning less boring and less taxing. Learning through play can be exciting, interesting and at the same time academically rewarding. Thus with Mathematics games, learning of Mathematics could be fun, particularly at primary and secondary schools levels.

Onuoha-Chidiebere (2015) defined Mathematics games as an enjoyable social activities with rules, goals and educational objectives. Mathematics games involve two or more players working together to find a solution to a given Mathematical problems. In a Mathematics game, the winner, the looser and the spectators are all expected to learn the Mathematics concept being practiced in the game, she noted. Furthermore Oldfield (1991) explained that Mathematics games are activities which involve a challenge, usually against one or more opponents; are governed by a set of rules and have a clear underlying structure; normally have a distinct finishing point and a

specific Mathematical objectives. Azuka and Awogbemi (2012) noted that an important aspect of Mathematics games is enjoyment, without which it may resemble tedious workbook activities rather than play. Hence adequate information and strategies should be put in place to make games enjoyable. Mathematics games are not quiz and should not be treated as such, they stated. Obioma (1992) noted that the role of Mathematics games in the classroom is making practice periods more pleasant and successful, enrichment of vocabulary, introduction of new ideas, allowing for individual differences, improvement of study habits, developing positive attitudes towards Mathematics. As a result of these immense benefits, Mathematics games have been recommended for inclusion in the curriculum (Oldfield, 1991). Oldfield further enumerated the following benefits of Mathematics games;

- It creates meaningful situation for the application of Mathematics skills.
- It fosters motivation in children as they freely choose to participate and enjoy playing.
- Mathematics games provide opportunities for building self-concept and developing positive attitudes towards Mathematics, through reducing fear of failure or error.
- Mathematics games leads to increased learning when compared to more formal activities due to the increased interaction between children, opportunities to test intuitive ideas and problem solving strategies.
- Mathematics games can allow children to operate at different levels of thinking and to learn from each other. In a group of children playing a game, one child might be encountering a concept for the first time, another may be developing his/her understanding of the concept, and a third consolidating previously learned concepts.
- Mathematics games can assist the teacher in assessing students. Children's thinking often becomes apparent through the actions and decisions they make during a game. So the teacher has the opportunity to carry out diagnosis and assessment of learning in a non-threatening situation.
- Mathematics games provide handsome interactive tasks for both the school and home.
- Independence: Children can work independently of the teacher. The rules of the game and the children motivation usually keep them on task.

In order to appreciate and functionally utilize Mathematics games in presenting learning tasks in school Mathematics, the Mathematics teacher ought to be familiar with some of the fundamental principles underlying Mathematics games. These fundamental principles include the philosophy of Mathematics games, roles Mathematics games can play in teaching Mathematics and benefits of Mathematics games among others.

There are different types of Mathematics games based on different topics in Mathematics and levels of students. Games can be computer based or manual. In this study four Mathematics games based on algebra and trigonometry are employed. They include spinner algebra, algebra snadder joint, trigratio and trigoludo.

A number of studies have been done to determine the effect of Mathematics games on achievement and attitude of students to Mathematics. Onuoha-Chidiebere (2015) investigated the effect of using number based game on the learning of number base in Mathematics using Jss3 students. She reported that incorporation of Mathematics games in the teaching of Mathematics enhanced the achievement of students more than the conventional teaching method. Ukeje and Obioma (2012) also noted that Mathematics games are effective in teaching both primary and secondary school children. Furthermore Okigbo and Agu (2010) revealed that Mathematics games equally enhanced the achievement of male and female students.

On the effect of mathematics games on attitude of students in Mathematics, Akinsola and Animasahun (2007) studied the effect of simulation-games environment on students' achievement and attitude to Mathematics in secondary school in Osun state, Nigeria. Their finding revealed that the use of simulation games environment led to improved achievement and positive attitude towards Mathematics. In support of this, Adewumi (2001) noted that the style of teaching employed by a teacher is a potent factor in motivating learners to learn. Cankaya and Karamete (2009) examined attitudes of 176 pupils who played educational computer games (proportional tetris and proportional clown). They reported that the games had a positive impact on pupils developing their positive attitude toward learning Mathematics. The research result emphasized that educational computer games can be used as a support for other teaching methods directed at improvement of teaching and goals realisation. Yamg and Chen (2010) suggest that playing computer games can help develop spatial orientation and spatial abilities, which might represent a problem to pupils in geometry in grade 5. Additionally, they determined that there was a big difference in the spatial orientation between boys and girls in favour of boys. Ping-Lim (2008)

established that using computer games for teaching increased pupils' active participation and motivation as well as their socialisation. Harter and Heng-Yu (2008) also reported enhanced achievement and learning satisfaction by pupils who were exposed to computer games in the teaching and learning of Mathematics.

A review of literature revealed that majority of studies on Mathematics games focused on its effect on attitude and achievement in other areas other than Abia state. The present work however focused on evaluating the effect of Mathematics games on attitude of secondary school students to Mathematics in Abia state.

There is a general impression that males show greater interest in games than females. Gender issues in studies in Mathematics education are not yet skewed to any direction. There are different findings on gender matters, some in favour of males, others in favour of females and sometimes no gender difference are found. In view of the above fact, gender implication especially as it affects attitude to Mathematics needs more verification.

Three research questions and two hypotheses guided the study:

1. To what extent does the attitude of students who are taught Mathematics with the use of Mathematics games and those who used only conventional teaching method differ?
2. To what extent does the attitude of boys and girls in experimental group differ?
3. What is the attitude of students (boys and girls) towards Mathematics games?
4. There is no significant difference between the mean attitude scores of students who are taught Mathematics with the use of Mathematics games and those who are taught with conventional teaching method.
5. There is no significant difference between the mean attitude scores of boys and girls taught Mathematics using Mathematics games.

Method

A pre-test post-test control group quasi experimental design was employed. A total of 180 SS2 students made up of 90 boys and 90 girls constituted the subjects for the experiment. The subject were drawn from all boys, all girls and coeducational schools using stratified random sampling techniques. Experimental and control groups were constituted in each of the schools. The experimental groups were taught algebra and trigonometry using Mathematics games in addition to the conventional teaching method whereas the control groups were taught algebra and trigonometry using only the

conventional teaching method. The instruments used for the study were Mathematics games and Mathematics attitude Questionnaire (MAQ).The researcher also prepared an instructional guide for the teachers to use. However only the MAQ was used to collect data for analysis. The MAQ, which was prepared by the researcher comprises two sections. Section A contains questions that seek information on the school, name and sex of students. Section B contains 23 items covering the students' cognitive, affective and behavioural attitude components to Mathematics. The students were required to indicate the degree of agreement or disagreement with each of the statements in a four-point Likert scale of strongly agree (4 points), agree (3 points) ,disagree (2 points) and strongly disagree (1 point).The scale is for positively skewed statements. The mean score of the attitude scale is 2.5. Any student who has a score above 2.5 points was deemed to have positive attitude whereas any student whose score is less or equal to 2.5 was deemed to have negative attitude to Mathematics.

The reliability coefficient of the MAQ was established using Cronbach coefficient alpha reliability method and was found to be 0.84. The Mathematics game, which was adopted by the researcher, is a standardized instrument by National Mathematical Centre Abuja. However the researcher prepared the instructional guide to suit the Mathematics games. The researcher trained three Mathematics teachers in the participating schools as research assistants to help in carrying out the research. However the researcher supervised and monitored the teachers during the teaching and game sessions to ensure strict compliance to the lesson procedure.

Prior to the commencement of the experiment, the attitude questionnaire was administered to all students in order to determine their attitude base line before the treatment. The trained Mathematics teachers taught during the experiment. The experiment lasted for eight weeks of double period (80 minutes) per week for each group. The control groups were taught algebra and trigonometry using the conventional teaching approach. For the experimental groups, the Mathematics game was incorporated into the conventional teaching method. The experimental group had two contesting groups of four students per group during each game. Other members of the class constitute the spectators. Their teachers superintended over the Mathematics game. The teacher ensured that every class member participated in the game. The students in the control groups were required to work on their own during the time the experimental groups used for the game. At the end of the experiment, the MAQ was re-administered to the students. Also Students in the experimental groups were asked to indicate the extent they enjoyed or benefited from the Mathematics games. Their responses were used to

determine and compare the attitude of the students (boys and girls) to Mathematics games.

Table 1. Percentage Gain Score of students in experimental and control groups.

	Pre-test score	Post-test	Gain score	Percentage gain
Control	2.2371	2.2249	-0.0122	-0.5%
Experimental	2.2136	3.1493	0.9359	42.3%

From table1, the mean of pre-test and post-test for control group are 2.2371 and 2.2249 respectively with a percentage gain score of -0.5% whereas the means of pre-test and post-test for experimental group are 2.2136 and 3.1493 respectively with a percentage gain score of 42.3%.This suggest that incorporation of games in the teaching of mathematics enhanced the attitude of students to Mathematics.

Table 2.Percentage Gain Score of boys and girls in experimental group.

	Pre-test score	Post-test	Gain score	Percentage gain
Boys	2.2209	3.6209	1.4000	63%
Girls	2.2062	3.0107	0.8045	36.5%

Result from table 2 shows that the means of pre-test and post-test of boys and girls in experimental group are 2.2209 and 3.6209 respectively with a percentage gain score of 63% while the means of pre-test and post-test of girls in experimental group are 2.2062 and 3.017 respectively with a percentage gain score of 36.5%.This result indicates that attitude of boys and girls were improved due to the introduction of Mathematical games. However the improvement in the attitude of boys is greater than that of girls.

Table 3. Responses of boys and girls on the extent they enjoyed/benefitted from Mathematics games.

	Large extent	Moderate extent	No extent	Total
Boys	30	13	2	45
Girls	14	20	11	45
Total	44	33	13	90

Table 3 reveals that out of 45 boys who participated in Mathematics games, 43 (96%) accepted that they enjoyed and benefitted from the game while 2 (4%) indicated that they neither enjoyed nor benefitted from the game. Similarly out of 45 girls who participated in Mathematics games, 34 (76%) acknowledged that they enjoyed and benefited from Mathematics games whereas 11 (24%) did not like the game. Generally out of 90 students who were exposed to Mathematics games 77 (86%) displayed positive attitude to Mathematics games.

Table 4: Analysis of Covariance of Attitude of Students in Experimental and Control Groups

Tests of Between-Subjects Effects

Dependent Variable: All Post-test for Control and Experimental Groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	67.463[a]	2	33.731	200.046	.000	.693
Intercept	32.485	1	32.485	192.655	.000	.521
allgroup	54.651	1	54.651	324.112	.000	.647
allpre	13.911	1	13.911	82.500	.000	.318
Error	29.846	177	.169			
Total	1478.763	180				
Corrected Total	97.308	179				

a. R Squared = .693 (Adjusted R Squared = .690)

Result gives f- value as 82.500 and significance level as 0.000. This implies that F-ratio is significant at 0.05. Therefore the null hypothesis is rejected. Hence there is significant difference between the mean attitude scores of experimental and control groups in favour of the experimental group.

Table 5: Analysis of Covariance of Attitude of Boys and Girls in Experimental Group.

Tests of Between-Subjects Effects

Dependent Variable: All Experimental Post-test for Boys and Girls

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	11.532[a]	3	3.844	43.837	.000
Intercept	26.517	1	26.517	302.389	.000
exppretest	2.946	1	2.946	33.600	.000
gender	8.298	2	4.149	47.314	.000
Error	7.542	86	.088		
Total	1008.568	90			
Corrected Total	19.074	89			

a. R Squared = .605 (Adjusted R Squared = .591)

From the table the f-value of 47.314 is significant at 0.05 since the significance level 0.000 is less than the set alpha level of 0.05. Hence the null hypothesis is rejected. The implication is that the difference between the mean attitude scores of boys and girls is significant in favour of the boys.

Discussion

The result of data analysis shows that the difference in the mean attitude scores of experimental and control groups is statistically significant with the experimental group recording higher mean score at post-test. Hence the study established that Mathematics games as an instructional strategy has positive impact on the attitude of secondary school students to Mathematics. The introduction of Mathematics games improved the attitude of students to Mathematics. This finding agrees with previous researchers (Akinsola & Animasahun, 2007; Afari, Aldridge, Fraser & Khine, 2013; Robertson & Howell, 2007) who reported positive attitude to Mathematics by learners who were exposed to Mathematics games. The agreements and consistencies in the result could be due to the inherent merits of Mathematics games. As noted by Oldfield (1991) Mathematics games creates meaningful situation for the application of Mathematics skills; provides opportunities for building self-concept and developing positive attitude towards Mathematics through reducing fear of failure or error; allow children to operate at different levels of thinking and to learn from each other, among others. Hence the result is in line with a priori expectation.

Furthermore the result of analysis indicated that the difference in the attitude mean score of boys and girls who learnt Mathematics with the use of Mathematics games is statistically significant with the boys having greater mean score than the girls. This implies that the strategy benefited boys more than and girls. This result is in line with a priori expectation. Boys are generally known to show greater interest in games than girls. Incorporation of games in the teaching and learning of Mathematics will no doubt enhance the attitude to mathematics of boys more than girls. This finding is at variance to the finding of other researchers who reported no significant difference in the achievement and attitude of boys and girls to mathematics due to instructional strategy (Abakpa & Iji, 2011; Ifeanacho & Ifeanacho 2015; Ihendinihu & Mkpa, 2015; Okigbo & Agu, 2010). It however corroborates Agomuoh (2010), Yamg and Chen (2010) who reported gender disparity in science and technology in favour of males.

Analysis of the responses of the students on the extent they enjoyed and/or benefitted from the Mathematics games revealed that 86% of the students were positively disposed to Mathematics games. Further analysis by

gender shows that boys were more excited by the Mathematics games than girls. Some of the boys exclaimed that games should be incorporated into every topic in Mathematics as it really removes the boredom/ phobia often associated to Mathematics. For female students, although they were not enthusiastic about Mathematics games at the initial time but when they were encouraged to participate, they attested to the efficacy of the games in enhancing achievement and fostering positive attitude to Mathematics. The teachers who superintended over the Mathematics games also testified that Mathematics games are worthwhile learning experiences both for the students and the teachers.

Conclusion

The widespread interest of secondary school students in games of all kinds calls for the need to investigate the effect of incorporating games to the teaching and learning process on the achievement and attitude of students to learning. This is especially important in Mathematics where students have consistently displayed negative attitude. Result of data analysis in this study has shown that incorporation of Mathematics games to the teaching and learning of Mathematics in secondary school would foster positive attitude to Mathematics by students. This will invariably enhance the achievement of students in Mathematics. This study therefore calls for the attention and cooperation of teachers, Parents, curriculum planners and even students to the need for the introduction, provision and utilization of Mathematics games in the teaching and learning of Mathematics in our secondary schools.

Recommendation

- Based on the result of the analysis, the study recommends that;
- Awareness on the availability and proper utilization of Mathematics games should be created in schools by the ministry of education.
- Curriculum planners should include use of games in the teaching and learning of all subjects especially Mathematics in students activities.
- Teachers should be trained through workshops and seminars on the use of Mathematics games and encouraged to incorporate games in their conventional teaching methods.
- Parents should provide materials for mathematical games for their wards

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