ASSESSMENT OF TEACHERS' CREATIVITY IN TEACHING MATHEMATICS IN SENIOR SECONDARY SCHOOLS IN KEFFI LOCAL GOVERNMENT AREA OF NASARAWA STATE

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Abstract
The purpose of this study was to assess teachers' creativity in teaching mathematics in senior secondary schools in Keffi Local Government Area of Nasarawa State. Specifically, the study determined the extent to which mathematics teachers use creativity assessment scale of fluency, originality, flexibility, and motivation in teaching mathematics. The study also examined teachers' creativity in teaching mathematics on the basis of gender. The population of the study comprised all the secondary schools in Keffi local government area. A sample size for the study consisted of one hundred and twenty (120) subjects (60 males and 60 females). The sample was selected through stratified random sampling technique. The descriptive survey research design was used. Two instruments on Teachers' Creativity in Teaching Mathematics (TCTM); one for students' responses and the other for the teachers responses were developed by the researchers and used to collect the data. Each item on both questionnaires measured the same characteristics or variables. The Pearson's product moment correlation statistic was used to test reliability of the instruments. Reliability coefficients of 0.87and 0.74 were obtained for teacher's and students' questionnaires respectively. Two research questions were raised and one hypothesis formulated and tested using t-test at 0.05 level of significance. Results were that, mathematics teachers' creativity in the domains of fluency, originality, flexibility, and Motivation in teaching mathematics was high. Mathematics teachers' fluency in teaching mathematics was however found to be low. Male teachers' creativity in teaching mathematics was higher than their female counterparts. The study found no significant difference in the mean responses between male and female teachers' creativity in teaching mathematics. Based on the findings of this study, it was recommended among other things that Mathematics teachers should be made to undergo regular retraining to remain creative in teaching mathematics in secondary schools in Keffi LGA.

Keywords: Teachers' creativity, fluency, originality, flexibility, motivation

Introduction

There is growing interest by many nations of the world in science and technology in recent times because of the potential of these areas of study to enhance their survival and development. Mathematics is the bedrock of all scientific and technological knowledge. To achieve modern development, nations must first improve their technological base. This requires creative teaching and effective learning of mathematics (Gimba & Agwagah, 2012). Nigeria, like most other African countries repose implicit confidence in the power of science and technology to save her from poverty, ignorance and diseases, the three indices of under development (Gimba & Agwagah, 2012). Yusuf (2003) argues that no subject strongly binds the various branches of sciences as mathematics. The influence of mathematics on science and technology as well as other fields of human endeavour today cannot be over

emphasised. Mathematics removes superficiality in knowledge. It is an important subject that is needed at all levels of education. The prescription of mathematics as a core and compulsory subject in both primary and secondary schools by the National Policy on Education (FRN, 2014) is therefore not a coincidence.

Mathematics is a compulsory subject in secondary schools and a vital entry requirement into tertiary institutions in Nigeria but in recent years, the percentage passes in results obtained from Senior School Certificate Examinations (SSCE) in many secondary schools is not encouraging (Erondu, 2015). This lead to relatively fewer numbers of students who opt for the pursuit of mathematics as well as mathematics oriented careers when compared with other courses. Several reasons could be attributed to this situation. Teachers' quality, lack of mathematics laboratories, non creativity in the teaching of mathematics by teachers, mathematics phobia, gender-related issues in instructional situations and poor methods of teaching may be adduced for this poor performances in mathematics.

Tahir (2003) observes poor teaching process exhibited by inexperienced teachers as a very serious issue among the many problems affecting students' performance in secondary schools in Nigeria. Adeyemi (2007) emphasizes that teachers' teaching experience was significant with learning outcomes as measured by students' performances in SSCE. Iwendi and Oyedum (2012) note that lesser confidence or anxiety on the part of females is an important variable which helps to explain sex- related differences in the study of mathematics. Yusuf (2003) attributes the poor performance of students in mathematics to acute shortage of qualified and competent mathematics teachers, which has made many schools to rely heavily on teachers who lack sufficient understanding of mathematics to teach the subject. This problem appears to have received inadequate attention and investigation. This portends danger to the development of the nation as the problem will lead to insufficient and shortage of mathematics teachers, technologists and scientists. The trend of this problem and its effects on the development of this nation will continue.

It is believed that the creative teaching of mathematics by teachers will go a long way in improving students' performances in the subject. Yusuf (2003) suggests that, mathematics underlies the whole build-up and fabrics of modern science and technology so there is need to concentrate teaching efforts towards developing students' abilities to see the subject in the real life situation and to use their knowledge to solve the problems arising from it. This involves teaching creativity which goes beyond memorizing formulae. It emphasizes teachers' ability to associate mathematics with student pleasant learning experiences. Teaching mathematics to foster creativity assessment scale of originality, flexibility fluency and motivation is therefore necessary to help bring improvement in students learning of mathematics. Creativity can be seen as the ability of man to establish new relationships to change reality. So, mathematical creativity can be seen as the mental activity in the area of mathematics education which is directed towards establishing new relationships which go beyond those given in a non-routine mathematical situation. Levi (2007) explored the concept of creativity in mathematics in the context of multiple solutions task, in this, flexibility refers to number of different approach adopted by teachers or mathematics solvers to arrive at the same solution.

Originality refers to the conventionality (relative to a specific curriculum) of suggested solutions. Fluency refers to pace of solving procedures and switches between difference solutions. According to Ortese (2009) creativity assessment scale of novelty refers to the production of teaching ideas which must be new and uncommon; original means that the ideas must be an original work of the creator without duplicating another person's earlier work; flexibility means the product or the ideas must be seen to be easily applicable to other

situations, problems or environment too and fluency means that, many ideas, concepts, interests are catered in the new product.

Teaching mathematics creatively means teaching with variations and innovations. Creativity as used in this research means production of new teaching ideas and better ways of teaching techniques, procedures or methods and to design and use instructional materials in teaching of mathematics to foster originality, flexibility, fluency and motivation to make mathematics real to students. Originality means producing statistically something new that is beyond what is written in books, producing new and innovative ideas that are suitable for a lesson and interesting to students, invention of personal teaching aids and activity to solve mathematics in different unusual ways. Flexibility as used in this study means the use of different methods and procedures in solving mathematics problems to arrive at the same answer, and redirection of lessons in line with students entering behaviours or questions during the classes, changing ideas, approaching a problem in various ways, and producing the required solutions by the teachers in mathematics. Motivation as used here refers to intrinsic, task-forced motivation rather than the potential rewards; Frequent giving of assignment, class work, marking and giving feedback, organization of practical lessons, use of audio-visuals and computer instructions and starting teaching from simple to complex. Fluency also as used here relates to the continuity of ideas, flow of associations, and use of basic and universal knowledge. Teaching of mathematics topics that are connected, observed planed repetitions in solving problems, relating mathematics topics to real life situations.

A creative lesson in mathematics is interesting, unconventional, productive and motivating. There are variation in teaching techniques, instructional materials, instructional activities and assessment. Creative mathematics teaching allows flexibility in adopting various pedagogical approaches that are suitable for students' level of understanding and that are appropriate for the nature of the content (Eid, 2000). Creativity in teaching mathematics means production of new teaching ideas and better ways of teaching techniques, procedures, methods and to design and use instructional materials in teaching of mathematics to foster originality, flexibility, fluency and motivation to make mathematics real to students.

The advances in technology have made it possible for equipment and materials to be produced to make teaching and learning clearer, more appealing and interesting, enabling the learners to assimilate knowledge and skills faster. Thus, the provision and the use of instructional materials and equipment in the classroom call for the establishment of mathematics laboratories in secondary schools to enhance teachers' creativity in mathematics. Nevertheless, it has been noted that no attention has been given to assess teachers' creativity in teaching mathematics to enhance students' performance. Research analysis on creativity in teaching mathematics is clearly overlooked in mathematics education research. Leikin (2011) reviewed research publications between 1999 and 2011 showed that the issue of creativity was neglected in mathematics education research and that research on creativity is still secondary to research on mathematical thinking, learning, and teaching. Two decades later, Mann (2006) noted that the lack of an accepted definition of mathematical creativity hinders research efforts.

Analyzing discussions with prospective mathematics teachers' conceptions of creativity in teaching mathematics, Shriki (2009) argues that their knowledge about creativity is insufficient for a discussion of the subject. Bolden, Harries, and Newton (2010) analysed written questionnaires and semi-structured interviews with prospective elementary school teachers about their conceptions of creativity and showed that these conceptions were narrow and associated with particular teachers' actions. Whitelaw (2006) evaluated teachers'

creativity on creative components, such as elaboration, originality, flexibility, and resistance to premature closure but did not include fluency and motivation in his work. An exploratory study by Lev-Zamir and Leikin (2011) using a qualitative research paradigm, through observations of lessons and individual semi-structured interviews with the teachers, analysed teachers' conceptions of creativity in teaching mathematics focusing on three components of creativity flexibility, originality, and elaboration but they did not consider fluency and motivation as a component of creativity. It has been observed that studies on teachers' teaching creativity in mathematics involving originality, flexibility, fluency and motivation are scanty. It is, therefore, against this background that this study assessed teachers' creativity in teaching mathematics in senior secondary schools in Keffi Local Government Area of Nasarawa State using Akinboye's Ibadan Creativity Assessment scale (ICAS) which measured creativity assessment Scale of originality, flexibility, fluency, and motivation as a basis to enhance students' performances.

Specifically, the study determined the extent to which mathematics teachers use creativity in teaching mathematics. It also determined the extent to which mathematics teachers use creativity in teaching mathematics on the basis of gender.

Research Questions

The following research questions guided the study:

(i) to what extent do mathematics teachers use creativity in teaching mathematics?

(ii) is there any difference in the mean rating between the male and female teachers' use of creativity in teaching mathematics?

Research Hypothesis

The following hypothesis was formulated and tested at 0.05 level of significance:

HO_1. There is no significant difference between the mean responses of male and female teachers on the use of creativity in teaching mathematics.

Methodology

The descriptive survey design was adopted in this research. This design was considered useful because it allowed the researchers to investigate a phenomenon and report on it as it was, allowing for the use of adequate and appropriate sample to make value judgment.

The population for this research was made up of all senior secondary two (SS2) students and all the mathematics teachers in the public senior secondary schools owned by the Nasarawa State Ministry of education in Keffi local government area. Total sample size was one hundred and twenty (120) subjects from five (5) senior secondary schools purposively selected. It comprised twenty (20) mathematics teachers (10 males and 10 females) and twenty (20) Senior Secondary two (SS2) students (10 males and 10 females) selected from each of the five schools through stratified random sampling techniques.

Two instruments; Teachers' Questionnaire on Teachers Creativity in Teaching Mathematics and Students' Questionnaire on Creativity in Teaching Mathematics in senior secondary schools containing twenty (20) items respectively were developed and used by the researcher. Each of the questionnaires had two sections; "Section A" was on personal data, while "Section B" on Creativity was on the rating scale of four points in the increasing order of magnitude of Never (1), Rarely (2), Sometimes (3), Often (4). The total score on the scale gave the index of creativity.

The instrument were validated by four experts in educational measurement and evaluation for the content and face validity. The instruments were trial tested on five (5) mathematics

teachers and twenty (20) students in a school within the population to determine the reliability coefficients of the instrument using test-re-test method. Two administrations of the instruments were made in two weeks interval. Data collected were used to calculate the reliability coefficient (r) using Pearson's product moment correlation. Reliability coefficients of r = 0.87 and r = 0.74 were obtained for teachers' and students' questionnaires respectively. This implies that the instruments were ideal for use in the study.

The instruments were administered personally by the researcher and collected after completion on the spot to reduce instrument mortality. All the one hundred and twenty (120) copies of questionnaires administered were collected.

The data collected were analyzed using mean ($\bar{X}$), and standard deviation (SD) to answer research questions. The hypotheses were tested using the t-test at 0.05 level of significance.

Results

Research Question One: To what extent do mathematics teachers use creativity in teaching mathematics?

Table 1: Mean and Standard Deviation of teachers' responses on the extent to which mathematics teachers use creativity in teaching mathematics variables

	$\bar{X}_1$	SD
Fluency	3.04	0.49
Originality	3.68	0.60
Flexibility	3.67	0.63
Motivation	3.43	0.96

Criterion mean = 2.50

$\bar{X}_1$ Mean response of teachers
SD Standard Deviation

Table 2: Mean and Standard Deviation of students' responses on the extent to which mathematics teachers used creativity in teaching mathematics Variables

	$\bar{X}_2$	SD
Fluency	2.72	0.75
Originality	3.06	0.80
Flexibility	3.21	0.96
Motivation	3.04	0.96

Key:
X_2 - Mean response of students
SD Standard Deviation

The table 1 and 2 show the mean and standard deviation on the creativity assessment scale; fluency, originality, flexibility, and motivation of teachers and students respectively; Based on the Criterion mean point of 2.50, the respondent's rating for all the creativity assessment scale for both teachers and students show mean scores above the criterion mean of 2.50. This indicates the use of all the measures of creativity assessment by mathematics teachers in teaching the subject. The extent to which mathematics teachers used creativity in teaching mathematics based on the tables revealed that, creativity

assessment scale of originality, flexibility, and motivation have higher mean scores of 3 points and above for both teachers and students except, fluency which shows 3.04 for teachers and 2.72 for students. Students rating is very close to the criterion mean which shows that fluency is rarely used by mathematics teachers whereas, teachers mean shows that, they used fluency sometimes. It signifies that mathematics teachers rarely use fluency in teaching mathematics in their schools. Standard deviation for teachers in each creativity assessment scale shows that individual mean scores clustered around group mean more than that of students except flexibility which is close to the mean score of teachers than students and motivation which have the same standard deviation.

Research Question Two: What is the difference between the mean score of male and female teachers' use of creativity in teaching mathematics?

Table 3: The Mean and Standard Deviation of teachers' responses on male and female teachers' creativity in teaching mathematics

Gender	N	$\bar{X}$	SD
Male	10	69.00	5.90
Female	10	67.60	4.88

Key:
$\bar{X}$ - Mean response of teachers
SD - Standard Deviation

Table 3 shows the mean response of teachers on male teachers creativity was 69.00 with standard deviation of 5.90, and female teachers' creativity mean was 67.60 with standard deviation of 4.88. This shows that there was a difference in the mean response on male and female teachers' creativity. The mean response on male teachers' creativity was found to be higher than that of female teachers by 1.4, indicating a little difference in the mean comparison of male and female teachers' scores on creativity in teaching mathematics. The standard deviation of male indicates that the individual mean scores for male clustered around the group mean but females' individual mean scores were more extreme to their group mean.

Hypotheses Testing
There is no significant difference between the mean responses of teachers' on male and female teachers' creativity in teaching mathematics.

Table 4: Mean, Standard Deviation and t-test of teachers' responses on male and female teachers' creativity in teaching mathematics

Variables	**N**	$\bar{X}$	**SD**	**df**	**t-value cal**	**t-value critical**
Male	5	69.00	5.90	8	0.41^{NS}	2.31
Female	5	67.60	4.88			

NS = Not significant at 0.05 level

Table 4 shows the t-test analysis of teachers' use of creativity in teaching mathematics. The male teachers' mean score was 69.00 whereas as female teachers have a mean score of 67.60. When the values were subjected to t-test analysis, the t-calculated value of 0.41 was lower than the critical value of 1.96 at 0.05 level of significance. Therefore, the null hypothesis was retained.

Discussion

Research question one is on the extent of mathematics teachers' creativity in teaching mathematics. The findings show that mathematics teachers used creativity in teaching mathematics. Both the teachers and students agreed that, the creativity assessment scale of fluency, originality, flexibility and motivation were used in teaching mathematics by mathematics teachers. A close look at the findings revealed that, mathematics teachers used originality and flexibility in teaching to foster creativity more than fluency and motivation. This means that, the originality, flexibility and motivation components were often used by teachers since their mean scores are far above the criterion mean but that of fluency were closer to the criterion mean. This implies that, fluency component of creativity assessment scale which relates to the continuity of ideas, flow of associations, and use of basic and universal knowledge, and motivation need to be improved upon by mathematics teachers in teaching of mathematics.

Research question two is on the difference between the mean score on male and female teachers' creativity in teaching mathematics. The finding revealed no significant difference in male and female teachers' creativity in teaching mathematics. This finding is against that of Erondu (2015) who found out that teachers of mathematics in secondary schools hardly use teaching approaches that have significant effect on the achievement mean score of students in sciences. The tested hypothesis on this effect revealed no significant difference in the use of creativity between male and female in teaching mathematics. This is in agreement with Bolaji (2012) that gender issue is a function of mind; being a male of female have no significant influence on science teachers' innovations and knowledge translation in teaching sciences. Gender difference therefore plays less important role in knowledge translation.

Conclusion

Mathematics teachers used creativity assessment scale of fluency, originality, flexibility and motivation in teaching mathematics in Keffi Local Government Educational Area. But they rarely used the fluency component of creativity. Gender has no significant influence on teachers' creativity in teaching mathematics.

Recommendations

Based on the findings, the study recommends that mathematics teachers should try to improve on their creativity to boost the teaching mathematics in secondary schools. They should be made to undergo regular retraining to remain creative in teaching mathematics in secondary schools in Keffi Local Government Area.

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