IMPROVING JUNIOR SECONDARY SCHOOL STUDENTS' ATTITUDE TOWARDS MATHEMATICS THROUGH BRAINSTORMING LEARNING STRATEGY: A STUDY IN SCHOOL EFFECTIVENESS

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Abstract
Academic achievement stands out as one of the measures of school effectiveness; however, the poor achievement of students in school subjects like mathematics both at school and at public examinations has been a concern to mathematics educators. The failure rate may be due to students' attitude to the subject which is likely to have its root from how the subject is taught. This study, therefore, examines the effect of brainstorming on students' attitude in junior secondary school mathematics. The study adopted a quasi experimental design with pre test – post test control group. Two instruments: response (Student Questionnaire) and stimulus (experimental package) were used to collect data. The result shows that students exposed to brainstorming strategy developed positive attitude to mathematics than those in the control group. It is, therefore, recommended that teachers should be taught to use brainstorming strategy in the teaching mathematics in school.

Key words: Brainstorming, students' attitude in mathematics, school effectiveness, junior secondary school mathematics

Background to the Problem

In order that students may develop ability to compete effectively in today's international economy, there is a need for them to increase their understanding and application of mathematical skills (Skibba, 2008). In this modern world, mathematics is being increasingly used in science, technology, industry, government, management, education, as well as economics. Any country that really wishes to produce men and women able to cope with the challenges in these areas must make sure that proper understanding of mathematics is pursued with vigour. Bush (2006) says, you have got to know mathematics if you are going to compete in this 21st century world. Mathematics is the foundation of science and technology. Its importance and contributions to knowledge acquisition, development and modernization cannot be over emphasized. Without good knowledge of Mathematics, no nation is likely to become self-prosperous, economically independent or technologically self-reliant. Advanced nations like Japan and USA are known for their prowess in mathematics and sciences. These underscore the importance of mathematical competence of all learners in all levels of education and mostly at the junior secondary schools where knowledge obtained from the foundational level (primary school) is built upon. Mathematics skills and knowledge acquired at this level is likely to equip them to fit well at the senior secondary school level, the higher education and the larger society. This probably accounts for the reason why prospective candidates seeking admissions into institution of higher learning are required to obtain, in most cases, basic entry requirement of credit pass in mathematics before they are admitted into various courses in sciences and social sciences related disciplines. Most of these courses have some mathematical aspect of which good knowledge of basic operations and concepts in mathematics are highly required.

Another major purpose of mathematics is preparation of an individual for useful living within the society. The knowledge of number and numeration helps an individual to engage in gainful interaction with objects. Knowledge of Mathematics helps individuals in counting and keeping records of the number of objects in the individuals' possession and in the surrounding, as well as events happening in the community. In addition, the knowledge of the four basic operations of addition, subtraction, multiplication and division provides basic skills being constantly applied in the solution of everyday problem. The child is part of the society; not only is (s)he expected to participate usefully in everyday activities, but (s)he also needs the knowledge of these four basic operations to be able to do simple calculations required in everyday living. These kinds of abilities are built on the knowledge of basic mathematical concepts and operations taught at the primary schools. When these abilities are demonstrated frequently, they build and encourage knowledge of numeracy and adaptive skills. They also foster reflective thinking and reasoned enquiry which are of immense value in integrating the child into larger society.

From societal point of view, mathematics competence and scientific culture are essential for preparation for an informed citizenry and necessary for the production of highly skilled personnel required by industry, technology and science. Weak knowledge of mathematics at the basic level of education constitutes a major setback in achieving the immediate and long range societal goals. For instance, considering our national goals and aspirations of attaining technological and scientific heights, one wonders how these can be realized without functional and qualitative educational programme at the basic education (primary school and junior secondary school) level with sound teaching of mathematics and sciences.

The enviable position of mathematics and its immense contribution to day to day activities in the society make it one of the core subjects in primary and secondary school curriculum (FRN, 2004). Thus in primary and secondary schools all over the world, much effort, time and resources are usually devoted to the teaching and learning of mathematics and sciences. The prominence accorded mathematics in school curriculum reflects accurately the recognition of the vital role it plays in educational setting and contemporary society.

Unfortunately, there are evidences of general poor performance (a measure of school effectiveness) of students at the public examinations in mathematics. To the students, schooling is uninspiring because science and mathematics seem unreal, vague and meaningless (Nwoji, 1999). Aborisade (2001) describes a disturbing scenario that for many Nigerian students in secondary schools, mathematics is a loathsome subject and that at the mention of the subject, some students curse and hiss. To those students who detest the subject, mathematics teacher is an arch-enemy. He is unpopular simply because the subject is unpopular. Since mathematics is critical to most students' future educational aspirations and career development, weak mathematics background can block route to such aspirations. To buttress this point, Igbokwe (2003) noted that there is a steady decline in the number of candidates who are qualified to study the basic sciences and none of the few applicants for mathematics in 1999 and 2000 was qualified for admission in mathematics in University of Uyo. It should also be noted that performance of students in mathematics does not present any specific pattern; in some years, number of students passing the subject may be on the increase, in some other years, it may decline.

The performance of Nigerian students at the junior secondary school levels is at variance with the educational goals and national aspirations. In the same vein, it could be argued logically that the poor performance trend at the secondary school level, institutions of higher learning and various public examinations is as a result of weak foundation at the basic education level. In spite of the prominence given to mathematics and increasing efforts of different government to provide necessary enabling environment and policy for its study, it is disheartening to learn that many students lack competence and basic skills in the subject.

Many factors have been adduced for students' poor performance in mathematics; some of them are home, school, teacher, society and student related. Of importance to this study are the students, and teachers' related factors – attitude to mathematics and teachers as moderators. Negative attitude to mathematics has been identified as one of the several problems which have adversely affected mathematics education in Nigeria (Oyeniyi, 2005). Although, Olatokun (2008) observes that the attitude of pupils to mathematics is positive, this does not translate into good performance of students as there is consistent poor performance in the subject as indicated by some studies (NAEP, 2006 & Makoju, Falayajo, Ayodele, Obaitan, Akinsola, Falaye, Adewale, Nwangwu, Shuaibu & Nwana, 2004).

To bridge the gap between students' attitude to and performance in mathematics, more attention must be directed towards the practices of teachers. This is because promoting confidence and positive attitude in mathematics class is an important responsibility for teachers, as most students who experience difficulty in mathematics develop negative attitudes toward the subject (Shellard, 2004). Factors responsible for such gap should be identified empirically, and necessary intervention programme should be designed and implemented by tapping the interest and positive attitude of the learning and direct same to desired end. This is why brainstorming is suggested in this study.

Encouraging students to think aloud and share (brainstorming) the way they approach problems with each other may be especially important in helping students feel confident and have a positive attitude (Bafumo, 2004). A variety of effective methods include presenting a problem to the class and having them brainstorm different mathematical techniques to solve it, asking students to share, verbally explain their thinking processes to the teacher and class, and rephrase another student's explanation for understanding (Chapko, 2004). The discussion among students and teacher provides the foundation for true understanding of mathematical concepts and positive attitudes in the classroom. Proficiency is much more likely to be developed when a mathematics classroom is a community of learners (who are posed to help each other through brainstorming) rather than a collection of isolated individuals (NCTM, 2002).

Sternberg and Lubart (1995) define brainstorming as a technique in which children are encouraged to come up with creative ideas in a group, say practically whatever comes to mind and argue each other's ideas in a friendly manner. Children are usually encouraged not to criticize each other's ideas, at least until the end of the brainstorming session. Brainstorming works by focusing on a problem, and then deliberately coming up with as many solutions as possible and by pushing the ideas as far as possible. It is also a group technique for generating new and useful ideas and promoting creative thinking. A good creativity strategy is to come up with as many new ideas as possible. The more ideas children produce, the better their chance of creating something unique (Rickards, 1999).

The effect of a treatment could be measured along two dimensions. The first one is using the statistically significant effect, and the second is using the effect size. In this study, the two approaches are considered. Statistically significant of brainstorming was obtained using Analysis of Covariance (ANCOVA), and effect size was obtained using the correlation approach. It is assumed in this work that readers are familiar with ANCOVA, so no attempt is made to explain the statistical tool. However, not many readers are familiar with the measures of effect size; therefore, a little explanation is provided. In general, effect size can be measured in two ways: (a) the standardized difference between two means, or (b) the correlation between the independent variable classification and the individual scores on the dependent variable. Effect size is a name given to a family of indices that measure the magnitude of a treatment effect. Unlike significance tests, these indices are independent of sample size. Pearson's *r* correlation can be used when the data are continuous or binary; thus, the Pearson r is arguably the most versatile effect size. This was the first important effect size to be developed in statistics. Pearson's *r* can vary in magnitude from -1 to 1, with -1 indicating a perfect negative linear relation, 1 indicating a perfect positive linear relation, and 0 indicating no linear relation between two variables. Another often-used measure of the strength of the relationship between two variables (effect size) is the Cohen's *d* which is most commonly used to refer to standardized measures of effect. The first approach (correlation) was used in this study. This correlation is called the "effect size correlation" (Rosnow & Rosenthal, 1996). Measures of effect size in ANOVA are measures of the degree of association between an effect (e.g., a main effect, an interaction, a linear contrast) and the dependent variable. They can be thought of as the correlation between an effect and the dependent variable. If the value of the measure of association is squared, it can be interpreted as the proportion of variance in the dependent variable that is attributable to each effect. Four of the commonly used measures of effect size in AVOVA are: Eta squared, η^2; partial Eta squared, η_p^2; omega squared, ω^2; and the intra-class correlation, ρ_I. In this study, eta squared, η^2 was used.

Statement of the Problem

Brainstorming is a useful way of getting started or generating new ideas. It can be done as a class, in small groups, or by individual students. Once students are familiar with the process, they can use this technique on their own when they are stuck revising their work. It is assumed that as students interact with themselves during brainstorming sessions; their attitude towards mathematics is likely to improve. Therefore, this study examines the effect of brainstorming in improving students' attitude to mathematics.

Research Questions

Two research questions were asked in order to guide this study. The questions are:

1. Is there a statistically significant effect of treatment (brainstorming) on students' attitude to mathematics?

2. What is the effect size of treatment on students' attitude to mathematics?

Methodology

The study adopted quasi experimental design with pre test – post test control group. Two treatment groups were used (the experimental group and the control group). The dependent variable was the students' attitude to Mathematics.

The target population of the study comprised the junior secondary school students in Ibadan North Local Government of Oyo State, Nigeria. Four of the junior secondary school were randomly selected as the samples for the study, while an arm of the junior secondary school three (JSS 3) was chosen with all the students (intact classes) as the samples. The selected arms of the JSS 3 students were randomly assigned to control and experimental groups.

The instruments used for this study are classified into two, the response instrument and the stimulus instrument. The response instrument was the Student Questionnaire (SQ). The SQ consisted two sections A and B. Section A focuses on bio-data information like students' sex, age, school location, language use at home and possession of mathematics textbooks. Section B is made up of 32 attitudinal items e.g. interest in mathematics, liking the mathematics teacher, wanting to do more mathematics in the class and at home, seeking help from older ones when there is a problem, amount of time spent solving mathematics problems, etc. on modified Likert Scale (Strongly Agree=4; Agree=3; Disagree=2 and Strongly Disagree=1 for positive statements and reverse for negative statements). The instrument was pilot-tested on a sample of 30 students in a school in another Local Government (Ibadan North East) not used in the study and a Cronbach alpha of 0.86 was obtained. The reliability coefficient is high enough showing that majority of the items hang together (internal consistency and construct validity). The stimulus instruments are the instructional packages designed for the brainstorming strategy and the conventional method of teaching. The use of the stimulus instruments lasted six weeks.

SQ was administered on the experimental and control groups prior to the experimental session or treatment. The scores obtained after administering SQ served as pre-test. The students in the two groups were taught geometry (this is one of the difficult topics in mathematics according to chief examiners' yearly reports) – the experimental group with the use of brainstorming strategy and the control group with the use of conventional method.

The students in experimental group were assigned to the brainstorming instruction. A brainstorming strategy teaching guide was prepared to direct teachers using the strategy. Students were grouped into maximum of six members and minimum of three members. In each group, they were asked to solve the identified problems by focusing on a problem at a time and asked them to deliberately come up with as many solutions as possible on each of the problems. Their solutions are discussed with the rest of the class members, issues that need clarification were tackled by the teachers in each of the classes where brainstorming strategy was used. On the other hand, the students in the control group were exposed to the conventional instruction; however, the same topics were taught to both groups of students for six weeks.

At the end of the six weeks, the post test in attitude to mathematics was administered on the two groups. The maximum score on the attitude instrument was 132. The Analysis of Covariance (ANCOVA) was used to analyse the data obtained. ANCOVA was used to remove initial differences between the attitude of students in the experimental and control groups.

Results and Discussion

The findings of this study are presented in the following tables.

Research Question 1

Is there a significant main effect of treatment on students' attitude to mathematics?

Table 1: Summary of Analysis of Covariance (ANCOVA) on Students' Attitude to Mathematics

Source	Sum of Squares	Df	Mean Square	F	Significant
Covariate (Pre Test)	89.513	1	89.513	1.701	.632
Treatment	2332.423	1	2332.423	44.876	.000
Residual	8627.827	164	52.609		
Total	10960.240	165	65.630		

Table 2: Multiple Classification Analysis on Students' Attitude to Mathematics
Grand Mean = 97.27

Variables	N	Unadjusted Deviation	Eta	Adjusted Deviation	Beta
Post test:					
Treatment:					
Brainstorming	85	18.39		18.15	.684
Control	81	-18.39	.718	-18.15	

The F-ratio for the pre test (covariate) is not significant $F_{(1, 164)} = 1.701$; $P > 0.05$. This implies that there was no significant difference between the pre-attitude scores of the two groups towards mathematics before the introduction of treatments (brainstorming and control). So, the two group can be assumed to be homogenous statistically (this does not mean that the two groups are homogenous in all respect). However, there is a significant difference between the post-attitude scores of students exposed to brainstorming and those exposed to conventional methods $F_{(1, 164)} = 44.876$; $P < 0.05$. The source of variation, therefore, could be traced to the treatment. From Table 2, the students exposed to brainstorming had better attitude (97.27 + 18.15 = 115.42) than those exposed to conventional strategy (97.27 – 18.15 = 79.12). This result implies that students in the experimental group developed better attitude than those in the control group after the treatment. This show that the brainstorming interactive instructional strategy provides a favourable effect on the experimental group and the effect led to improvement in students' attitude to mathematics.

Research Question 2

What is the effect size of treatment on students' attitude to mathematics?

The effect size is measured by eta value. Table 2 reveals that an eta coefficient of 0.718 was observed. This means that 0.516 is the relationship between the treatment (brainstorming and control). It also means that 51.6% of the variance in students' attitude to mathematics is accounted for by the treatment.

Discussion

In this study, students exposed to brainstorming learning strategy developed positive, stronger and significant attitude to mathematics than those in the control group. This corroborates the report of researchers who had been involved in the use of brainstorming strategy with this conclusion that brainstorming improves students' achievements, attitudes, maximize intellectual potentials and ability to understand and solve real life problems. For example, Wilborn (1994) designed practicum to improve third grade students' problem solving abilities through brainstorming strategy and the result indicated that students' performance improved significantly and they enjoyed (improved attitude) solving mathematics problems. Seamon and Kenrick (1992) in discussing a case of a seven-year-old girl discover that even gifted individuals' attitude could be raised, especially when they find assignments unchallenging and school work boring; but brainstorming brings out the best in them and enhances their attitude which in turn increases performance. Brainstorming is so important that Sears and Barbee (1977) concluded that if the mentally gifted children are not adequately challenged by giving them such roles as leading brainstorming sessions, they could turn out to be misfits. Brainstorming and attitude could be seen as one leading to the other (vicious cycle) because brainstorming improves attitude and attitude also enhances brainstorming. For example, if team members do not abide by the rules of brainstorming, its use will be limited to arguments which may eventually lead to fight as some of the students in brainstorming session are most likely to criticize one another, discourage freewheeling – wild and strange ideas, discourage piggyback ideas – share credit and their accomplishments**,** discourage so many ideas**,** over bearing (some students are opinion leaders and their opinions must be followed). However, with good sound character or attitude, members of the team can work together in a friendly manner which in the end will lead to higher achievement.

Coefficient of determination (the square of *r*, referred to as "*r*-squared") is used in determining the strength of correlation as shown in Table 2 (coefficient of determination 0.468). This is a measure of the proportion of variance shared by the two variables (in this case, treatment and attitude to mathematics) and varies from 0 to 1. Pearson's *r* correlation, introduced by Karl Pearson, is one of the most widely used effect sizes. The effect size of 51.6% obtained in Table 2 is considered large using the Cohen's yardstick. Cohen (1988) gives the following guidelines for the social sciences with respect to the relative size of effect sizes: small effect size, r = 0.1; medium, r = 0.3; large, r = 0.5. This implies that the effect of brainstorming on students' attitude to mathematics in this study is large.

Conclusion and Recommendations

Considering the statistical and the effect size of brainstorming on students' attitude to mathematics, we can conclude that brainstorming is a potent interactive instructional strategy that can be used to improve students' attitude to mathematics. Therefore, for developing strong attitude to mathematics, the use of brainstorming is being recommended for the mathematics teachers and students of all grades.

The preliminary results (before the intervention) leading to this study shows that teachers of students used for this study were not familiar with this method, hence, it is recommended that mathematics educators should organize workshops and seminars to educate teachers on brainstorming strategy. They should also give teachers established guidelines which they can use as immediate tool in their own classrooms for effective teaching learning process, which is potent to develop students' attitude to mathematics.

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