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RESEARCH ARTICLE

MATHEMATICAL PROBLEM-SOLVING ABILITY AS A PREDICTOR OF MATHEMATICAL CREATIVITY AMONG SECONDARY SCHOOL STUDENTS

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Abstract

The study is attempted to find the predictive ability of the Mathematical Problem-Solving Ability on Mathematical Creativity among Secondary School Students. 280 secondary school students were selected as the sample of the study. Test of Problem-Solving Ability in Mathematics by Sumangala and Rinsa (2008) and Mathematical Creativity Test by Vijayakumari and Midhundas, (2017) were used as tool for data collection. Results of the study reveals that that there exists a significant positive relationship between Mathematical Problem-Solving Ability and Mathematical Creativity for total sample and relevant subsamples and Mathematical Problem-Solving Ability is significant predictor of Mathematical Creativity of secondary school students.

Introduction:-

Education is the process of facilitating learning that make possible for people to not merely to live but to live adequately. The educated person aware of socio-economic scenario of the country and help the overall progress of any country. For the cultural, scientific and social progress of any country development of creativity among citizens are essential. One of the goals of any education system should be encourage the development of creative people. Out of all the talents creative talent is most important and is related with subject like mathematics. Mathematical teaching and learning of mathematics are important aspect and make it fruitful and attractive through creative way. Undoubtedly, mathematics is a universally accepted displine. According to Galileo Galilei "Mathematics is the key and door to the science. Mathematics make life of people orderly and prevents any barriers by certain qualities of mathematics like reasoning power, creativity, critical thinking, problem solving ability and effective communication skills".

Mathematics is a vehicle to train a child to think, reason, and analyze logically. Nature of mathematics is appropriate to be used as a scaffold for fostering creativity. Creativity should be evident in the mathematical activities. There for one of the important tasks of mathematics education is to identify and develop mathematical creativity. Through mathematics learning students attain higher intellectual and mathematical abilities like logical reasoning, concentration, orderly presentation and precision and above all general problem-solving abilities.

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Mathematics also helps in the development of certain mental ability, ability to analyses a statement, to arrive at conclusions and reason out different situations. At school level, creativity in mathematics is generally related to problem solving (Chamberlin & Moon, 2005). Students should be provided opportunities to engage in struggling to solve mathematics problems. Solving such mathematical problems could lead students to experience creativity in doing mathematics and also try to think as a mathematician, which means that students are encouraged to reflect on their own ideas.

Some researches recommend that mathematical performance of students can be improved by training them spatial tasks. The creativity of such students can be improved by practicing spatial ability. It predicts a young person's achievement in science and technology, engineering, mathematics. They are crucial for career development as architect, sculptor, surgeon, but they get little attention in schools.

Spatial ability is one of the factors of creativity in mathematics (Panagiotis, Avgerinos, Deliyianni,Elia,Gagatsis&Geitona (2021). Also, spatial training helps the students to understand the subject with ease and helps to develop proper caliber and creativity in mathematics. So, the investigator selected the topic for the study.

Need and Significance of the Study:-

In the history of the world, there had been several philosophers, poets, writers and painters who were turned out of their school classes considered as backward students, but who created great works in their later life. Hence in modern times the progressive nations try to develop creativity in their new generations.

In general, most teachers think there are a single correct answer and one correct method to solve a mathematical problem. This is because traditional Mathematics education was intended to focus mostly on convergent thinking in which a student memorized existing mathematical rules and theorems and then applied them to problems to find one exclusive solution rather than to apply these rules and theorems in new and different ways.

Problem solving ability is important because it enhances the clear understanding in many areas of mathematics. Identifying students with exceptional spatial abilities has an important social function. Spatial ability is required in technical and design jobs where drawing and plans used, architecture, surveying, engineering, design. It is also important in some branches of science and technology where three-dimensional components are interacting.
Today life of everyone is through the constant journey of problem solving. For living in this world, each of us must be a problem solver. Problems may be, different and different depending on the nature. From these, problem solving is the one of essential factor for the development of the nation. When saying about problem solving, it is clear that to present the importance of the term mathematical creativity. So, the investigator selected the topic for study.

Objectives of the Study:-

1. To find out the difference in mean scores of Mathematical Problem-Solving Ability among Secondary School Students based on Gender and Locale.
2. To find out the difference in mean scores of Mathematical Creativity among Secondary School Students based on Gender and Locale.
3. To find out the significant relationship between Mathematical Problem-Solving Ability and Mathematical Creativity among Secondary School Students for the total sample and subsamples based on Gender and Locale.
4. To find the predictive ability of Mathematical Problem-Solving Ability on Mathematical Creativity
5. To develop a regression equation to predict Mathematical Creativityfrom Mathematical Problem-Solving Ability.

Hypotheses of the Study

1. There exist no significant difference in mean scores of Mathematical Problem-Solving Ability among Secondary School Students based on Gender and Locale.
2. There exist no significant difference in mean scores of Mathematical Creativity among Secondary School Students based on Gender and Locale.
3. There exist no significant relationship between Mathematical Problem-Solving Ability and Mathematical Creativity among Secondary School Students for the total sample and sub samples based on Gender and Locale.
4. Mathematical Problem-Solving Ability is not a significant predictor of Mathematical Creativity

Methodology in Brief:-

Method used

Investigator adopted descriptive survey method for the study

Sample of the study

Present study was carried out on a representative sample of 280 secondary school students. Sample was drawn by stratified random sampling method, given due representation to factors, Gender and Locale.

Tools used for the Study

The tools used for the data collection are

1. Test of Problem-Solving Ability in Mathematics (Sumangala &Rinsa, 2008)

The test has 25 multiple choice questions and it covers Six types of problems viz., Logical problems, Algorithmic Problems, Story Problems, Rule using Problems, Troubleshooting Problems and Situated case Problems. Test-retest reliability coefficient of the tools is .75 and correlation coefficient for the concurrent validity is .59

2. Mathematical Creativity Test (Vijayakumari&Midhundas, 2017)

The tools developed with the components of creativity as Fluency, Flexibility and Originality as per the theories on Creativity by Guilford (1967) and Torrence (1969). Mathematical Creativity test consists of ten items 7 from arithmetic and 3 from geometry. Test-retest reliability coefficient of the tools is .782 and Cronbach α obtained for the components Fluency, Flexibility and Originality are .778, .692 and .743 respectively. The correlation coefficient for the concurrent validity is .764

Statistical techniques used

For the analysis of obtained data following statistical techniques were used.

1. Test of significance of mean difference for large independent sample
2. Pearson's product moment coefficient of correlation(r)
3. Simple regression

Analysis and Results:-

To find the predictive ability of Mathematical Problem-Solving Ability on Mathematical Creativityamong secondary school students, data were analysed using suitable statistical techniques. The analysis and results are presented under relevant headings.

Difference in mean scores of Mathematical Problem-Solving Ability among Secondary School Students based on Gender and Locale

The test of significance difference between mean scores of the variable Mathematical Problem-Solving Ability based on gender and locale of secondary school students were calculated.

The details of results of mean difference analysis of Mathematical Problem-Solving Ability based on gender and locale is presented in table 1

Table 1:-Data and results of comparison of mean scores of Mathematical Problem-Solving Ability based on Gender and Locale.

Sample	Gender	N	Mean	Std. Deviation	t-value
Gender	Male	145	8.46	3.56	2.71**
	Female	135	9.69	4.06	
Locale	Urban	162	10.43	4.03	8.21**
	Rural	118	7.16	2.61	

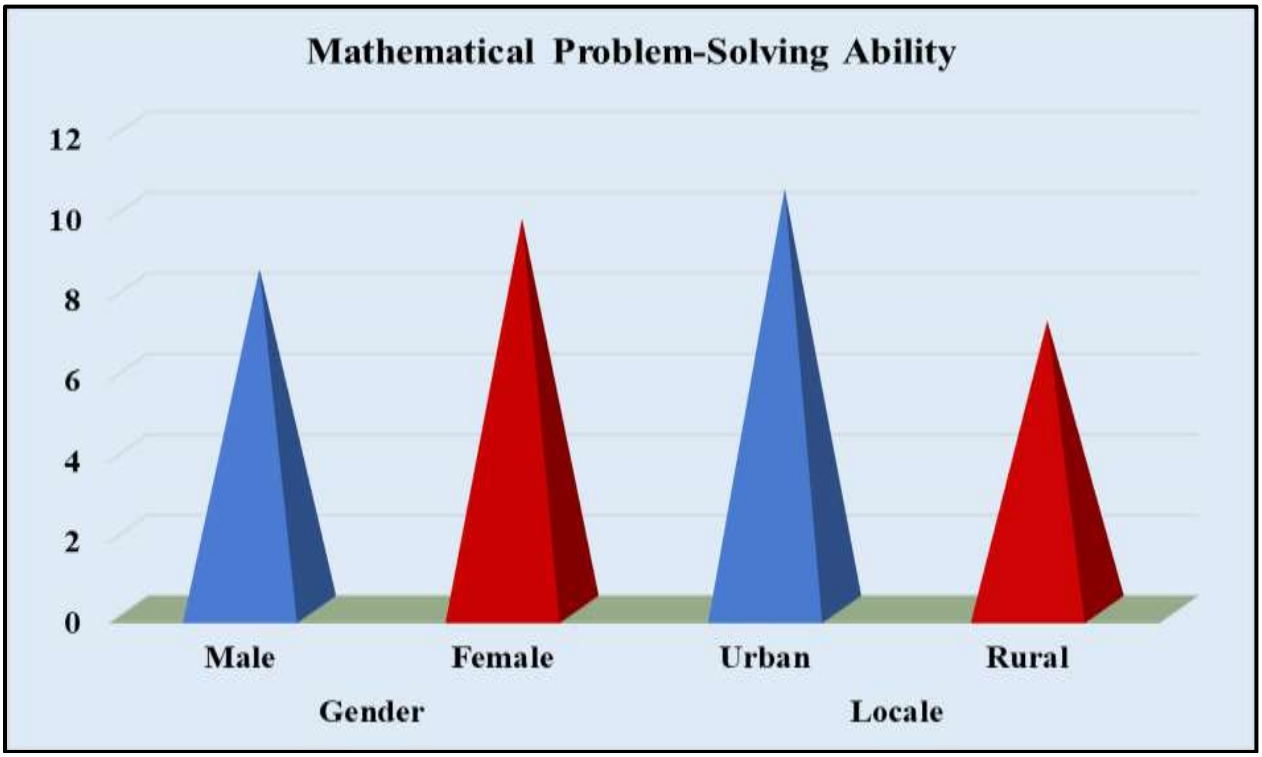
****Significant at .01 level**

Table shows that the t-value obtained for male and female students for the Mathematical Problem-Solving Ability is 2.71 which is greater than the tabled value (2.58) for significance at .01 level. Thus, there exists significant difference in the Mathematical Problem-Solving Ability of secondary school students with respect to gender, t

=2.71, p≤ .01. The mean scores of Mathematical Problem-Solving Ability for female students is significantly higher than that of male students.
The t-value obtained for rural and urban students for the Mathematical Problem-Solving Ability is 8.21 which is greater than the tabled value (2.58) for significance at .01 level. Thus, there exists significant difference in the Mathematical Problem-Solving Ability of secondary school students with respect to locale, t =8.21, p≤ .01. The mean scores of Mathematical Problem-Solving Ability for urban students is significantly higher than that of rural students.

Graphical representation of comparison of mean scores of Mathematical Problem-Solving Ability based on Gender and Locale is presented in figure 1.

Figure 1:-Graphical representation of Comparison of Mean Scores of Mathematical Problem-Solving Ability based on Gender and Locale.



Difference in mean scores of Mathematical Creativity among Secondary School Students based on Gender and Locale
The test of significance difference between mean scores of the variable Mathematical Creativity based on gender and locale of secondary school students were calculated.

The details of results of mean difference analysis of Mathematical Creativity based on gender and locale is presented in table 2
Table 2:-Data and results of comparison of mean scores of Mathematical Creativity based on Gender and Locale.

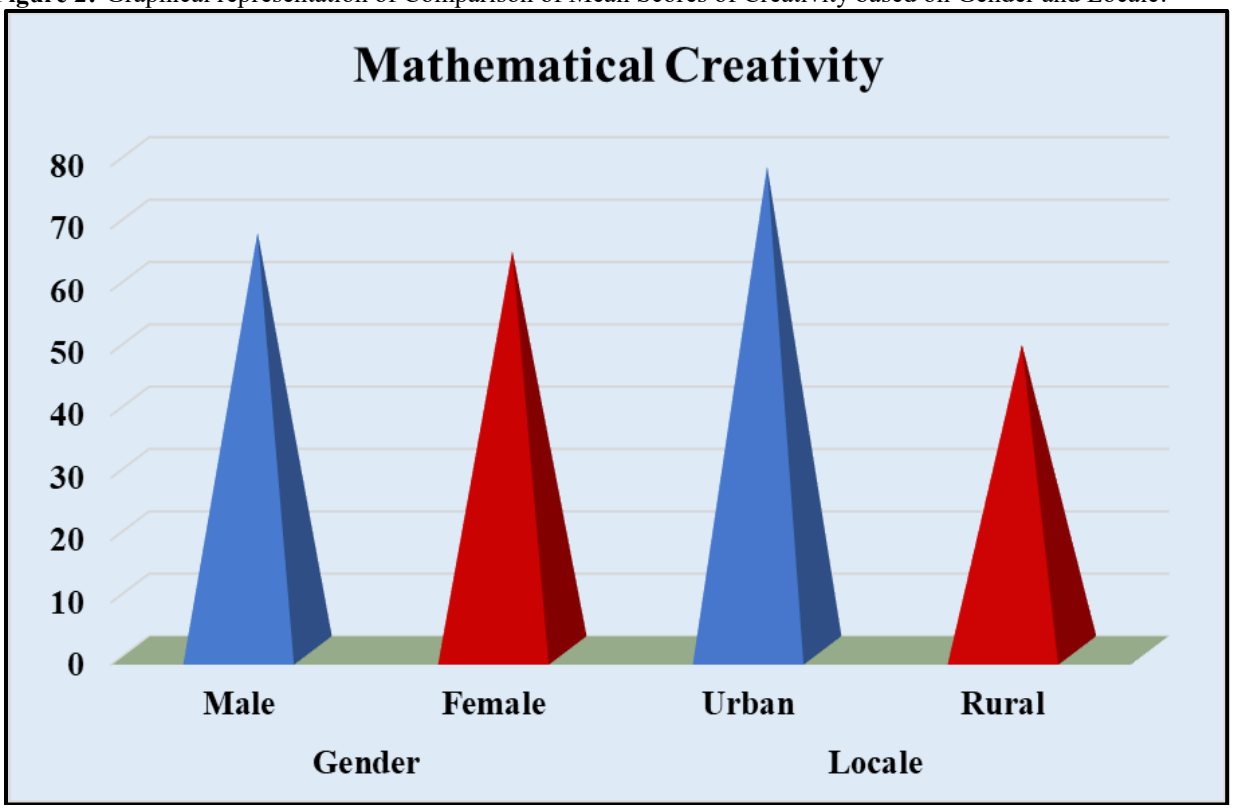
Sample	Gender	N	Mean	Std. Deviation	t-value
Gender	Male	145	67.06	32.53	.727
	Female	135	64.09	35.76	
Locale	Urban	162	77.67	33.59	7.84**
	Rural	118	49.09	27.26	

****Significant at .01 level**

Table shows that the t-value obtained for male and female students for the Mathematical Creativity is .727 which is less than the tabled value (1.96) for significance at .05 level. Thus, there exists no significant difference in the Mathematical Creativity of secondary school students with respect to gender, t =.727, p> .05.
The t-value obtained for rural and urban students for the Mathematical Creativity is 7.84 which is greater than the tabled value (2.58) for significance at .01 level. Thus, there exists significant difference in the Mathematical Creativity of secondary school students with respect to locale, t =7.84, p≤ .01. The mean scores of Mathematical Creativity for urban students is significantly higher than that of rural students.

Graphical representation of comparison of mean scores of Mathematical Creativity based on Gender and Locale is presented in figure 2.

Figure 2:-Graphical representation of Comparison of Mean Scores of Creativity based on Gender and Locale.



Relationship between Mathematical Problem-Solving Ability and Mathematical Creativityamong Secondary School Students
To find the relationship between Mathematical Problem-Solving Ability and Mathematical Creativity among secondary school students, Pearson's product moment correlation is used. Data results of analysis are presented in table 3.

Table 3:-Coefficient of correlation of Mathematical Problem-Solving Ability and Mathematical Creativity for total sample and subsample based on Gender and Locale.

Sample	Total	Male	Female	Urban	Rural
r-value	.552**	.549**	.582**	.515**	.318**

****Significant at .01 level**

Table 3 shows that there exist a significant relationship between Mathematical Problem-Solving Ability and Mathematical Creativity (r = .552, p<0.01) for total sample. Positive sign of the correlation coefficient indicates that for increase of Mathematical Problem-Solving Ability there is a increase in the score of Mathematical Creativity. Magnitude of correlation coefficient indicates moderate relationship between Mathematical Problem-Solving Ability and Mathematical Creativity. It can be concluded that there exist a significant positive moderate correlation between

score of Mathematical Problem-Solving Ability and Mathematical Creativity of secondary school students for total sample. Sub sample wise analysis also shows that there exists a significant positive moderate relationship between Mathematical Problem-Solving Ability and Mathematical Creativity for subsamples male, female and urban students. There exist a significant positive weak relationship between Mathematical Problem-Solving Ability and Mathematical Creativity for subsamples rural students.

Predictive ability of Mathematical Problem-Solving Ability on Mathematical Creativity

To find the predictive ability of Mathematical Problem-Solving Ability on Mathematical Creativity, simple regression was used. Data and results of regression analysis is presented in table 4.

Table 4:-Model Summary of Simple regression analysis of Mathematical Creativity.

Model	R	R Square	Overall Model Test			
			F	df_1	df_2	p
1	.552	.305	122.00	1	278	.01

From table it is evident that the correlation coefficient obtained is 0.552, which is significant at .01 level. Obtained r square value is .305, it indicates that predictor variable explained 30.5 percent of variance in predicting Mathematical Creativity of secondary school students. The analysis of simple regression reveals that Mathematical Problem-Solving Ability contribute significantly in predicting Mathematical Creativity of secondary school students. Details of regression coefficients are presented in table 5.

Table 5:-Details of Regression Coefficients.

Model	Unstandardized Coefficients (B)	Standardized Coefficients (Beta)	t	p-value
(Constant)	21.37		4.91	.01
Mathematical Problem-Solving Ability	4.89	.552	11.05	.01

From table it is clear that unstandardized coefficient (b) obtained for the Mathematical Problem-Solving Ability is 4.89, it means that the increase in the score of Mathematical Creativity is 4.89 for increase in each unit of Mathematical Problem-Solving Ability score. The obtained t value shows that the b-values obtained differ significantly from zero ($t = 11.05$, $p < .01$). Hence the variable Mathematical Problem-Solving Ability is significant predictor of Mathematical Creativity of secondary school students.

With the values of b, the regression model can be expressed as

$$\mathbf{Y^1 = 21.37 + 4.89\ X_1}$$

Where,

Y^1 - Predicted value of Mathematical Problem-Solving Ability

X_1 - Score on Mathematical Problem-Solving Ability.

Major Findings:-

Major findings of the study are listed below.

1. There exists significant difference in the Mathematical Problem-Solving Ability of secondary school students with respect to gender, $t = 2.71$, $p \leq .01$.
2. There exists significant difference in the Mathematical Problem-Solving Ability of secondary school students with respect to locale, $t = 8.21$, $p \leq .01$.
3. There exists no significant difference in the Mathematical Creativity of secondary school students with respect to gender, $t = .727$, $p > .05$.
4. There exists significant difference in the Mathematical Creativity of secondary school students with respect to locale, $t = 7.84$, $p \leq .01$.
5. There exists a significant positive moderate relationship between Mathematical Problem-Solving Ability and Mathematical Creativity for total sample and subsamples male, female and urban students. Relationship between Mathematical Problem-Solving Ability and Mathematical Creativity for rural students is weak.
6. Mathematical Problem-Solving Ability is significant predictor of Mathematical Creativity of secondary school students.

Conclusion and Implication:-

Findings of the study reveal that there exist a significant positive correlation between Mathematical Problem-Solving Ability and Mathematical Creativity. It means that by developing Mathematical Problem-Solving Ability among students it also enhances Mathematical Creativity and vice versa. The study suggests that in order to develop Mathematical Creativity among secondary school students, it is necessary to develop Problem-Solving Ability. Therefore, educational programs should integrate problem-solving tasks across subjects to encourage divergent thinking and innovation. Teachers can adopt inquiry-based learning, project-based activities, and real-life challenges that require students to analyze situations, generate solutions, and evaluate outcomes. By doing so, schools can nurture both cognitive flexibility and originality, ultimately preparing students for complex and dynamic real-world scenarios where creativity and problem-solving are essential.

Boys and rural students are showing low a Mathematical Problem-Solving Ability, to develop this teacher can engage students by giving activities that enhance problem solving ability by giving special attention to boys and rural students. Programmes which focuses on the problem solving and inquiry training can be arrange in the schools, so it will results development of Mathematical Problem-Solving Ability among secondary school students. Educational practices should therefore aim to develop these interconnected skills through interdisciplinary approaches, open-ended tasks, and experiential learning. By fostering both mathematical Problem-Solving Ability and Mathematical Creativity in the classroom, educators can equip learners with the tools needed to adapt, innovate, and succeed in diverse academic and life situations.

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