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EFFECTS OF SCIENTIFIC PROCESS SKILLS ON STUDENTS' CREATIVITY AT J.S.S III, FOR TEACHING BASIC SCIENCE IN NIGERIAN SECONDARY SCHOOLS

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Abstract: The objective of this study was to investigate the effects of scientific process skills on the students' creativity at JSS III for teaching basic science in Nigerian secondary schools. Three research questions and three hypotheses guided the study. The hypotheses were tested at p≤0.05 level of significance. The pre-test and post-test experimental and control groups design was used for the research. The population of the study comprised of all the junior secondary school JSS III students in Potiskum educational zone of Yobe state. the experimental group was taught basic science concepts using scientific process skills scale approach, while the control group subjects was exposed to lecture method. Three validated instruments called Scientific Process Skills Scale (SPSS) Science Creativity Scale (SCS) and Basic Science Achievement Test (BSAT) was used to gather the date. The data collected were analysed using the reliability coefficient of the instruments 0.75, 0.78 and 0.86 respectively. The results of the study revealed that: there is statistically significance difference between the mean scores of the favour of the experimental groups; there was significance difference between in the creative thinking skills attainments between the experimental group taught using scientific process skills scale approach and control groups taught using lecture method. The researcher recommended that basic science teachers should be trained and encouraged to incorporate the use of SPSS approach in teaching in the classroom situation.

Keywords: Process skills, Basic Science, Science education, Creativity

INTRODUCTION

One of the goals for school Science indicates that, Science education should produce students who experienced the riches and excitement of knowing about the natural world. This according to Yager, Machinnk & Yager (2005), occur from natural curiosity and the use of human brain in dealing with that curiosity-traits that all human beings have. However, science according to them demands doubting initial explanations offered to satisfy curiosity. It requires offered satisfying curiosity. It requires searching for evidence that, the explanation has validity in terms of logic experimentation, a collection of evidence that, to share with others. All of these activities exemplify and require creativity thinking skills.

Unfortunately, a focus on creativity and the acts that constitute it are not frequently found in typical science education classroom. (Bartel, 2005. Roberts (2008), defined creativity as the ability to imagine or invent new mental or physical objects. According to him, creativity is not the ability to create out of nothing, but ability to generate new ideas by combing changing or reapplying existing ideas. Sambo (2010), sees creativity as the ability of an individual to produce new ideas that ended help in resolving normal conflict situation, where such new ideas are useful.

Most popular concept of creativity involves production of something new or unique which is of value and accepted to society, Olorukooba et al (2010). However, creativity goes beyond originating something new to the society. Therefore, there is the need to enhance students acquisition of these creative thinking skills by intensifying the way Basic science are being taught in the classrooms. When this is achieved, the academic achievement of students in all fields of life including Basic science and technology will be promoted. Scientific process skills scale (SPSS) include skills that every individual students could use in each step of his/her daily life by being scientifically literate and increasing the quality and standard of their lives by comprehending the nature of science. Therefore, these skills affect the

personal, social, and global lives of individuals. The SPSS are a necessary tool to produce and use scientific information, to perform scientific research, and to solve scientific problems. These skills can be gained by students through certain science education activities (Harlen, 1999; Huppert, Lomask & Lazarorcitz, 2008). For example, the purpose of learning Basic science by using a research study is to help teach the scientific processes. The students undertaking a scientific research study can learn the processes of science (Dhillon, 2006). Scientists use their creativity in every stage of scientific research (Abd-el Khalick & Lederman, 2010). So the creativity has supplementary roles in many scientific processes. It is used especially in introducing problems hypotheses and designing experiments. That's why science is a process containing the creativity components affecting each step of our lives, in addition to being a product (Saxena, 2004). Individuals need to think creatively and to be able to use their scientific process skills in order to develop a fundamental scientific understanding. And creative scientists are required to find useful and new solutions for the problems existing in daily life. Creative scientists are much more sensitive regarding problems. Every educated individual may not be a scientist, but it is important for each person to begin his or her educational life by applying creative thinking. All individuals who learned to think creatively while dealing with the scientific work can also apply these skills in other areas (Meador, 2008). Although creativity is accepted as a problem solving skill in research literature, it requires creative performance, recognizing the problem, thinking differently, and finding solutions. Recognizing the problem plays extremely important roles in the creative process (Dass, 2008).

The best definition of creativity related to the science was done by Torrance; the definition is that, "The creativity is recognizing the gaps in the problem or the information, creating ideas or hypotheses, testing and developing these hypotheses, and transmitting the data" (Torrance, 2007 in Dass, 2008). When we examine this definition, it's seen that the definition of SPS and creativity look similar. Both are

resulting from the necessity of eliminating a problem in daily life. Hypotheses are introduced in order to show how to eliminate this problem, and to test these hypotheses, experiments are done. As a result of these experiments, application can find whether the problem has been eliminated. These results are shared with society and correlated to other result (Dass, 2008). In this context, it can be accepted that the creativity is an important aspect of scientific skills. The problem solving, creating hypotheses, designing experiments, and technical innovation require a special type of scientific creativity. The human being is creative in a special field. For instance, while an individual is creative in in~, science, he or she may not be creative in painting (Liang, et al 20'. Therefore, it is generally necessary to separate the scientific creativity from creativity (Lin et al., 2007). Scientific creativity (creativity in science) can be considered to help original steps in performing the targets of Integrated Science. (2007:222) defined the scientific creativity by saying, "it can explain itself in comprehending the new ideas and concepts added to scientific knowledge, in formulating new theories in Integrated Science, finding new experiments presenting the natural laws, in recognizing new regulatory properties of scientific research and the scientific group, in giving the scientific activity plans and projects originality, and many other areas".

Creative thinking in Basic Science is necessary to search for solutions to all kinds of problems that are encountered in daily life and to make new products. According to scientific studies, creativity takes complementary roles in many scientific processes. The individuals who use creativity can make their Basic science education functional, and therefore, the scientific information can be the basis for producing valuable products instead of just amassing information, Therefore, for students to gain the creative thinking skills in Integrated Science they will need as young students each stage of their education, beginning in primary school, must be one of the most important purposes of science education (Koray, 2010).

Basic science educators recognized the importance of creativity in Basic science education, and started work on methods and techniques which can improve creativity (Mari 2001, & Liang, 2001, & Meador, 2008). However, 'there are not many studies presenting creativity improvement and supporting methods for science students (Liang, 2008). And the studies have generally used cognitive aspects to determine the scientific creativity of students. For example, certain studies have used finding the problem and formulating the hypotheses skills as criteria to evaluate the scientific creativity (Hoover, 2006; Hoover & Feldhusen, 1990). Finding the problem and formulating the hypotheses are important in improving the scientific creativity, and at the same time, they are the components of SPSS. Therefore, it is believed that the scientific creativity of individuals who use SPSS was better of Hoover, 2006 Meador, 2008 Lian 2008 Au & Adey, 2008 Cheng, 2009).

When the National Science Education Standards RC, 1996) are examined, it is seen that SPSS and creativity had important roles in science. However, in the school education, the problem and materials are given to the students', and this prevents improvement of thinking skills. Moreover, scientific knowledge and theories are directly told to the students in their textbooks, and they are not allowed to think for themselves. While the teacher teaches a lesson at the classroom, first he/she tells about the concepts, and then makes the students do experiments to understand the concepts. This type of education does not exactly represent the scientific exploring process Basic Science education.

If during this study some evidence related to improving SCS scientific creativity could be provided, and then Basic science teachers could consider scientific creativity as an educable skill rather than as a comprehension endowment or an extraordinary skill. The results of the study can help Basic Science teachers to understand the factors affecting the scientific creativity of the students. Therefore, teachers can use SPSS to increase the scientific creativity scale of the students.

Although creativity has been studied by psychologists and researchers for many years, there are very few studies about scientific creativity and scientists' creative processes (Liang, 2008). For all these reasons, SCS are a subjects needed to be emphasized. Also, knowing how much the students gained SCS can improve their scientific creativity. The attitude towards Basic science contains the attitudes towards scientific attitudes, and the attitudes towards scientific careers. Basic science teaching methods, interest related to scientific knowledge, and the contents of the Basic science. Determining the students' attitudes towards Basic science and scientists takes a key role in determining their scientific creativities (Mari, 2001).

Although a study presenting scientific creativity Basic science and the effects of SPS on scientific creativity has not been encountered in the field of literature, it is thought that, this study would bring a new point of view for primary school Basic Science and Technology education and other related studies.

Research Questions

1. What is the effect of SPSS approach and lecture method on academic achievement of Basic Science students?
2. Does a student exposed to scientific process skills approach and lecture method differ in their creative thinking skills?
3. Is there any significant different in scientific creativity scale approach and Basic science students when exposed to lecture method?

Hypotheses

Three null hypotheses were formulated and tested at $p<0.05$ level of significance.

HO_1: There is no significant difference in the mean scores of students taught using scientific process skills scale approach and lecture method when exposed to Basic Science Achievement test (SAT).

HO_2: There is no significant difference in the scientific creativity scale attainment by the students when exposed to scientific process

skills scale approach and those exposed to Basic science using lecture method.

HO3: There is no significant difference in scientific creativity scale (SCS) approach when exposed to Basic science using lecture method.

METHODOLOGY

The research design adopted for this study was experimental and control group design. The experimental and control groups were pre-tested before treatment and post-tested after the treatment was administered. The population of the study comprised all the Junior Secondary School (JSS) II students in Potiskum educational zone of Yobe State. They were already exposed to Basic Science concepts teaching for at least one year before the study was carried out. The average age of the students was 13 years. Two co-educational Secondary Schools were randomly selected for the study and randomly sorted out into experimental and control groups. The experimental group was made up of 40 students likewise the control group with 40 students.

Three instruments were used for data collection Basic Science Achievement Test (BSAT) which was developed by Inyang (1998), Scientific Process Skills Scale (SPSS) was developed by Aktamis (2008) and Science creativity scale was developed by Olorukooba & Lawai (2010). The reliability coefficient of the instrument is 0.75, 0.78, and 0.86. A total of thirty (30) minutes were given to each respondent to attempt the 40 items on the scale. Students who scored 60 and above were considered to be higher creative thinkers, that means that, individual student is a creative type, while those that scored below 60 were not very creative. The BSAT comprised of 30 multiple choice items based on the topics taught he instrument was adopted from Inyang's (1988) Basic Science Achievement Test (BSAT) which is a standardized instrument with reliability coefficient of 0.86. The topics treated in the Basic Science were "conservation Natural resources and solid matter" drawn from the Junior

Secondary, School (JSS) II Science Curriculum Scientific Creativity Scale (SCS) The SCS was used to assess the creative thinking in Basic science which was adopted from Olorukooba & Lawai (2010). The reliability coefficient of the instrument is 0.75, section A of the instrument sought for biodata of the respondents. The respondents were asked to use a 10 point scale to rate themselves on the items listed in section B, C and D. They were expected to rate most descriptive of themselves high in an increasing order of magnitude (6, 7, 8, 9) , and to rate items least descriptive of themselves low in decreasing order of magnitudes (4, 3, 2, 1, 0). Zero being the rating for an item that is totally unlike the respondents. Items the respondents are not sure about are rated 5. Thirty minutes (30) minutes were given to each respondent to attempt 80 items on the scale.

For data collection, the pre test was administered to both experiment using Basic science achievement test (BSAT) and scientific process science skills scale (SPSS) SCS respectively. The experimental group was taught using Scientific Process Science Scale (SPSS) approach while the control group was taught using lecture method. The control group was taught the same topic using the conventional lecture method. The teaching in both groups lasted for thirty -five minutes. A post test using BSAT and SPSS, SCS was administered to the two groups at the end of the treatment. The scores from both instruments were collected to statistical analysis using that test statistics for significant difference.

Findings and Comments

HO_1

There is no significant difference in the mean scores of students taught using scientific process skills scale approach and lecture method when exposed to Basic Science Achievement Test (BSAT).

Table 1: Comparing Pre-Tests of Experimental and Control Groups

	Number	Mean scores	Standard Deviation	t-test	P-value	Remark Significance
Pre-test Experimental group	40	9.00	4.70	1.83	0.001	*Significance
Pre-test (control) P<0.05	40	6.90	4.70	1.83		

The result in table 1 shows a P-value of 0.001 which is less than p-value of 0.05 significant levels. This shows that, there is statistically significant difference between the mean scores of the experimental and the control groups in favour of the 'experimental group. The null hypothesis of no significant difference in thus rejected. This by implication means that, the students in the SPSS class performed better than those exposed to lecture method class. Hence, SPSS produced a higher effects on students academic achievement Basic science.

HO_2

There is no significant difference in the scientific creativity scale attainment by the students' when exposed to scientific process skills scale approach and those exposed to Basic science using lecture method.

Table II: Comparison of Basic Science Achievement Test of Post-Test of Experimental and Control groups.

Table 2: Comparison of Basic Science Achievement Test of Post-Test of Experiment and Control groups.

	Number	Mean scores	Standard Deviation	t-test	P-value	Remark Significance
re-test Experimental group	40	12.90	5.15	3.83	0.001	*Significance
Pre-test (control)	40	8.30	3.70	1.83		

P<0.05

The data in table 2 showed that the P-value for the creative thinking skills attainment, is 0.001, while the mean scores of the experimental group is 12.90, which shows that of the control group is 8.30 at P<0.05 level of significant. The P-value is lower than the level of significance. The P-value is lower than the level of significance of P<0.05, showing a significant level of the creative thinking skills. Thus the null hypothesis of no significant difference is rejected. It implies that there is a significant is rejected. It implies that, there is a significant difference in the creative thinking skills attainment between the experimental groups taught using scientific process skills scale approach and control group taught using the lecture method in favour of the experimental group.

HO_3

There is no significant difference in Scientific Creativity Scale (SCS) approach when exposed to Basic Science using lecture method.

Table 3: Scientific Creativity Scale Pre-Text Experimental and Control Groups

	Number	Mean scores	Standard Deviation	t-test	P-value	Remark Significance
Pre-test Experimental group	40	14.30	5.38	2.73	0.001	*Significance
Pre-test (control) P<0.05	40	15.65	4.99			

Table 3: Table 3 results shows that, t-calculated was 2.73 and p-value is 0.001 which is less than P<0.05. This shows that there was a significant difference in the academic achievement of male and female students exposed to scientific creativity scale in post-test experimental and control groups of which male experimental group have a result null hypothesis of no significant difference is thus rejected. By this implication, it means that the students in the SCS class performance better than those in the lecture class. Hence, SCS produced a higher affects on students' performance in integrated science.

DISCUSSION

The result in table 1 showed that, the mean scores of subjects in the experimental group in BSAT is greater than that of the subjects in control group. This shows that, the use of SPSS approach in teaching Basic science is potentially viable in enhancing students' academic achievement at JSS level. This result is supported by the findings of other scholars like (Butin 2000, Nwosu 2004, Onu 2007, Mohammed, 2008 & Olorukooba & Lawai 2010).

In SPSS class, students try to relate what they .are learning to what is obtains in their societies. That is, students see the relationship between the science in the classroom and what is happening around them outside the classroom. Also, the students are encouraged task questions and perform activities to verify their observations. These do

not happen in the lecture method group. Thus the academic achievement of the students' in the experimental group has been greatly enhanced. The result in table 2 showed that the mean scores of experimental group in the creativity thinking skills scale is higher than that of the control group. This suggests that, the SPSS approach does offer an advantage over the lecture method in encouraging more students' questions. More of the students' hypothezing, and stimulating more, students to seek evidence for the validity of the explanations they offered. To such forum was provided in the control group where all ideas, activities and evaluations focused on what was delivered by the teacher. These findings are in agreement with the findings of Olorunkooba & Lawai (2010). They discovered that, using activity oriented teaching strategies increased students abilities to come up with higher thinking creativity view on issues hence their creative ideas are widening. The result in table 3 showed that, there is a significant difference between total scores of scientific creativity scale SCS of the experimental group than that of the findings of other scholars (Yager et a1200S, Onu 2007, Wakili, 2007 & Olorukooband Lawai (2010).

CONCLUSION

This study has shown that SPSS approach can be used to enhance the development of creative skills and academic achievements of learners in integrated science. Therefore, stimulating the spirit of inquiry and critical thinking skills through Scientific Process Skills Scale, and Scientific creativity Scale approach should be the watch word of Basic science: teachers. When this is done, the students will form the habit of done, the students will form the habit of thinking and acting creativity, thereby being more favourably disposed to undertake innovations that could result in scientific creativity and technological breakthrough that will more this country educational, and economically advanced.

RECOMMENDATIONS

From the findings of this study, the following recommendations are made.

1. Basic Science teachers should be trained and encouraged to incorporate the use of SPSS approach in teaching in the classroom. They should be trained in the art of encouraging learners to:

◇ Observe things around their environment.

◇Develop the habit of asking questions about things.

◇ Examine critically what they have through radio and television, or read from books and magazines.

◇ Examine actions and solutions to Issues and problems with a View to offering alternative to viable solutions.

2. Professional bodies like science Teachers Association of Nigeria (STAN) Mathematical Association of Nigeria (MAN) should organize workshops and conferences that teach the science teacher on how to use SPSS approach and teachers on the in-service be encouraged to attend such.

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