

EFFECT OF BRAINSTORMING STRATEGY IN DEVELOPING CREATIVE PROBLEM SOLVING SKILLS AMONG PRIMARY SCHOOL PUPILS IN MATHEMATICS

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Abstract

The study investigated effect of brainstorming strategy in developing creative problem solving skills among primary school pupils in mathematics. This study was carried out in Living World Academy Primary School in Owerri North Local Government Area of Imo State. Based on the objectives of the study, two research Questions and two hypotheses were posed for the study. Quasi-experimental design was used for the study adopting pre-test posttest, non-equivalent control group design. A sample size of nine-eight (98) pupils was used in the study. The experiential group had (51) pupils while the control group had (47) pupils. The experiential group was taught mathematics using brainstorming strategy while control group was taught the same concept using conventional method. The instrument for data collection was 25 item multiple choice objective test questions constructed by the researchers. The items internal-consistency had a reliability coefficient (r) of 0.74 determined using Pearson product Moment Correlation. The findings of the study showed that there are statistical significant differences between the experimental group and the control group in the total scores and the sub-skills of the creative problem solving skills in the favour of the experimental group indicating the effectiveness of using brainstorming strategy in developing creative thinking skills. Some useful recommendation was Primary school mathematics teachers should use brainstorming strategy in teaching difficulty topics in mathematics.

Keywords: *Brainstorming strategy, Creative Problem Solving Skills and Mathematics*

Introduction

Every individual needs mathematical knowledge to function intelligently and efficiently in his or her world. Mathematics is one subject that is an integral part of everyone's life and affects virtually every

field of human endeavour. There are many uses and applications of mathematics in the home offices, business, industries, agriculture, decision making and even in governance. Usman (2002) noted that everywhere we go, everything we do or propose to do, either the structure of mathematics or its applications play a vital role and this is why most countries, races and peoples place emphasis in all aspects of studying, developing and applying mathematics. Mathematics is also a body of knowledge essential for the achievement of a scientific and technological growth of a nation. Ale and Adetula (2010) stated that the line of demarcation between the developed and the under developed nations is based on their level of mathematical attainment and in genuity. According to them, mathematics is an undisputed factor of national development and wealth creation. Confirming this statement, Nosa & Ohelen (1998) stated that evidence to show that any nation that embrace mathematics, science and technology enjoy better standard of living and are less dependent on others. The word is speedily becoming a global village and that makes it even more importance that all individuals have a better understanding and appreciation of mathematical procedures and methods of reasoning to be carried along. Adedayo (1997) stated that knowledge of mathematics promotes the habit of accuracy, logical, systematic and orderly arrangements of facts in the individual learner. It is also said that mathematics encourages the habit of self-reliance and assists learners to think and solve their problems themselves. Mathematics knowledge indeed equips individuals with the skill to solve a wide range of practical task and problems they may encounter in life. Usman (2007) commenting on the importance of mathematics stated that the study of mathematics helps the mind to reason and organize complicated situations or problems into clear, simple and logical steps. The reality, they noted is that in a society such as ours, high paying jobs often demand some who can simplify complicated situations and reduce them to the level everyone can understand. Unfortunately despite the high level of importance placed on mathematics it still remains the subject that student's performance has been consistently poor.

The problems of learning mathematics in Nigeria primary and post primary school levels has continued to be a topic that attracts the attention of researchers. The incessant low level of performance in mathematics among Nigeria pupils and students is a clear manifestation of this perceived problem (Eniayeju & Azuka, 2010). These consistent reports on student's low achievement in mathematics are indications that teaching and learning of mathematics across primary schools in Nigeria are tainted. It suggests that mathematics teachers appear to have exhausted all strategies. It appear that teachers use the traditional rote learning of mathematics and teaching materials that are align to the student background. Result trend in teaching of mathematics worldwide demands conceptual change approach as against the traditional method which promotes rote learning of mathematics. Educational reforms in mathematics teaching at both pre-

secondary school levels in Nigeria have achievement for the use of student-centered method approach such as brainstorming.

Brainstorming is a teaching technique that deals with student –centered learning. Brainstorming can be defined as a group or an individual creative method in which attempts are made to determine a definite conclusion for a particular problem by obtaining information in form of a list of ideas that are spontaneously contributed by the members (Rowan 2014). The idea was originally introduced by Alex Osborn in 1953. He claims that individual working alone to come up with ideas is less efficient than when the ideas are generated through brainstorming. Al-Maghrawy (2012) defines brainstorming as a group creativity forum for general ideas. Brainstorming helps learners to identify and come up with real questions to necessary for learning (ODE, 2014). Students are able to come up with ideas regarding how to solve particular problems; and therefore, can come up with question relating to how the problem comes about and the best way to tackle it. (Ikwumelu & Oyibe 2014). Brainstorming has a great importance in the teaching process as Sayed (2009) noted that it's; helps students to solve problems in an innovative solutions, it helps students to benefit from the ideas of others through the development and build on them, it helps the cohesion of the students and build relationship among them. Brainstorming incorporates other forms of study such as creative problem solving. The creative problem solving means finding a way to solve problem. The problem refers to obstacles that present challenges to the individual to reach the goal.

Qattami (2010) defined creative problem solving as taking decision through thinking, reflecting, predicting ideas, and solutions through deep awareness. The creative problem solving is the effort by the individual or the group creative thinkers to solve a problem. Abu Jao and Nwfal (2007) mentioned that the model of creative problem solving contains the following six stages:

1. **Finding the Dilemma:** This stage includes considering trends, experiences and interests with careful attention to number of general subjects that can be adopted for the creative solution.
2. **Findings Information:** This stage leads to an increased awareness of the problem through available facts, knowledge, information and feelings regarding the problem from previous stage.
3. **Findings the Problem:** In this stage many questions are taken into consideration and many phrases of the problem are considered for collecting information.
4. **Finding Ideas:** This stage contains the search for many responses or proposed ideas or the question or problem that is chosen previously.
5. **Findings the Solution:** This step includes findings the solution by determining the standards of evaluating promising ideas then choosing suitable ones. Accordingly, ideas are analyzed and organized.

6. **Acceptance:** In this case the focus is on considering certain elements that may affect the successful use of the proposed promising solutions.

The study of Harbi (2002) that aimed to measure the impact of the use of brainstorming and the development of critical thinking and academic achievement among biology students the results have shown the presence of statistically significant differences between the average achievements of the objectives knowledge of Bloom's Taxonomy for the experiment groups which studied the use of the brainstorming. Darayseh (2003) aimed to determine the impact of a proposed program based on the two strategies of the semantic map and brainstorming in the development of attitudes and writing ability in English for students , results showed that brainstorming is effective than semantic. Hung (2003) tried to develop revised creative problem solving instructional units and assessment tools in elementary school chemistry courses. The treatment was studied using a quasi-experimental design including the pre and post testing of 25 fifth graders. The RCPS instructional units were "Acid-base Properties of Aqueous Solutions". The assessment tools were "Test of Scientific Problem Solving" and "Test of Scientific Creativity". The major findings was that RCPS instruction of "Acid-base Properties of Aqueous Solution" can increase students' scientific creatively and science problem solving ability because there was significant difference between the pre-test and post-test scores in scientific creativity and scientific problem solving. Based on the findings of this study, the researcher proposes that RCPS instruction of "Acid-base Properties of Aqueous Solutions" be used in elementary school natural science instruction and also provides suggestions for science instruction and future science education research. Al-Bilwi (2006) conducted a study to investigate the effectiveness of brainstorming in developing creative thinking and measuring the thinking skills among science stream students. The findings of the study showed that there were significant statistical differences between the study groups attributed to the teaching method of creative thinking. Bani Hamad (2006) investigated the effect of brainstorming in eighth grade student's achievement in sciences according to Bloom taxonomy.

The findings of the study showed that there is a significant statistical difference between the means of student's scores in both groups on the pre test attributed to the teaching strategy. Al-Olimat (2008) studied the effect of brainstorming and discovery strategies in developing creative thinking among eighth grader students. The findings of the study showed that there is an evident effect for brainstorming and discovery in developing creative thinking. Moreover, there were differences between both strategies in the favour of brainstorming. Al-abadi (2008) conducted a study to explore the effect of an educational program in developing creative thinking skills among gifted disabled students. The findings of the study showed that there were statistical significant differences between the means of both groups on creative thinking test in the favour of the experimental group attributed to the educational program. Al-qarni (2011) studied the effectiveness of brainstorming strategy in developing creative thinking among third intermediate

students in Qurayyat city. The findings of the study showed that there are statistical differences between the means of both groups on the test in the favour of the experimental group studied through brainstorming. Moreover, there were statistical significant differences between the means of male and female student's scores on the creative thinking test and sub skills. Therefore the study aimed to investigate the effect of brainstorming strategy on developing creative problem solving skills among primary school pupils.

Purpose of the Study

The main purpose of the study was to investigate effect of brainstorming strategy on creative problem solving skills among primary school pupil. Specifically the study sought to determine

- i. The difference in the achievement scores of pupils taught mathematics using brainstorming strategy and those taught using conventional method.
- ii. The difference in the achievement scores pupils taught mathematics using brainstorming strategy and those taught conventional method among the creative thinking sub - skills (fluency, flexibility, and Originality).

Research Question

1. What is the difference in the mean achievement scores of pupils taught mathematics using brainstorming strategy and those taught conventionally.
2. What is the difference in the mean achievement scores pupils taught mathematics using brainstorming strategy and those taught conventional in creative thinking sub-skills (fluency, flexibility, and Originality).

Hypotheses

The following research hypotheses were tested at 0.05 level of significance.

1. There is no significant difference in the mean achievement scores of pupils taught mathematics using brainstorming strategy in developing creative problem solving skills and those taught conventionally.
2. There is no significant difference in the mean achievement scores of pupils taught mathematics using brainstorming strategy in developing creative thinking sub-skills (Fluency, Flexibility and Originality) and those taught conventionally.

Methodology The design of the study was quasi-experimental type adopting pre-test, post-test non-equivalent control group design. The population for the study was 642, made up of all primary six pupils in Living World Academy in Owerri North Local Government Area of Imo. The sample of the study

consists of nine-eight (98) pupils from two randomly selected classes from the school. The selected classes were assigned to experimental totaling (47) pupils while the control group total (51) pupils. The instrument used for data was Torrance test of creative thinking. The test has three sub-skills Fluency, Flexibility and Originality. It was a 25 item multiple choice objective test question constructed by the researcher with special attention on (1) thinking and its development (2) Critical thinking (3) creative thinking. The construction of the instrument was guided by a table of specification to ensure adequate coverage of the content areas covered in the study as well as maintain even spread across the different levels of the cognitive domain. The face and content validity of the instrument were determined by two research experts, one of whom was an expert in measurement and evaluation and the other from mathematics education. The reliability of the instrument was determined through test-Retest-method. The scores of the test were correlated using Pearson-Product Moment Correlations of 0.74. The control group was taught using the conventional method. In administering the instrument, the control and experimental groups were pretested to ensure equity in their cognitive background. The experimental group was exposed to brainstorming strategy. The control group was assessed using the conventional method of teaching. After six weeks of treatment, the Torrance test was re-arranged and administered to the entire subjects as posttest. The data collected were analyzed using mean to answer the research questions while analysis of covariance (ANCOVA) was used to test the hypothesis at 0.05 level of significance.

Results

Research Question 1: What is the difference between the mean achievement scores of pupils taught mathematics using brainstorming strategy and those taught conventionally?

Table 1: Means and standard deviations scores on pupil's achievement.

	Control Group				Experimental Group				Difference in mean gain
	Number	M	SD	Mean Gain	Number	M	SD	Mean Gain	
Pre-test	51	37.59	3.24	3.86	47	38.15	3.94	16.51	12.65
Post-test	51	41.45	3.20		47	54.66	3.70		

Table 1, shows that, the experimental group had a mean achievement gain of 16.51 while the control group had 3.86. This gave a difference in mean achievement gain of 12.65 in favour of the experimental group.

Research Question two: What is the difference between the pre-test and post test mean achievement scores pupils taught mathematics using brainstorming strategy and those taught conventionally in creative thinking sub-skills (fluency, flexibility, and Originality)

Table 2: Summary of student mean achievement score on creative thinking (fluency, flexibility, and Originality).

Skill	test	Control Group			Mean Gain	Experimental Group			Mean Gain	Mean Difference
		N	Mean	SD		N	Mean	SD		
Fluency	Pre-test	51	24.61	2.38		47	24.49	2.42		
	Post-test	51	25.49	2.55	0.88	47	32.96	1.77	8.47	7.59
Flexibility	Pre-test	51	9.41	1.08		47	10.04	1.30		
	Post-test	51	11.22	1.51	1.81	47	15.02	2.15	4.98	3.17
Originality	Pre-test	51	3.57	1.47		47	3.62	1.66		
	Post-test	51	4.75	1.53	1.18	47	6.68	1.73	3.06	1.88

Table 4, shows that the experimental groups of sub-skills had a mean achievement gain of 8.47, 4.98, and 3.06 while the control group had 0.88, 1.81, and 1.18. this gave a differences in mean difference of 7.59, 3.17 and 1.88 in favour of the experimental group.

H₀₁: There is no significant difference in the mean achievement scores of pupils taught mathematics using brainstorming strategy in developing creative problem solving skills and those taught conventionally.

Table 3: Results of analysis of covariance (ANCOVA) of pupils in experimental and control group.

Source	Type III Sum of Square	Df	Mean Square	F	Sig
Pre	300.846	1	300.846	34.011	.000
Method	4065.550	1	4065.550	459.611	.000*
Error	840.335	95	8.846		
Total	5206.730	97			

Table 3, shows that there is a statistical significant difference at the level of ($\alpha - 0.05$) between the two means of pupils scores on post test as a whole in both groups (experimental that was taught using

brainstorming strategy and the control group which didn't receive any training). F value totaled (459.611) showing a statistical significant value at ($\alpha = 0.000$).

H₀₂: There is no significant difference in the mean achievement scores of pupils taught mathematics using brainstorming strategy in developing creative problem solving sub-skills () and those taught conventionally.

Table 4: Result of analysis of covariance (ANCOVA) of pupil's scores in post-test according to the three sub-skills (fluency, flexibility, and Originality).

Source	Skill	Squares	df	Mean Square	F	Sig	Effect Size
Pre (Fluency)	Fluency	271.066	1	271.066	134.126	.000	.591
	Flexibility	.130	1	.130	.041	.841	.000
	Originality	.335	1	.335	.137	.713	.001
Pre (Flexibility)	Fluency	.124	1	.124	.061	.805	.001
	Flexibility	8.190	1	8.190	2.562	.113	.027
	Originality	12.825	1	12.825	5.233	.024	.053
Pre (Originality)	Fluency	2.974	1	2.974	1.472	.228	.016
	Flexibility	14.499	1	14.499	4.536	.036	.047
	Originality	21.333	1	21.333	8.704	.004	.086
Hotelling's	Fluency	1298.533		1298.563	642.540	*.000	.874
	Flexibility	297.533		297.533	93.078	*.000	.500
	Originality	102.432		102.432	41.791	*.000	.310
Error	Fluency	187.952	93	2.021			
	Flexibility	297.283	93	2.021			
	Originality	227.948	93	2.451			
Total	Fluency	1760.678	97	1760.678			
	Flexibility	617.635	97	617.635			
	Originality	364.874	97	364.874			

Results in table 4, shows that there is a significant differences at the level of ($\alpha = 0.05$) (F) values were significant at the level of ($\alpha = 0.05$). To investigate the significance of those differences according to group variable: eliminating the differences on the post test. Table (6) presents the results.

Table 5: Modified means of students' scores in both groups on Torrance post-test for each skill.

Skill	Group	Modified Mean	Standard Error
Fluency	Control	25.44	.20
	Experimental	33.02	.21
Flexibility	Control	11.30	.26
	Experimental	14.93	.27
Originality	Control	4.65	.22
	Experimental	6.78	.23

Table 5, shows that modified means for the pupils scores in the experimental group and the control group on each skill of post creative thinking test (originality, flexibility and fluency) after eliminating the differences on the pre test. Differences were in the favour of the experimental group who was taught through the brainstorming strategy as the means were (6.78, 14.93, 33.02) respectively and it is higher than the means of the control group that totaled (4.65, 11.30, 25.44). To find the effectiveness of the method Eta square was calculated. It totaled (31.0%, 50.0%, and 87.4%). This means that the group variable interpret (87.4% 50.0% 31.0%) respectively on the variance between the means of students achievement on each skill of Torrance creative thinking test.

DISCUSSION

The findings of this study showed that brainstorming strategy is effective in developing creative problem solving skills among pupils in mathematics. This was demonstrated through the high mean achievement gain of pupils in the experimental group against those in the control groups. Also the ANCOVA analysis showed that, a significant difference exist between the mean achievements of those taught conventionally using traditional method. This result is in line with the findings of Al-Olimat (2008) who investigated the effect of brainstorming and discovery strategies in developing creative thinking among eighth graders in science in Jordan and found that there is an evident effect for brainstorming and discovery in developing creative thinking. Moreover, there were differences between both strategies in the favour of brainstorming.

The findings also showed that significant differences exist among the sub-skills of creative problem solving skills (fluency, flexibility and originality). The differences were in favour of the experimental group who was taught through brainstorming strategy. The results in line with findings of Al-Blwi (2006) conducted a study to investigate the effectiveness of brainstorming in developing creative thinking and measuring the thinking skills among science students. The findings of the study showed that there were significant statistical differences between the study groups attributed to the teaching method of creative thinking skills.

Conclusion

The results revealed that brainstorming strategy helps in developing creative problem solving skills among primary school pupils in mathematics. Also the results sub-skills of creative problem solving skills (originality, flexibility and fluency) revealed significant difference among the experimental and control group in favour of the experimental group.

Recommendations

Based on the findings of the study the researcher recommended that:

1. Primary school mathematics teachers should use brainstorming strategy in teaching difficulty topics in mathematics.
2. Workshops and seminars should be organized for mathematics to enhance their knowledge on how to use brainstorming strategy in teaching and learning of mathematics.

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