Students' Attitudinal Change Towards the use of Instructional Animated Object Based Card Game in Learning Mathematics

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Abstract

This study examines students' attitudinal change in learning Mathematics after been treated with structured animated instructional object based card game designed using technological of instruction. 200 (two hundred) Junior Secondary School II (JSS 2) students (subjects) were selected from two educational zones (Lagos Island and Eti-Osa, 50% proportionate on each zone) in education district III, Lagos State, Nigeria. Twenty (20) junior secondary schools were chosen from the two educational zones and ten (10) subjects were selected in each school using multi stage stratified random sampling to avoid interclass mixed. The subjects were divided into two groups (control and experimental groups); control group was treated with Mathematics Achievement Test (MAT) (conventional method) and experimental group was treated with Instructional Animated Object Based Game (IAOBG) and Attitudinal Game Inventory (AGI) after the lesson. Forty (40) minutes lessons on substitution were conducted for the two groups for two weeks, twice per week for 4 weeks in the two educational zones. Experimental group was treated with AGI immediately after being treated with card game. Action research and quasi-experimental control group design with repeated measures analysis of covariance was adopted. The attitudinal responses indicated that, the test of regression analysis in model 4 shows that $\beta = .78$, $t = 5.41$, $p < .002$, accounted for 89% ($p < .000$) of the respondents variance in attitude scores. The result indicates that responses from the card game had a multiple correlation of 0.8960 with attitudinal responses.

Key words

Instructional game, Object based game, TPACK, Conventional method, performance, Achievement and Attitude.

Introduction

Today's children need not only basic education, but also the ability to deal with an increasingly complex and connected world. There is need to create inclusive and inquisitive educational

solutions that address all sections of society and transform them through motivation, provision of adequate teaching and learning facilities that facilitate positive attitude to learning. The transformation has to be a way to improve students' performance in school subjects particularly Mathematics. In doing this, educators have to create means that make learning meaningful and active construction of an individual's own knowledge by integrating new information that will enhance recall such as animated instructional card games (Garris, 2010).

Enhancing teaching and learning outcomes through technology has been a major concern in educational block. Some researchers in the field of instructional technology and pedagogy were of the view that in most developing nations; inadequate teaching tools and lack of modern instructional strategies inhibited Mathematics performance (Olatoye, 2014 and Olatoye & Nleya, 2014). Asim, Kalu, Idaka, and Bassey, (2009) suggested that, in secant Mathematics poor performance was as a result of poor learning facilities and incompetency in learning delivery on the part of teachers. These problems have been blamed in part, on the methods of imparting knowledge to learners. The general consensus is that, the mode of instruction has become grossly inadequate to handle the needs of learners and to boost require attitude to learning. The present delivery system is considered obsolete, inefficient and incapable of achieving pedagogical objectives in most African countries particularly in Nigeria (Chandra & Lioyd, 2008).

In essence, inadequacy of instructional materials and lack of effective attitudinal morale booster strategies resulted into the decline in the standard of Mathematics education and its detrimental effects on the social-economic and technological development of most developing countries in Africa. This has been a major challenge in educational thinking and policy formulations in recent times. Some scholars blame the colonizers of Africa for applying direct transfer of Western curricula, examinations and teaching methods, which fail to address the continental challenges of Africa (Asim et al., 2009). Yoloye (2008) submitted that the result of this direct transfer of western curricula, in science and Mathematics decontextualized pedagogical objectives and knowledge being transmitted by poorly trained teachers. As a Consequence, the situation in Nigeria is that, academic performance in post primary education is still deplorably low particularly in Mathematics, both in certificate and non certificate examinations Asimeng-Boahene (2010). Effective teaching strategies stem the quest for optimizing students' learning outcomes in all school subjects. These strategies become pertinent in Nigeria where debates on the instructional process hinge mainly on the quality of education that is measured in terms of students learning outcomes. Studies in various subject areas have established the several factors responsible for poor performance but the most glaring of all are poor quality of teaching and dilapidated instructional materials in Nigeria public schools to facilitate positive attitude particularly in Mathematics learning.

According to Olatoye, Nleya and Batane (2013) the scrutiny of how well students are learning depends heavily on the assessment of teaching effectiveness. Teaching effectiveness in this context is the act or skill in the organization of pedagogy, content and knowledge of subject matter that does not devoid adequate instructional technology. Shulman (1986) asserts teaching as pedagogy that involves teaching processes; giving consideration to every individual learner whose learning mode is being facilitated by using different teaching approaches that make learning experience to be more meaningful. These approaches include adoption of various teaching and learning styles that facilitate learners' interests with varying learning abilities. The variances of pedagogical and technological approaches become a necessity to address the present day abstract and drill teaching that dominated both private and public schools.

There is need however, to incorporate self-motivated experience scenes such as gaming, which characterized play and activity as being the young child's most powerful tool in all areas of learning particularly Mathematics. The gaming activities adopted by this study integrated content-specific technologies and appropriate pedagogies (e.g., problem-based learning), grounded in Technological, Pedagogical and Content Knowledge (TPACK) framework designed using gaming as process technology.

Students' learning attitudes largely depend on their beliefs about Mathematics learning. Martorella (2005) asserts that every learner shows certain perspectives about how they acquire Mathematics skills. Ashcraft and Kirk (2001) suggested that due to long-term avoidance of math, and placement of little time on the mastery created high-math-anxiety and individuals are simply less competent at doing math. Fennema (1989) sees math competence as high math performance, while avoidance of math tasks creates an interaction of affect (attitudes and math anxiety) and behavior during learning tasks. Reliable measure of attitude has relationship on affect to course selection, performance, achievement, and cognitive processes. For the purpose of this study therefore, attitudinal scale involves causes of anxiety, value, enjoyment, and motivation towards learning math called the Attitudes Toward Mathematics Inventory (ATMI) designed by Martha and George (2004) was adopted.

Attitudinal features in Mathematics learning

Learners' Mathematics achievement or performance and levels of math engagement seem to be directly linked to their academic successes or failures in the classroom. Because of this, students' attitudes are strong predictors of levels of engagement and achievement. Bragg, (2007) asserts that Mathematical games are alternatives to more traditional forms of repetitive practice, for many parts of Mathematics curriculum especially in arithmetical calculation. What is reported in this study is based on studies which explored games as a pedagogical approach that enhance Mathematical learning. Though there were conflicting attitudinal responses from the students about games. Bragg was of the view that, success or failure in the classroom impacts on learners initial attitudes and anxiety about math derives towards learning from their home environment.

Success or failure in life is determined by personal attitudes. Students' attitudes about Mathematics are strong predictors of levels of engagement and performance. Teacher needs to explore and encourage students' attitudes towards Mathematics, in order not to create anxiety. Learning and development of a deep conceptual understanding in Mathematics evokes very strong feelings that greatly influence learners' abilities. Math-phobia creates a wall this prevents learners with adequate concepts formation and the phobia needs to be broken down so as to create leverage for learners to be successful in learning math. When students are exposed to a curriculum that is centered on various math games, there would be a shift in students' attitude and an increase in student achievement (Olatoye & Nleya, 2014). There are several teaching strategies that can also perpetuate this math anxiety, such as being taught directly from a textbook without differentiating for a variety of learning styles or abilities, or if students are made to feel there is only one way to solve a problem as this inhibits creativity.

Purpose of the Study

The main purpose of this study is to identify impact of the animated instructional card game on students' attitudinal shift in learning Mathematics among subjects treated with the card game.

Research Questions

1. What are the mean scores variation of subjects treated with IAOBG (card game) technique and those treated with conventional (traditional) method of learning Mathematics?

2. To what extent is card game has the effect on attitudinal change among students (subjects) treated with IAOBG (card game) and their performance in mathematics?

3. What are the implications of questions 1 and 2 for effective pedagogical practices?

Method and Results

Materials

Condie and Munro (2007) were of the view that game had great impact in facilitate students learning of basic Mathematics skills such as simple algebraic substitution and inverse operations and game also optimize teaching and learning approach. Research carried out by Miller and Robertson (2010) identified that in learning Mathematics, students must have access to quality instructions, master basic Mathematics skills (such as arithmetic operations) in the early stages of the learning experience. This current study used Mathematic Achievement Test (MAT) (the MAT was a 30 item achievement test designed based on substitution), Object Based Card game designed (using technology of instruction) and Attitudinal Game Inventory (AGI). AGI designed by Martha (2004) was used to investigate the underlying dimensions of students' attitudes toward the use of the card game design for this study.

7%(seven) of the sampled size of JSS II students were taken from two schools in Lagos Island using purposeful stratified sampling with the same features with the sampled schools and subjects for instruments pilot test. This 7% subjects sampled were treated with research instruments for pilot test and reliability indexes of the instrument. The reliability index of the IAOBG (design card game) using Cronbach's alpha was equal to .85, this show that the main variable that serves as focal point in the study that is the AGI had high degree of consistency. While the reliability indexes of MAT and design card game were Cronbach's alpha .85 and .86 respectively. The results showed that the instruments had high psychometric properties and these make them useful for this study.

Participants

Two educational Zones (Eti-Osa and Lagos Island) were chosen from educational district III of Lagos state, Nigeria, using purposeful random sampling. 20 (twenty) co- educational schools with Junior Secondary School Two (JSS II) were chosen, 50% proportionate on each zone. Multi stage stratified random sampling was used to avoid interclass mixed. And simple stratified random sampling technique was adopted to give non mixed schools within the zones equal chance of being taken. Ten subjects (students) in JSS 2 were chosen from each school with the same number of male and female to give the total of 200 (two hundred) JSS 2 students selected from the chosen educational Zones. The subjects were divided into two groups i.e. experimental and control groups, 100 (one hundred) subjects were assigned to each group.

Procedure

The subjects were given test (pre-test) related to substitution. 40 (forty) minutes lesson on substitution was conducted for the subjects for two weeks, twice per week. This was conducted in each school for 3(three) weeks in the whole of the two zones. After the lessons the subjects were divided to two groups (experimental and control) in every chosen school. Research assistants were used to administer the instruments AGI, MAT and design card game. The last two instruments

(MAT and Object based card game) were administered to control and experimental groups respectively for one week after been taught substitution through conventional and game based methods to the groups respectively. This was to elicit data from the two groups in order to ascertain mean difference between the groups. The AGI contains 12-items in the domain of attitudes toward the design card game and were used to address the intervening and extraneous factors that militate against the success of the design card game reported to be important in this study. Items were constructed to assess confidence, anxiety, value, enjoyment, motivation. The AGI was a 12-item scale. The items were constructed using a Likert-scale format with: 1, 2, 3, and 4 represent strongly disagree, disagree, agree, and strongly agree respectively. This 12-items inventory was administered to the subjects (experimental group) in their classes immediately after playing the cards.

Research Design

The study contains action research and a quasi-experimental pretest-post test control group design.

Results

Research question one: What are the mean scores variation of subjects treated with IAOBG (card game) technique and those treated with conventional (traditional) method of learning Mathematics?

Table 1 shows that the experimental group had the mean gain of .8334 with standard deviation of .6610 and the control group had the mean gain of .6198 with post test standard deviation score of .5011.This showed that experimental group performed better than the control group, this was associated with the treatment (card game) by the lather group.

Table 1. Mean and Standard Deviation Scores of the Groups on the Treatments

Group	Mean pre test	Mean post test	Mean gain	Std. Deviation
Experimental n= 100	1.3569	2.1903	0.8334	0.6610
Control n= 100	0.8954	1.5152	0.6198	0.5011
Mean differences	0.4615	0.2751	0.2136	

Table 2 shows that the treatment was statistically significant @.005 F (1,199) = 8.97, p = 0.018 (model 1). This implies that the use of the object based card game in teaching and assessing learning outcomes had significant effect on the performance of learners in Mathematics. This has significant implications to the current study (Olatoye, 2014; Olatoye & Nleya, 2014).

Table 2. Summary of Analysis of Covariance (ANCOVA) of the Posttest Scores on Card Game after Controlling for the Influence of Pretest Scores

Test	Sum of Squares	df	Mean Square	F	p
Regression	7430.81	1	7430.81		
Residual	18546.92	199	93.20	8.97	0.018
Total	25977.73	200			

Research Question Two: To what extent is card game has the effect on attitudinal change among students (subjects) treated with IAOBG (card game) and their performance in mathematics?

Table 3 presents the proportionate frequency of the responses of the experimental group after the treatment to mathematics card game. The responses indicated that all the attitudinal indicators had strong positive responses. All the 12 items except item 6 with 87.0% had above 90% positive responses, that playing mathematic card game design for this study helped them in learning mathematics. This indicated that with the stated proportion that the attitudinal attributes influenced performance in mathematic. The responses also showed that proportionate attitudinal indicators showed that the respondents after the treatment strongly indicated their interest and motivational attitude of the card game.

Table 3. Attitude scale Results for Game Playing Experimental Group (n = 100)

Attitude statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The game makes me to love Mathematics.	42 (47.3%)	57 (52.3%)	1 (.3%)	-	-
I am at easy and feel like doing Mathematics with this game	43 (47.7%)	55 (51.7%)	2 (.7%)	-	-
Solving Mathematics problems Become easier, if I see this type of game	42 (47.3%)	56 (52.0%)	1 (.3%)	1 (.3%)	
Mathematics is applicable to everyday life.	48 (49.3%)	48 (49.3%)	2 (.7%)	1 (.3%)	1 (.3%)

Mathematics is a compulsory subject at all level.	34 (44.7%)	57 (52.3%)	8 (2.7%)	1 (.3%)	-
High school Mathematics would be very helpful no matter what I decide to study.	12 (37.3%)	49 (49.7%)	18 (6.0%)	18 (6.0%)	3 (1.0%)
I enjoyed this game process of teaching mathematics	50 (50.0%)	46 (48.7%)	3 (1.0%)		
Mathematics class will not be dull and boring if games can be used.	45 (48.3%)	53 (51.0%)	2 (.7%)		
I am happier in mathematics class than in any other class now	33 (44.3%)	45(48.3%)	14(4.7%)	4(1.3%)	4(1.3%)
I would like to solve Mathematics problems with the use of games.	38 (46.0%)	57 (52.3%)	3 (1.0%)	2 (.7%)	-
I like the animals and the color of the card I am willing to solve more mathematics problems now.	46 (48.7%)	51 (50.3%)	1 (.3%)	2 (.7%)	
I plan to take as much mathematics problems as I can if such game process is involved.	46 (48.7%)	51 (50.3%)	1 (.3%)	2 (.7%)	-

Figure 1 shows 12 attitudinal items and their responses strength as shown in eigenvalue that item 1 had about 2.8 values, while items 2, 3, and others had their values from .5 downward the graph corroborate attitude scale results for game playing experimental group. To understand how students in the experimental group responded to the attitudinal instrument after the test was shown in the regression analysis. Table 4 (model 4) shows thus: $\beta = .78$, $t = 5.41$, $p < .002$, accounted for 89% ($p < .000$) of the respondents' variance in attitude scores. The results indicated that responses from the card game have a multiple correlation of 0.8960. The combination of these variables explained

81.52% of variance in the responses as shown by the coefficient of determination ($R^2 = 0.8960$). This shows that the card game had attitudinal influence on the treatment scores.

Figure 1. Screen Plot on 12 Attitudinal Items

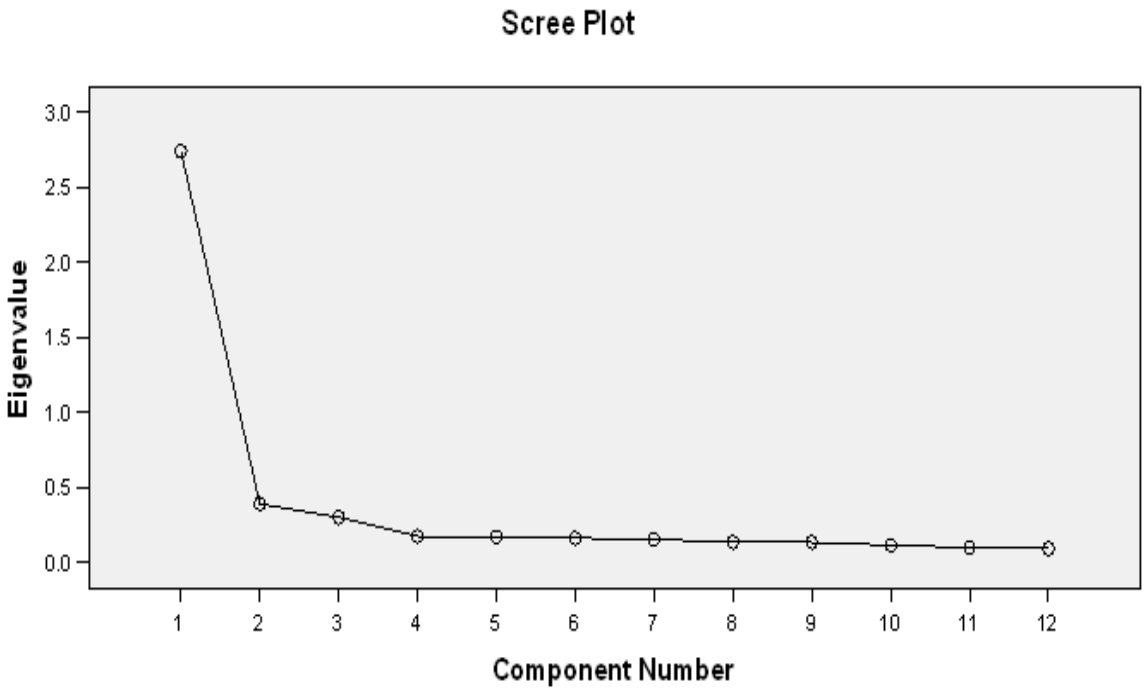

Table 4. Summary Regression Analysis for Attitudinal Variables Predicting Card Game Performance

Variable	B	SEB	β	t	p
Card game attitude	6.72	0.00	0.78	5.41	.002
Constant	28.03	6.09		2.95	.016

Multiple regression analysis summary: $R^2 = .8960$ ($p < .002$), Adjusted $R^2 = .8152$, Standard Error = .4266 and Multiple R = .9211

Implications for classroom practices

The Mathematics cards (game) used for the study were alternative way of teaching and a positive attitudinal change that took the students away from pencil and paper. The games had an experiential nature which allowed the students to interact with the familiar environments in the games and construct their Mathematical concepts through completing game missions. While the comparisons between the experimental and control groups (pre- to post test) changes provide at best, modest evidence of the effectiveness of the game, findings from the treatment variations may

suggest features to explore in the design of learning games, specifically variations in feedback and incentives.

One of the concern is the use of incentives in this study was the use of negative reinforcement; that is giving back some "lost points" if feedback was sought after an error rather than a more straight forward reward of positive behavior. In contrast to this procedure, positive incentives are consistent with research on the use of rewards for learning following desired behaviors (Holland & Skinner, 1961). A study that provided positive incentives may be more worth exploration. As asserted by Sulhman, (1986) that good pedagogical process in class must involve presenting the learners with enabling learning situations. The situations in which learners experiences in the broadest sense by try things out to see what happens, manipulate: figures, cards, pose questions and seek their own answers.

The use of Mathematics object based games like the one design for this study in the classroom, increased students' learning activities, participation and involvement in the process of learning Mathematics. Animated card game design for this study services as programmed instruction that can be used and reused for a number of time. This creates a classroom scene where students are more comfortable sharing resources and thinking about Mathematics concepts. This could be with his or her partner, or with the whole class. This culture was facilitated as a result of their learning using gaming in solving difficult Mathematics concepts. Learners were more relaxed with less anxiousness while playing game and solving Mathematics problems, though they do more talking. Gaming will give learners opportunities to work cooperatively and sort out misconception in learning Mathematics. Johnson and Johnson (2011) agreed that gaming facilitates cooperative learning so as to achieve a specific shared goal. Cooperative learning creates team work in order to ensure successful performance, meaningful outcomes and positive responses of all group members.

Conclusion

Based on the results of this study, it can be concluded that the card game activity is beneficial to the students' indifference of learning ability of students. Though learning ability from the context of this study was observed as a continuous variable where by attitude of learners to respond to the card items was the major focus on this study. And the result showed that experimental group responded positively and demonstrated high mastery of card game procedure.

The card game results have positive influence on students' attitude toward math class. Though significant differences found in students Mathematics attitude among those who played the card game .This can be associated with animals on the cards as suggested by Bobby (2008) while corroborating Piaget's formal operations stage with Mathematics teaching. The stage anchors representation of ideas, thought, through images or animation and uncommon expression (gesticulation) to facilitate deduction, this allows a child to construct his own Mathematics solutions.

The findings of the current study were in conformity with Filler (2009), who identified bad Mathematics attitude being a result of math phobia. Many researchers have found that students' attitudes about math often change and they begin to dislike and avoid math. The fear and avoidance of math were often caused by poor methodology, lack of adequate instructional materials and insensitive to individual differences in math class (Johnson & Johnson, 2011 & Filler, 2009). The result in Model 4 of this study confirmed the broken math phobia cycle due to the success of attitudinal changed and positive performance of all the respondents treated with the card game.

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