

# Effect of Problem Solving Strategies on Achievement in Mathematics in Relation to Creativity

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**Abstract** – *The present study investigates the effect of problem solving strategies on achievement in mathematics in relation to creativity. The sample consisted 120 students of class 9th selected from two different schools of Chandigarh (UT). Instructional material based on problem solving strategies was prepared and utilized to teach the experimental group. After pre and post-testing on all the students, gain scores were computed. Verbal test of creativity by Mehdi (1973) was also administered. Mean, SD, Analysis of Variance (2x3) and t- ratio were used to arrive at the following conclusions: (i) The performance of problem solving strategies group was found significantly higher as compared to the conventional teaching group. (ii) The performance of high creativity group was found significantly higher than that of average and low creativity groups. (iii) There was no significant interaction effect was found between the problem solving strategies and creativity group.*

**Keywords:** *Problem Solving Strategies, Achievement, Traditional Teaching Strategy, Creativity*

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## INTRODUCTION

Mathematics is the study of space and numbers, where study of space means Geometry; study of numbers is called Arithmetic, while the blending of geometry and arithmetic is called Algebra. Therefore, we can say mathematics as the bedrock of technology. For proper understanding of science, mathematics play a major role, hence referred to as the queen of all sciences. Despite the importance attached to mathematics and its crucial role in technology, student sees it as a difficult subject and as such show little or no interest in the subject. This problem is often caused by too much theoretical expressions or formulae by the mathematics teachers while learners remain passive listeners (Odili, 2006).

Currently we are widely using mathematics in every field and the decline in mathematics achievement is a matter of concern. Among many reasons the major reason of the decline in mathematics achievement in schools is because students consider mathematics as a difficult and boring subject. According to Keefe (1987), the phenomenon of frustration among teacher and students need to be overcome in order to achieve excellence in mathematics. Therefore, teachers should take note of the needs of individual

students. Therefore, academics ought to note of the wants of individual students.

Problem-solving methods are the steps that one would use to seek out the problem(s) that are in the way to getting to one's own goal. Bransford and Stein (1993) refer to this as the 'problem-solving cycle'. In this cycle one can acknowledge the problem, define the problem, develop a strategy to fix the problem, organize the knowledge of the problem cycle, figure-out the resources at the user's disposal, monitor one's progress, and evaluate the solution for accuracy. Although known as a cycle, one does not have to do each step in order to fix the problem; in fact those who don't are usually better at problem solving. The reason its known as a cycle is that once one is completed with a problem another usually will pop up. Blanchard-Fields (2007) looks at problem solving from two facets. The first one is watching at those issues that solely have one answer (like math problems, or fact based questions) which are grounded in psychometric intelligence. Another one is socio-emotional in nature and is unpredictable with answers that are constantly changing.

Problem solving considered as one of the important cognitive activities applied in daily life contexts; and mathematical problem solving looked as the

most useful part in the field of mathematics. The students should understand their environment and world together and they should apply what they learn to real life. They have to use mathematical skills and mathematical knowledge in modern society. Otherwise, students with traditional methods of learning do not help students to solve the problems and they are unable make relations between real life and their learning in rapidly changing world. Problem solving in mathematics also holds great importance in being the final objective and outcome of the teaching and learning process; it seen as the correct approach to thinking in general; for there is no mathematics without thinking, and no thinking without problems. In the history of teaching mathematical problems, the year 1945 was the turning point ; it was the year in which Polya set the steps of mathematical problem solving and encouraged people to initiate the problem-solving process; in his book "How to Solve It"(Aljaberi,2015).

One way to teach students to problem solve is to teach the four-step processes developed by Polya (1957): (i) understand the problem, (ii) devise a plan, (iii) carry out the plan, and (iv) lookback. Farooq (1980) points out that a "problem" usually indicates a challenge, the meeting of which requires study and investigation. Skinner (1984) defined the term "problem-solving" as the framework or pattern within which creative thinking and learning takes place. Problem solving can be considered a process of overcoming difficulties, which appear to interfere with the attainment of a goal.

Achievement is psychological necessity of a man; He needs it not only to establish himself in the eyes of others but also for self-satisfaction. Achievement refers to accomplishment. It signifies successfully carried out performance by an individual or a group as assured after the completion of a task, whether it is academic, manual or social. To achieve is one of the most important social needs. People from infancy to old age want to achieve something. Achievement in academics generally refers to the degree or level of success attained in some specific area concerning to academic work. Walia (1979) holds that achievement signifies accomplishment or gain or performance carried out successfully. Achievement is one of the most important goals of education. In the process of education of the young ones the stress and focus have come to measurement and evaluation of the students' achievement in school and college subjects. According to Oxford Advanced Learners Dictionary (2000) achievement is a thing done successfully especially with effort and skill.

There are many possible reasons as to why students fail in mathematics. Most of the reasons related to curriculum and strategies of teaching rather than the learners' lack of ability to learn. Airasian and Walsh (1997) criticize that the present mode of teaching of mathematics in schools has not fulfilled the needs of the vast majority of our learners, and that not nearly

enough instructional stress put on the higher order skills. Conventional techniques of teaching and learning makes the learner to cram information, perform well-organized experiments, and do mathematical calculations using a specific algorithm and makes them submissive and rule-bound. The conventional teacher as information giver and the textbook guided classroom have failed to bring about the desired outcomes of producing thinking learners (Young & Collin, 2003).

The word "creativity" in itself is meaningful. However, we have grown accustomed to offer an explanations and elaboration of an already familiar term. Whatever is novel, unique, unconventional, original is considered creative. To quote foster, it is like letting down a bucket into the subconscious and bringing up things you knew, and mixing them with things of ordinary day life that maximize you make a work of art (Crotty, 1998). Creativity can be defined as "the ability and disposition to produce novelty". Almighty is the supreme power, the creator of universe who possesses the finest creative abilities. Each one of us is a unique creation, but we do not possess the same creative abilities as our peers. Some of us possess high creative talents and creative abilities to contribute in different fields. Teachers make a significant contribution with proper care and attention in the creative expressions of students during teaching and learning. They are required to help the children in nourishing their creative abilities to the utmost. The educational process, therefore, should be aimed at developing creative abilities among children (Hart, 1982).

### Need and Significance of the Study

The purpose of the study was to conduct research regarding the perception of students studying with problem solving strategy to solve the problems in mathematics. Mathematics is a leading logical science upon which other sciences like Chemistry, Physics, Biology and Geography depend. It is considered a basis for social life and the exploration of the entire universe. Problem solving is a very complex process in which students need to be properly supported and coached. In traditional Mathematical instruction problems used are mostly goal-directed, narrow, disconnected and simplistic. When students are faced with those type problems, they tend to engage in a host of undesirable behaviors rather than in cognitive activity that builds and structures learner's knowledge and develops desirable habits cognitively. They focus excessively on the goal of determining the answer. They employ means-ends analysis to determine a solution path, and engage in equation manipulation. And they try to use mathematics that is familiar, rather than new and unfamiliar solution way. What students don't do, but should, is: analyze situations in terms of concepts; interpret mathematical formulation; employ multiple representations; seek and weigh

alternative solutions; formulate a strategy before solving; compare and contrast with more familiar situations; and monitor and reflect on their own problem solving. Mathematical problem-solving instruction is not to equip learners with a collection of skills and processes, but rather to enable them to think for themselves. The value of skills and process instruction should be judged by the extent to which the skills and processes actually enhance flexible, independent thinking. In the eyes of mathematicians, mathematics is the single method of thinking that leads us to certain knowledge. The individual tries to solve the problem by correlating among the concepts for the solution of problem, and at this stage, thinking starts. Individual's mathematical thinking skill improves in the problem solving stage. The objective of mathematics teaching is, on the one hand, to enable individual to solve problem and to teach problem solving stages, on the other, to allow him to think mathematically. Therefore, the investigator made an attempt to enquire the effect of problem solving strategy on achievement in mathematics in relation to creativity.

## OBJECTIVES

1. To compare the groups taught through problem solving strategies and traditional teaching strategy on achievement in mathematics.
2. To compare the groups having high, average and low creativity on achievement in mathematics.
3. To examine the interaction effect of problem solving strategies and creativity on achievement in mathematics.

## HYPOTHESES

H<sub>1</sub>: The performance of problem solving strategies group will be higher than that of traditional teaching strategy on achievement in mathematics.

H<sub>2</sub>: The performance of high creativity group will be higher than that of average and low creativity group.

H<sub>3</sub>: There will be significant interaction effect between problem solving strategies and creativity groups.

## SAMPLE

The present study was conducted on English medium public schools of Chandigarh affiliated to Central Board of Secondary Education, New Delhi. A random sample of 120 students of 9<sup>th</sup> class mathematics students including 60 students from the Government Model Senior Secondary School, Sector-37 Chandigarh and 60 students from the Government Model High School, Sector-38

Chandigarh. It was random and purposive sample. The study was conducted on two intact groups viz. one is experimental group and other is control group in each school. The two schools were randomly selected from the total school of Chandigarh. The two intact sections of 30 students were selected from each school.

## DESIGN

The present study was in experimental in nature. A pre and post-test factorial design was employed. In order to analyze the data, mean, SD, analysis of variance (2x3) and t-ratio were used for the two independent variables viz. instructional treatment and creativity. The impact of teaching strategies was examined at two levels, namely problem solving strategies and traditional teaching strategy. The classification of creativity groups was done at three levels viz. high, average and low creativity. The main dependent variable was the performance gain which was calculated as the difference in post- test and pre-test scores for the subject.

## TOOLS USED

The following tools were used for the collection of data:

1. Standard Progressive Matrices (SPM) by Raven, Raven and Court (2000) was used for matching the groups.
2. Verbal test of creativity by Mehdi (1973) was used.
3. An Achievement Test in Mathematics was prepared by investigators.
4. Five Lessons in Mathematics based on problem solving strategies and traditional teaching strategy were prepared by the investigators.

## PROCEDURE

After the careful selection of the sample, students were allocated to the two instructional strategies and the experiment was conducted. It was conducted in five phases. Firstly the students of experimental and control groups were matched with Standard progressive matrices test. Secondly, the Verbal test of creativity was administrated in each school for the classification of the students. Thirdly, a mathematics achievement pre-test was administered to the students of experimental and control groups to obtain information regarding the previous knowledge of the students. Fourthly, one group was taught through problem solving strategies and control group was taught through traditional teaching strategy by the investigators. Fifthly, with the completion of treatment, the

mathematics achievement post-test was administered to the students of both the groups. The answer-sheets were scored with the help of scoring key.

**ANALYSIS AND INTERPRETATION OF THE RESULTS**

**Analysis of Descriptive Statistics**

The data were analyzed to determine the nature of the distribution of scores by employing mean and standard deviation. The Analysis of Variance (2x3) was used to test the hypotheses related to problem solving strategies, traditional teaching strategy and creativity levels. The mean and standard deviation of different sub groups have been presented in table- 1, 2, 3, & 4.

**Table-1: Means and SD of Gain Achievement Scores for the Different Sub Groups**

Creativity Group	Instructional Strategies						Total		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
High Creativity A Creativity	16	7.75	2.54	16	6.43	1.5	32	7.09	2.18
Average Creativity	28	7.43	1.46	28	5.92	1.85	56	6.67	1.83
Low Creativity	16	5.00	1.66	16	3.56	1.62	32	4.28	1.79
Total	60	6.87	2.18	60	5.43	2.05	N=120		

*Source: Field Study, 2018*

Table-1 observes that the mean gain scores of problem solving strategies group (M=6.87) is higher than that of traditional teaching strategy group (M=5.43). This shows that problem solving strategies was more effective than that of traditional teaching strategy group. It is also confirmed that the mean of the three groups such as high, average and low creativity groups are 7.09, 6.67 and 4.28 respectively. It is concluded that the mean gain scores with problem solving strategies group has shown significant differences for high, average and low creativity students. These differences are also found with respect of the different creativity groups taught through traditional teaching strategy group.

**Analysis of variance on Gain Achievement Scores**

The mean of different sub-groups, sum of squares, degree of freedom, mean sum of square and the F - ratio have been presented in table-2

**Table-2: Summary of Analysis of Variance (2x3) Factorial Designs**

Source of Variance	Sum of Squares	df	Mean Sum of Squares	F- ratio
Problem Solving Strategies (A)	61.64	1	61.64	18.46**
Creativity Level (B)	155.90	2	77.95	23.34**
Interaction (AxB)	0.16	2	0.08	0.02
Error Term	380.6	114	3.34	

\* Significant at 0.05 level      \*\*Significant at 0.01 level  
 (Critical Value 3.93 at 0.05 and 6.86 at 0.01 levels, df 1/114)  
 (Critical Value 3.08 at 0.05 and 4.80 at 0.01 levels, df 2/114)

**Problem Solving Strategies (A)**

Table-2 reveals that that the F-ratio for difference in mean gain scores of problem solving strategies and traditional teaching strategy group is 18.46, which in comparison to the table value was found significant at 0.01 level of significance. It shows that the groups were not different beyond the contribution of chance. Hence, the hypothesis H<sub>1</sub>: The performance of problem solving strategies group will be higher than that of traditional teaching strategy group in mathematics, is accepted. The result indicates that the performance of problem solving strategies

group was more effective than that of traditional teaching strategy group in mathematics.

To probe deeper F-ratio was followed by t-test. The value of t-ratio for experimental and control group have been placed in table-3.

**Table – 3: t-ratio of gain mean scores between experimental and control groups**

Variables	Experimental Group			Control Group			SE <sub>D</sub>	t-value
	N	Mean	SD	N	Mean	SD		
Gain Scores	60	6.87	2.08	60	5.43	2.05	0.38	3.79**

\*\* Significant at 0.01 level  
 (Critical Value 1.98 at 0.05 and 2.62 at 0.01 level, df 118)

Table-3 reveals that mean gain score of experimental group is 6.87, which is higher than the corresponding mean gain score of 5.43 of the control group. The t-value testing the significance of mean differences of problem solving strategies and traditional teaching is 3.79, which in comparison to the table value was found significant at 0.01 level of significance. The result indicates that the performance of problem solving strategies

group was more effective than that of traditional teaching strategy group.

**Creativity Level (B)**

Table-2 shows that the F-ratio for difference in mean gain scores of the three groups of creativity levels are 23.34, which in comparison to the table value were found significant at 0.01 level of significance. It suggests that the three groups were different with respect of achievement scores. Hence, the hypothesis H<sub>2</sub>: The performance of high creativity group will be higher than that of average and low creativity groups, is accepted. The result indicates that the performance of students in mathematics taught through problem solving strategies has significant differences for high, average and low creativity groups.

To probe deeper F-ratio was followed by t-test. The value of t-ratio for experimental and control group have been placed in table-4

**Table-4: t-ratio for different combinations of creativity groups**

Creativity Levels			High Creativity			Average Creativity			Low Creativity		
			N	Mean	SD	N	Mean	SD	N	Mean	SD
			32	7.09	2.18	56	6.67	1.83	32	4.28	1.79
<b>High Creativity</b>			-----			0.91			5.62**		
N	Mean	SD									
32	7.09	2.18									
<b>Average Creativity</b>			-----			-----			5.98**		
N	Mean	SD									
56	6.67	1.83									
<b>Low Creativity</b>			-----			-----			-----		
N	Mean	SD									
32	4.28	1.79									
			<i>*Significant at 0.05 level</i>			<i>**Significant at 0.01 level</i>					
<i>(Critical Value 2.00 at 0.05 and 2.66 at 0.01 levels, df 62)</i>											
<i>(Critical Value 1.99 at 0.05 and 2.63 at 0.01 levels, df 86)</i>											

Table-4 shows that the high creativity groups with mean of 7.09 exhibits higher mean gain score than average creativity group with mean of 6.67. The t-ratio for the difference in gain mean scores of high and average creativity groups is 0.91, which in comparison to the table value was not found significant even at 0.05 level of significance. Hence, the hypothesis of significant differences is rejected in case of high and average creativity irrespective of grouping across other variable. The result indicates that high and average creativity group was significantly different with respect of gain scores.

Table-4 observes that high creativity group with mean of 7.09 shows higher mean gain score than low creativity group with mean of 4.28. The t-ratio for the difference in gain mean scores of high and low

creativity groups is 5.62, which in comparison to the table value was found significant at 0.01 level of significance. Hence, the hypothesis of significant differences is accepted in case of high and low creativity irrespective of grouping across other variable. This infers that high creativity group performs significantly better than that of low creativity group on achievement in mathematics.

Table-4 reveals that average creativity group with mean of 6.67 exhibits higher mean gain score than low creativity group with mean of 4.28. The t-ratio for the difference in gain mean scores of average and low creativity groups is 5.98, which in comparison to the table value was found significant at 0.01 level of significance. Hence, the hypothesis of significant differences is accepted in case of average and low creativity irrespective of grouping across other variable. This infers that average creativity group performs significantly better than that of low creativity group on achievement in mathematics.

**Interaction Effect (AxB)**

Table-2 reveals that the F- ratio for the interaction between instructional strategies and creativity groups are 0.02, which in comparison to the table value was not found significant even at 0.05 level of significance. It indicates that the two variables do not interact with each other. Thus, the hypothesis H<sub>3</sub>: There will be significant interaction between problem solving strategies and creativity groups, is rejected. The result indicates that there was no significant difference on gain achievement scores in mathematics.

**DISCUSSION**

The result of the present investigation have led to the conclusion that problem solving strategies group in mathematics improved as compared to the traditional teaching strategy group. Hence, the hypothesis H<sub>1</sub>: The performance of problem solving strategies group will be higher than that of traditional teaching strategy on achievement in mathematics, is accepted. The result is consistent with the findings of Farooq (1980), Chang, Kaur, Koay and Lee (2001), Mokhtari-Hassanabad, Shahvarani and Behzadi (2012) and Lasak (2017) support the results. Parveen (2010) concluded that the problem-solving strategy group of achievement in mathematics improved as compared to the expository strategy group. Guvercin and Verbovskiy (2014) indicated that contrary to traditional teaching methods, problem posing instruction produces significantly positive results in students' attitudes toward word problems and mathematics and mathematics achievement.

The performance of students in mathematics taught through problem solving strategies has shown significant differences for high, average and low creativity groups. Hence, the hypothesis the

H<sub>2</sub>: The performance of high creativity group will be higher than that of average and low creativity groups, is accepted. The result is supported by the findings of Gardunio (2001), Nicolaidou and Philippou (2003), Zakaria, Chin and Daud (2010).

The performance of problem solving strategies was not found interacting with each other at different levels of creativity. Hence, the hypothesis H<sub>3</sub>: There will be significant interaction effect between problem solving strategies and creativity group, is rejected. The result is supported by the findings of Marchis (2013) and Chan (2011) indicated that student creativity and mathematics learning can impact mathematics achievement and also problem-based learning promotes students creativity.

## FINDINGS

1. The performance of students taught through problem solving strategies group was found more effective than that of traditional teaching strategy group in mathematics.
2. The mean gain scores of high creativity group were higher than that of average and low creativity groups. Further analysis revealed that :
  - (i) The mean gain achievement scores in mathematics of high creativity group were not found significantly higher than that of average creativity group.
  - (ii) The mean gain achievement scores in mathematics of high creativity group were found significantly higher than that of low creativity group.
  - (iii) The mean gain achievement scores in mathematics of average creativity group were found significantly higher than that of low creativity group.
3. There was no significant interaction effect was found between problem solving strategies and creativity groups.

## EDUCATIONAL IMPLICATIONS

The faculty members are advised to adopt applications of problem solving strategies in teaching because of its effectiveness in the development of the knowledge and skills of students and their creativity. More attention should be paid to the preparation of workshops and training courses for the training of faculty members at universities on the use of problem solving strategies. Special facilities are provided to teachers for inculcating problem solving strategies in their daily routine class as mathematics laboratory where various apparatus are available for students.

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