EFFECTS OF INCENTIVE AND GENDER ON FRACTION PROBLEMS SOLVING SKILL ACQUISITION AMONG SENIOR SECONDARY SCHOOL STUDENTS

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Abstract

The poor performance of students in mathematics has been a major concern for education stakeholders over the years. One of the reasons ascribed to this is the absence of incentives from the government to the students. The study investigates the effects of incentive and gender on fraction problems solving skill acquisition. The participants comprised of 40 (20 males and 20 females) senior secondary II students selected through a simple random sampling technique. Two hypotheses were postulated and tested to guide the conduct of the study. The design of the study was an experimental control group research design and t-test statistics was used to test the hypotheses. The null hypothesis HO_1 was rejected at 0.05 level of significant. There was statistically significant difference in the fraction problems solving skill acquisition between incentive group and no incentive group. The null hypothesis HO_2 was accepted at 0.05 level of significant. There was no statistically significant difference in the fraction problems solving skill acquisition between males and females incentive group. Findings were discussed and suggestions made for students' better performance in mathematics.

Keywords: Incentive, Gender and Fraction Problems Skill Acquisition.

INTRODUCTION

Mathematics is one of core subjects and highly scientific discipline. Salman (2005) pointed out that Mathematics has become an indispensable tool in the study of sciences, humanities and technology. Mathematics is the foundation upon which technology is built. It has import functions in this fast developing scientific world of civilization. It has also become the basis of the world's entire business and commercial system. Most individual and group projects in life fail for want of sense of calculation. Broadly speaking, there are three main considerations for which a child is sent to school. Education must contribute towards the attainment of these three values: (i) knowledge and skills, (ii) intellectual habits and power, (iii) desirable attitude and ideals. These three values can be called utilitarian, disciplinary and cultural values of education respectively (Kulbir, 2012). If Mathematics is capable of possessing these values, it is a most welcome part of education. Therefore, the importance of mathematics in the world today cannot be over-emphasized. In as much as the problem of mathematics in Nigeria is not with curriculum content but with the methodology of institution (Odili, 1986), mathematics educators will not relent in their efforts in surveying all possible ways to make its teaching and learning successful.

In recent years, the branches of mathematics have rapidly expanded because of its increasing application to the scientific and technology invention. Probability, statistics, computer science, etc. are some of the modern branches of mathematics. Likewise, the components which are very helpful in the study of various useful sciences include; arithmetic, algebra, geometry, trigonometry and calculus. In all these branches and components, fraction is a concept in mathematics that cuts other mathematical concepts. A fraction represents a part of a whole, or more generally, any number of equal parts. When speaking in every day english, a fraction describes how many parts of a certain size there are. For example, one-half, eight-fifths, three-quarters (Fraction Encyclopedia of Mathematics, 2012).

A common, vulgar or simple fraction consists of an integer numerator, displayed above a line and non-zero integer denominators, displayed below that line. The numerator represents a number of equal parts and the denominator indicates how many of those parts. In the fraction ¾, the numerator, 3 parts of 4 parts that make up a whole and denominator, 4, tells us that 4 parts make up a whole. Numerators and denominators are also used in fractions that are not simple, including compound fractions, complex fractions, and mixed numbers. It can be written without using explicit numerators, by using decimals, percentage signs, or negative exponents as in 0.01, 1% and 10^{-2} respectively, all of which are equivalent to $\frac{1}{100}$. An integer such as 5 can be thought of as having an implied denominator of one: 5 equal $\frac{5}{1}$. Other uses of fraction are to represent ratios and to represent division. This fraction $\frac{3}{4}$ is also used to represent the ratio 3:4 (the ratio of the part to the whole) and the division 3÷4 (three divided by four).

In Mathematics, the set of all numbers which can be expressed in the form, $\frac{a}{b}$ where a and b are integers and b is not zero, is called the set of rational numbers and is represented by the symbol Q, which stands for quotient. The test for a number being rational number is that, it can be written in that form (i.e. as a common fraction). However, the word fraction is also used to describe mathematical expressions that are not rational numbers.

As early as 1958, Hartung acknowledged that the fraction concept is complex and cannot be grasped all at once. It must be acquired through a long process of sequential development. Orton (1992) supports this view when he writes that the concept of fraction has developed over a long period, during which time children experience the different meaning of fractions in a variety of situations.

Researchers have concluded that this complex topic causes more trouble for elementary and middle school pupils than any other area of mathematics (Bezuk & Bieck, 1993). Teaching fractions is therefore both important and challenging at the lower level of schooling. Consequently, in teaching fractions, teachers should provide experiences that involve other mathematical concepts including number, length, weight and money, and these should be set in meaningful situations to which children can relate. In educational laboratories and classrooms, results of researches carried out indicated that many slow learners could learn in the same level of achievement as the fast learners. This means that they could apply ideas to new problems and retain ideas equally well, in spite of the fact they learn with more time.

However, there are devices which are very useful as aids in teaching this complex topic, fraction. These include ‘Hundred Board’, which contains a hundred chips or disks. When one chip is taken out, that means one from a group of hundred or one per cent. With a little practice on this type of device, the students can easily understand the value of the fraction $\frac{1}{2}, \frac{1}{4}, \frac{2}{7}$ and so on in term of per cent. ‘Filmstrips’ can also be used to give a new colour and attraction to different ideas of Mathematics. It explains the basic concept of a fraction as an equal part of an object. This filmstrip gives visual examples of multiplying $\frac{1}{2} \times \frac{1}{2}$, $\frac{1}{3} \times \frac{1}{4}$ and $\frac{1}{3} \times \frac{1}{2}$ with many practice exercises. Another aid to teaching mathematics is ‘Fractional Parts’. It consists of disks which are dissected respectively into halves, fourths, eights, thirds, sixths, fifths, etc. It provides material necessary for a meaningful study of fractions.

Kulbir (2012) stresses that many parents believe that they would improve their children’s chances of success in school and in life through the acquisition of knowledge of mathematics. The provision of incentives by the government, organizations and agencies like United Nations Development Program (UNDP), Niger Delta Development Commission (NDDC) and Life Enhancement Agencies (LEA) prove its readiness to promote and encourage the acquisition of fundamental mathematical skills, current and emerging technologies. Incentives provided to student include money, which comes as monthly stipends and personal computer units at the end of the program.

Education Africa is a non-profit organization, established in 1992 with its headquarters office in Johannesburg, South Africa, provides the following programs as incentives to aid Education in Africa, among others:

Early Childhood Development. A project established in 2008 which aims at training and providing ongoing support to Principal Care-givers at pre-schools, with a view to ensuring school readiness of the children as they progress to primary school.

Edu-bike Africa. This is a practical educational program which uses the familiar object of a bicycle as a teaching and learning tool. The organization provides teachers and learners with fully-prepared cross-curricular teaching materials and runs teacher training.

Cycle Aid for Africa. Since 1997, the organization has distributed over 11000 bicycles and equipment to under-resourced schools in rural communities changing the lives of many children who would normally walk long distances to attend school.

Although there are many factors responsible for students' poor performance in mathematics; one of which is poor method of instructional delivery, research study like that of Egunjobi and Ibode (2005) revealed that despite the age in which we are, that is information age, and the level of Information and Communication Technology (ICT) awareness, the commonest media of instruction still in use in many schools, especially in public schools, are text books and chalk-board. Kareem (2003) also points out that the types of instructional materials being used in schools include charts, pictures, paper clipping and maps. These materials are classified as visual materials. Reasons for using these types of instructional materials may be due to their cheapness or availability in the local environment. They are used alongside with chalk-board and text books to illustrate some facts in various text books by the authors.

Theoretical Perspective

The theoretical base of the study hinges on the incentive theory of Pavlov, Thorndike and Dorfinan, Skinner's operant conditioning and Bandura's social learning.

According to Oyewo, Ayana, and Adediran (2003), human beings learn not to be able to survive but also importantly, to gratify other non-survival propensities like plain excitation, imagination, curiosity to understand phenomena, the urge to change, improve or control our environment for greater effectiveness in and even that environment, and so on. There are several competing theories which have been used to explain the acquisition of behaviour like fraction problems solving skill acquisition (e.g. incentive theory, Dorfinan, 1980; Frederick, 1959; Ivan Petrovich Pavlov, 1904; Thorndike, 1898; and Skinner, 1930). The law of effect states that behaviour followed by positive consequences strengthened, while behaviour followed by negative consequences are weakened. The theories explained that people learn faster when they are motivated to acquire a skill. Incentive here pulls the individual toward achieving a goal or skill. The major limitation of this theory does not focus on the internal state of the organism that controls the response to stimuli but focus on the environmental factors that 'pull' the organism towards the performance of a task.

The proponents of the operant conditioning, Skinner (1930) has on the other hand, argued that animal or human being perform some behaviour, and the following consequence (reward or punishment) increases or decreases the change that an animal or human will again perform that same behaviour. Operant conditioning seems rather straightforward. You perform an action or operate on your environment, such as study hard. The consequence of your studying, such as how well you do on examination increase the likelihood that you will perform the same behaviour (studying hard) in future. Operant conditioning has now been applied to training animals to perform action, training children to use the potty, stopping retarded children from injuring themselves and helping autistic children learn social behaviours. An operant response is a response that can be modified by its consequences and is a meaningful unit of ongoing behaviour that can be measured.

By measuring or recording operant responses, Skinner can analyse animal's ongoing behaviours during learning. He called this kind of learning operant conditioning, which focuses on how consequences (rewards or punishments) affect behaviours. A simple example of operant conditioning occurs when a rat in an experimental box accidentally presses a lever, the lever press is followed by food, and this consequence increases the chance that rat will press the lever again. As the rat presses the lever more times, more food follows, which in turn increases the chances that the rat will continue to press the lever. Cognitive learning, according to Oyewo, Ayana and Adediran (2003) is a kind of learning that involves mental processes, such as attention and memory; may be learnt through observation or imitation; and may not involve any external reward or require the person to perform any observable behaviour. Investigators such as Edward Tolman, Albert Bandura, Piaget, Brunner and others have made note-worthy contributions to the cognitive perspectives of behaviour and learning. The concepts of cognitive learning have become popular in explaining both animal and human behaviour as well as development of a new area called cognitive neuroscience.

One of the limitations of the theories is that it places emphasis on intellectual development and mappings. The theory does not consider the role of the environment towards acquiring skills. Social learning theory by Bandura (1977) posits that people learn from observing other people. Such observations take place in a social setting. The theory added that socialization which is the acquisition of culture and ability through participation in group life in order to regulate social interaction is the primary source of learning.

Kulbir (2012) indicates that the aims of teaching mathematics pertaining to the entire school stage are to enable the students to acquire essential mathematical knowledge, skills, interests and attitudes, and to help them apply these mathematical knowledge and skills in many ways. Ultimately, the overall aim of teaching mathematics and all the subjects is to ensure all-round and harmonious development of the personality of the child.

Studies have found that the achievement gains associated with the monetary incentive programmes were short-lived. In a multi-year evaluation study, conducted by Bettinger (2012), where students could be eligible for incentives in one year, but not the next, the researcher found out that the achievement gains demonstrated by the incentive recipients in the previous year did not persist into the following year. Levitt, List, Neckermann and Sado (2013) examine test performance during non-incentivized testing sessions. A few days after the removal of the incentives, some of these testing sessions took place. Other testing sessions took place a few months after the incentives had ceased. Regardless of the timing of these testing sessions, incentives no longer had a significant impact on subsequent test performance.

On achievement after the removal of incentives, Kremer, Miguel and Thornton (2009) found out that even one year after the incentive programme has ended, the programme continued to have a positive impact on test scores, which suggested that the initial learning gains reflected real leaning. Likewise, examining the incentive programme in Dallas (USA), Fryer (2010) found that a year after the incentives had ended, the treatment group continued to outperform the control group, although the impact was not as when the incentives were in place.

The existing results on the impact of the monetary incentive programmes as a function of the size of the cash reward are contradictory. Fryer and Holden (2013) paid students $2 per mathematics objective mastered. The researchers found that when the amount of incentives was temporarily increased from $2 to $4, and then to $6, the rate of objectives mastered per week also showed a commensurate increase. For example, when the incentive amount was $2, students mastered an average of 2.05, objective increased to 3.52 and 5.80 respectively. Likewise, Levitt et al. (2013) found that offering a $10 cash prize had a null effect. The researchers explained that, this effect appeared to be driven mostly by older students, as younger children responded in similar ways to both the larger and smaller incentives. In contrast to the studies of Fryer and Holden (2013) and Levitt et al (2013), Jackson (2014) did not find a relationship between programme effect size and the size of the reward.

Significance of the Study

This research work investigates the effect of incentive and gender student's performance on fraction problems solving skill acquisition at the Senior Secondary School level of the educational system. The study is of great significance because it is hoped that, the finding would improve and uplift the standard of teaching and learning of mathematics at senior secondary school of our educational system through the use of incentives.

Research Questions

Specifically, this study addressed the following questions:

(i) Does a monetary incentive have influence on fraction problems solving skill acquisition?

(ii) Does gender has influence on fraction problems solving skill acquisition?

Research Hypotheses

Two null hypotheses were tested in this study:

HO_1: There is no statistically significant difference in the fraction problems solving skill acquisition between incentive group and no incentive group.

$HO1_2$: There is no statistically difference in the fraction problems solving skill acquisition between males and females.

In this study, the researcher conceptualized "incentives" as the promissory motivational item that is money used to motivate students and improve their knowledge and ability to simplify fraction problems effectively. "Gender" was also used to mean male and female students used in this study.

Research Methodology

Research Design

The design of the study was an experimental control group research design.

Population, Samples and Sampling Techniques

The population of the study is senior secondary school students in Ogbomoso North Local Government of Oyo State. The target population is Federal Government College, Ogbomoso. The sample for this research consists of forty (40) students; twenty (20) males and twenty (20) females, randomly selected from one hundred and fifteen (115) SS11 student of Federal Government College, Ogbomoso. A random sampling was done using the "deep-hand" technique. Students randomly picked from the basket. Those who picked "yes" were used for the study to minimize unnecessary interference.

Research Instrument

The instrument used for the study consists of 6 written test items on Mathematical Problems Test on Fraction (MPTF) which were drawn based on the topic taught. The topics are compound fractions, algebraic fractions and word problems involving fractions, that the participants were exposed to or trained on for skill acquisition. The instrument (MPTF) contains six problems on fraction problems, out of which two of the problems were compound fractions; two were algebraic factions and remaining two were word problems involving fractions. Wrist-watch was used by the researcher to time when to start and when to stop the lesson and test. Lesson note on fraction problems was a book that served as a guide for the lesson during the teaching session. Money was used by the researcher to motivate the participants in group A, while students in group B (control group) were not promised to be rewarded with money.

Validation of the instrument

In order to determine face and content validity of the instrument (MPTF), it was given to two mathematics experts in the Department of Science Education, University of Ilorin and three experienced senior secondary school mathematics teachers in Oyo State. The index of reliability of the instrument (MPTF) was determined using a test-retest approach. The instrument (MPTF) was administered on 30 SSII students different from the selected school for the study. The test was re-administered on the sample after an interval of seven days, and then Pearson's Product Moment Correlation formula was used to determine the index of reliability of 0.83.

Procedure for Data Collection

The researcher visited the school of study and discussed the purpose of the study with the school principal. The school principal then assigned the Head of Department (Mathematics) to assist the researcher. The researcher randomly selected 40 SSII students as participants for the experiment. The researcher had a lesson/ teaching of two hours with the participants on the tree types of fractions, that is, compound fractions, algebraic fractions and word problems involving fractions. After the lesson, the researcher then randomly assigned the participants into two groups. Each group had 20 participants of 10 males and 10 females. Group A was the incentive or experimental group and Group B was the no incentive or control group. The participant were also given identification numbers according to their group and gender like GrAm1, GrAm2, GrAm3, … meaning that (group A male 1, group A male 2, respectively) and GrBf2, GrBf2, GrBf3, … meaning that (group B female 1, group B female 2 respectively).

Before the commencement of the test, instructions were given to the two groups on how the test was to be conducted. The instructions were as follows:

(i) "Everybody is expected to get ready for the test; answer booklet would be given to you. Make sure you write your identification number clearly. You have just 50 minutes to answer the 6 questions".

The researcher gave the second verbal material incentives instruction to the experimental group (incentives group) only, in a separate classroom.

(ii) "Anybody among you that emerges as the best will be given a handsome reward of N3000 (three thousand naira only)"

The Head of Department (Mathematics) assisted in supervising the groups. The essence of the organized supervision was to make sure that the questions were answered by the participants themselves based on their efforts and the skill they have acquired during the lesson on fraction problems. At the end of the test, their answer booklets / scripts were collected accordingly for the two groups. The researcher ensured that what the students were taught was not strange and that all the items in the instrument were properly taught by the researcher. The performance of the students were compared and explained mainly by the effect of incentives.

Questions 1 and 2 on compound fractions attracted 30 marks; questions 3 and 4 on algebraic fractions attracted 30 marks and questions 5and 6 on word problems involving fractions also attracted 30 marks. The scores awarded were used for statistical analysis.

Data Analysis Techniques

The data collected were analyzed using the t-test statistics. There were two independent variables which are incentive (incentive and no incentive) and Gender (male and female) groups.

Results

Ho_1: There is no statistically significant difference in the fraction problems solving skill acquisition between incentive group and no incentive group.

Table 1:

T-test result of the incentive (experimental) and no incentive (control) groups.

Variable	**Number of sample**	**Mean**	**Standard deviation**	**df**	**T**	**Sign Level**
Incentive	20	43.20	7.61	38	4.11	0.000
No Incentive	20	34.85	4.98			

The means revealed that participants in the incentive group performed significantly better than their counterparts in the no incentive group (x = 43.20 Vs 34.85) on fraction problems skill acquisition. The null hypothesis HO_1 was rejected at 0.05 level of significant difference in the fraction problems skill acquisition between incentive group and no incentive group.

$HO_{2:}$ There is no statistically significant difference in the fraction problems solving skill acquisition between males and females.

Table 2:

T-test result of the males and females incentive (experimental) group

Variable	**Number of sample**	**Mean**	**Standard deviation**	**df**	**T**	**Sign. Level**
Males	10	43.80	3.91	18	0.345	0.734
Females	10	42.60	10.29			

It was also revealed in Table 2 that males had a higher mean performance in fraction problems skill acquisition than the females (x = 43.80 Vs 42.60), but the difference was very minimal. The null hypothesis HO_2 was accepted since the p-value 0.734 > 0.05 level of significant. There was no statistically significant difference in the fraction problems solving skill acquisition between males and females incentive group.

Discussions

The findings in this research are relevant to a number of on-going practical and theoretical issues in the assimilation of fraction problems solving skill acquisition. The result of the study showed that incentive had a significant effect on fraction problems solving skill acquisition. This is in agreement with Kremer et al. (2009), Fryer (2010), Okediji et al.

(2010), Bettinger (2012) and Fryer and Holden (2013) that found significant higher performance scores as a result of the provision of incentive. According to these researchers, incentive schemes encouraged managers to concentrate either on executing current tasks or on developing and implementing new business ideas to fuel future growth. In addition, when the amount of incentives was temporarily increased, the rate of mathematics objectives mastered per week also showed a commensurate increase. Thus, in this study, participants given incentive performed better than those that received no incentive. The finding of the study justifies the proposition of incentive theories by Skinner (1930), as the rat presses the lever more times, more food follows, which in turn increases the chances that the rat will continue to press the lever.

The second finding of this study showed that gender has no significant difference in the fraction problems solving skill acquisition. This result is in agreement with the finding of Salam (2000) who identified three categories of errors committed by concrete and formal operational students in word problems leading to logarithms. It was affirmed that people tend to function very well on their gender tasks performances ascribed to them by the society.
Social learning theory by Bandura (1977) posited that people learn from observing other people. Such observations take place in a social setting.

The finding of this study suggests that fraction problems solving skill acquisition can be improved through the provision of incentives because they serve as motivator to the learners. Therefore, better performances on task can be achieved when people are motivated and gender type matched according to task. The performance of students in Mathematics, Physics, Chemistry, Technical and Commercial subjects would significantly improve due to their knowledge in fractions. More students would also be attracted into the science subjects; since one of their problems is the fear of mathematical concepts, which would be reduced drastically.

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