A Study to Examine the Relationship between Mathematical Creativity and Mathematical Problem-solving Performance

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Abstract

The present study aimed to investigate whether a relationship exists between the mathematical creativity and mathematical problems solving performance. As bi product of the main study the sex and cultural differences were also examined in the study. In addition, whether the both variable differ with respect to gender and locality. Data were collected from four hundred eighty participants (201 male and 279 female) of eighth grade standard selected through random cluster technique from eight intermediate and high schools located in Varanasi region, India. Data were analysed by Pearson moment correlations, t-test and simple regression analysis. The results showed positive and significant relationship between mathematical problem solving performance and mathematical creativity. Male students were found to be significantly higher on both mathematical problem solving performance and mathematical creativity than their counterparts. Mathematical problem-solving performance significantly contributed in the prediction of mathematical creativity.

Introduction

Mathematics is a very important discipline on this planet but due to complex nature it could not be understood easily by everyone. Therefore, the most people feel mathematics as a boring subject and resultant of which a large

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number of students are feared from solving the mathematical problems. Mathematical problem-solving is one of the most central aspects of mathematics and it helps students to make sense how mathematics can be used in daily situations. Each student has different problem solving conceptions and the complexity of problem-solving procedure has caused the confusion in the minds of young generations. Polya's (1957) theory defined mathematical problem solving as s process that involved four dynamic activities; understanding the problem, making a plan, carrying out the plan and looking back. Hadamard (1949) describes problem solving as a process which has four stages namely preparation, incubation, illumination and verification. Problem and problem solving both are the core of the subject mathematics. Thus, problem solving is evidently and essential component in mathematics.

Mathematical problem-solving is the complex area of human behaviour. Zhu (2007) reported that many complex variables (biological, psychological, and environmental) are revealed to contribute in gender differences in problem-solving performance in some specific area like, mathematics. Amani et al. (2011) and Gallagher et al. (2000) also reported little difference between male and female in math problem solving favouring male students. In contrast, Caplan and Caplan (2005) argued that the link between gender and mathematics performance was very weak. Pajares (1996) found that gifted girls outperformed than their counterparts in mathematical problem solving. Orhun (2003) concluded that there was not any important effect of gender and attitude towards mathematics on mathematical problem-solving performance. These conclusions were even sometimes challenged by the opposite evidences. However, the main goal of our educational system is that the students learn mathematics at each level effectively and easily.

Mathematical creativity has been accepted as an insurance of the growth of the field of mathematics (Sriraman, 2004). Teachers at elementary and secondary levels have not recognised the importance of creative thinking and problem solving in mathematics. The role of culture in development of mathematical creativity has been reported by Milgram (2008), Nevo (2008), and Subotnik (2008). Bahar and Maker (2011) also found significant correlations among all the measures of creativity and measures of mathematics achievement. Some research studies found gender differences with respect to mathematical creativity (Sethi, 2006; Sak and Maker, 2006; and Jensen, 1973). They concluded that girls excelled than boys in fluency, flexibility and originality aspects of verbal mathematical creativity. In contrast, Singh (1989) and Walia (2012) reported no significant difference between boys and girls.

Yet there has been no general consensus among creative workers and psychologists about relationship between mathematical creativity and mathematical problem-solving performance. Universal definition of mathematical creativity (Mann, 2005) and the reliable criteria could be used in measuring mathematical creativity. The declining popularity of mathematics among students and poor mathematical performance and creative ability in mathematics of students are not only a national but also a global concern of the past years. Therefore, this study has been conducted to examine the relationship between mathematical creativity and mathematical problem solving performance. As bi-product of the main study the sex and cultural differences were also examined by the investigator.

Objectives of the study

The objectives of the study were as follows.

1. To study the relationship between mathematical creativity and mathematical problem-solving performance.
2. To find out the contribution of mathematical problem-solving performance in the prediction of mathematical creativity.
3. To compare the mathematical problem-solving performance of rural and urban students.
4. To compare the mathematical problem-solving performance of male and female students.
5. To compare the mathematical creativity of rural and urban students.
6. To compare the mathematical creativity of male and female students.

Hypotheses

Following hypotheses were formulated to test the objectives of the study.

1. There is no significant relationship between mathematical creativity and mathematical problem-solving performance.
2. Mathematical creativity does not contribute in the prediction of mathematical creativity.
3. There is no significant locality difference in mathematical problem-solving performance.
4. There is no significant gender difference in mathematical problem-solving performance.
5. There is no significant locality difference in mathematical creativity.
6. There is no significant gender difference in mathematical creativity.

Design

The descriptive survey method was used in the present study.

Sample

The Ss of this study consisted of 480 (83 urban male + 107 urban female +

118 rural male and 172 rural female) of eighth standard students selected through random cluster technique from nine intermediate and high schools located in Varanasi region, India.

Tools Used

The following tools were used to collect the data.

1. Mathematical creativity test developed by Singh (1985).
2. Hindi adaptation of Krutetskii's mathematical problem-solving performance test by Singh (1993).

Procedure of Data Collection

Both the tests were administered on the selected sample at the interval of 3 hours.

Analysis

Table 1 shows the mean age group of participants include in selected sample were eleven to thirteen years. All participants in the study scored on mathematical creativity and mathematical problem-solving performance. Difference in mean scores of mathematical creativity and mathematical problem-solving performance was found with respect to gender and locality. Minimum and maximum scores on mathematical creativity test of male participants were found to be higher than their counterparts.

Table 1
Study of Participants

Mathematical Creativity					Mathematical Problem-solving Performance				
Gender	N	Min	Max	Mean	SD	Min	Max	Mean	SD
Male	201	74	209	100.59	23.83	0	14	3.124	2.85
Female	279	31	168	94.09	18.21	0	14	1.86	1.90
Total	480	31	209	96.81	209.98	0	14	2.39	2.42

Table 2
Correlation Coefficient between Mathematical Creativity and Mathematical Problem-solving Performance (N =480)

Sr. No.	Variable	r	p
1.	Fluency vs Mathematical Problem-solving Performance	0.64	≤ 0.01
2.	Flexibility vs Mathematical Problem-solving Performance	0.62	≤ 0.01
3.	Originality vs Mathematical Problem-solving Performance	0.39	≤ 0.05
4.	Mathematical Creativity vs Mathematical Problem-solving Performance	0.61	≤ 0.01

As can be seen from the Table 2 that the obtained coefficient of correlations between fluency, flexibility, originality dimensions of mathematical creativity and as well as total mathematical creativity scores, and mathematical problem-solving performance scores were found to be significant at .01 level with df = 478. Singh (1993) also support similar findings. Lekin, & Kloss (2011) found that problem solving is highly correlated with fluency, flexibility and originality while originality as shown as a special mental quality.

Regression Analysis

The following simple linear regression models were considered,

$$X = \alpha_1 + \beta_1 Y + \varepsilon \quad \ldots(1)$$

$$Y = \alpha_2 + \beta_2 X + \varepsilon \quad \ldots(2)$$

Where, β_1 and β_2 are the regression coefficients, α_1 and α_2 are the intercepts and is the random error which is normally distrusted with mean zero and certain variance. R-software was used for the computation of simple linear regression. Results are given in Table 5.

Table 3
Analysis of Variance Table

Source	df	Sum of Square	Mean Sum of Square	F value	p
Regression (between)	1	1060.6497	1060.6497		
Residual (within)	478	1744.4444	3.64		
				290.63	< 0.01
Total	479	2805.02			

F = 290.63

Correlation Coefficient: r = 0.61,

Adjusted R2 = 0.3781

Equations:

X = 5.30Y + 84.1

Y = 0.07X – 4.51

The relationship between mathematical creativity and mathematical problem solving performance was found to be moderate positive and significant. It means that both the variables are significantly correlated to each Other. From the regression analysis it can be easily observed that X on Y and Y on X effect significantly (p < .01). However, the effect of Y on X is high rather than the effect of X on Y. From equation -1 we observed that if one unit increase in Y leads to increase 5.30 units in X. furthermore, if the effect of Y supposed to zero then

X remains 84.13. Similarly from equation - 2 we observed that if 100 unit increase in X leads to increase 7 units only in Y.

The result in Table 3 shows that F-value from ANOVA was significant at 0.01 level. Mathematical problem-solving performance explained 37.8 percent of variance in mathematical creativity. The result of F-ratio indicates that mathematical problem-solving performance is significantly contributed to the prediction of mathematical creativity. (Ho 2 is rejected).

Table 4 shows that the obtained 't' values with respect to mathematical problem-solving performance scores of male and female, and rural and urban students were found to be significant at df = 478. The group of male and urban students was found to be significantly better than their counterparts with respect to mathematical problem-solving performance scores. Amani, et al. (2011), Gallagher et al. (2000) and Pajares (1996) also supported similar findings. In contrast, Chukwuyenum (2013) and Caplan, Caplan (2005) found no significance gender difference in mathematics problem-solving performance. Mathematical teaching was considered as a culture free subject. This conception has been declined by the students' motivation and solution of their difficulties particularly in mathematics or mathematical sciences.

It is evident from the Table 5 that obtained 't' value was found to be significant between male and female and rural and urban students with respect to mathematical creativity (df = 478). The group of male participant was found to be significantly higher than their counterparts. The group of urban students was also found to be significantly higher than their counterparts. Gender difference was also found in mathematical creativity (Sethi, 2012; Sak and Maker, 2006; and Jensen 1973). In contrast, Walia (2012) do not support similar findings. Singh (1989) found that rural and urban science students do not differ with respect to mathematical creativity. It is clear from the above result that gender and locality affect to mathematical creativity scores.

Table 4

Mean, SD and 't' values of Mathematical Problem-Solving Performance Scores with respect to Gender and Locality

S. No.	Variables	Groups	N	Mean	SD	t-value	p-value
1	Gender	Male	201	3.124	2.85	7.86	< 0.01
		Female	279	1.86	1.90		
2	Locality	Rural	290	1.30	1.44	19.17	< 0.01
		Urban	190	6.975	3.91		

Table 5

Mean, SD and 't' values between gender and locality with respect to Mathematical Creativity

S. No.	Variables	Groups	N	Mean	SD	t-value	p-value
1	Gender	Male	201	100.59	23.83	2.90	< 0.01
		Female	279	94.09	18.21		
2	Locality	Rural	290	91.41	13.47	15.04	< 0.01
		Urban	190	125.27	28.92		

It is evident from the Table 5 that obtained 't' value was found to be significant between male and female and rural and urban students with respect to mathematical creativity (df = 478). The group of male participant was found to be significantly higher than their counterparts. The group of urban students was also found to be significantly higher than their counterparts. Gender difference was also found in mathematical creativity (Sethi, 2012; Sak and Maker, 2006; and Jensen 1973). In contrast, Walia (2012) do not support similar findings. Singh (1989) found that rural and urban science students do not differ with respect to mathematical creativity. It is clear from the above result that gender and locality affect to mathematical creativity scores.

Discussion and Conclusion

The present study investigated the relationship between mathematical creativity and mathematical problem solving performance. Mathematical problem solving performance was found to be significantly related to mathematical creativity. Significant positive relationship between these two important variables may be due to the fact that both the abilities belong to the same cognitive domain. The significant relationship between the two important variables may open the door to detect the causal relationship between them. Furthermore, it was found that mathematical problem-solving performance made a significant contribution to the prediction of mathematical creativity. Furthermore, the findings of this study also suggested that mathematical creativity and mathematical problem solving performance both were affected by gender and locality, favouring males and urban students. The findings of the studies (Sethi, 2012; Sak and Maker, 2006 and Jensen, 1973) do not support the result of this study. Walia (2012) found no significant difference between boys and girls with regard to mathematical creativity. Singh (1989) found that rural and urban science students do not differ with respect to mathematical creativity. Therefore, it emerges that mathematical problem-solving performance plays an important part in the development of mathematical creativity among middle school

students in India. In contrast, Singh (1993) concluded that mathematical creativity does not contribute in the development of mathematical problem solving performance.

The results of this study show gender and cultural differences in both mathematical creativity and mathematical problem-solving performance. The following may be the reasons of these results; (1) the tests used in the study are not gender and culture free; (2) In India particularly in rural, remote and low educated families, disparities between the education of boys and girls may be the possible reason for the same; (3) due to lack of awareness, parental support and parental education and fear about mathematics very few girls may select mathematics or mathematical sciences as a subject for their future career.

Understanding of pupil's cultural diversity is essential for teaching and fostering their creativity. Government should open some good institutions in rural and remote areas and reserve some seats in reputed schools located in urban areas for girls and rural students. Teachers of rural schools should be trained how they can develop mathematical creativity and mathematical problem-solving performance among children. Some extra activities like mathematical quiz and debate be conducted in rural schools particularly in girls institutions. In this study regression equations between mathematical creativity and mathematical problem-solving performance have also been developed. One can know the mathematical creativity of a child with the help of mathematical problem solving performance and vice versa. In future, impact of some environmental and social factors on mathematical creativity and mathematical problem solving performance should be examined by longitudinal studies. Furthermore, cross-lagged panel analysis should be used to find out which one variable is cause and which one is effect between mathematical creativity and mathematical problem-solving performance.

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