Effect of Problem Solving Strategy on Achievement in Mathematics in Relation to Academic Anxiety

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ABSTRACT　The present study investigates the effect of problem solving strategy on achievement in mathematics in relation to academic anxiety. The sample consisted 100 students of class 10th selected from two different schools of Amritsar (Punjab). Instructional material based on problem solving strategy was prepared and utilized to teach the experimental group. After pre- testing and post-testing on all the students, gain scores were computed. The academic anxiety test was also administered. Mean, S.D, Analysis of Variance (2×3) and t- ratio were used to arrive at the conclusions – (i) The performance of problem solving strategy group was found significantly higher as compared to the conventional group. (ii)The performance of students with different academic anxiety group was found significant. (iii)No significant interaction effect was found between the two variables.

KEYWORDS : Problem solving strategy, Achievement, Academic anxiety

Introduction

Educators and researchers are trying to find new methods in teaching and learning of mathematics. Today many educators around the world agree that traditional methods of teaching and learning process cannot prepare individuals to the future. The aim of teaching mathematics is to develop cognitive abilities of children, logical thinking, self-sufficiency, and empowering the memory. Generally, all curriculums about teaching and learning mathematics agreed, that the aim of teaching mathematics is to extend the students' ways of learning and to develop the students' abilities in problem solving and provide applicable mathematical knowledge, expertise, and skills for future needs (Guvercin &Verbovskiy, 2014).

 Especially problem solving is accepted as the heart of mathematics education. Problem solving considered one of the essential cognitive activities used in daily life contexts; and mathematical problem solving seen as the most important 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 cannot solve the problems and cannot make relations between real life and their learning in rapidly changing world. Mathematical problem solving 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.

The year 1945 was a turning point in the history of teaching mathematical problems; it was the year in which George 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 (1971): (i) understand the problem, (ii) devise a plan, (iii) carry out the plan, and (iv) look back. 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. It is a process of overcoming difficulties, which appear to interfere with the attainment of a goal. Bay (2000) explains teaching about problem solving is the teaching of strategies, or heuristics, in order to solve problems.

Anxiety is a state of mind in response to some stimulus in the environment, which brings the feelings of apprehension or fear. When the person is been exposed to the cause of anxiety the next time, the conditioning effect causes a repeat response and the person will try to

avoid the cause. All the responsibilities of being an academic brings with it a state of mind referred to as "academic anxiety". This can be associated with almost all the tasks associated with academics i.e. starting from attendance to classes to the biggest cause of academic anxiety, exams. Academic anxiety arises out of the apprehension of rebuke from teachers, parents, and peers regarding the failures of performing academic responsibilities properly. Developing a state of academic anxiety causes a decrease in attention span, concentration, and memory, which can result in having a negative effect on the performance of the individual.

It is now been learnt that some level of anxiety is required for the person to take up all the responsibilities seriously but both high levels of academic anxiety or too low level has deleterious effects on academic performance, which in turn may lead to more academic anxiety. The era of competition makes students more anxious and the eagerness of whether they can do well in their academic part or perform well in academic activities may adversely affect the mental health of students. It is the painful uneasiness of mind while doing or focusing on academic activities in school or at home. If academic anxiety has not properly addressed, it can have many serious and lasting consequences, such as causing a student to procrastinate, perform poorly on schoolwork, fail in classes, and withdraw from socializing with peers. Although anxiety is a normal, even healthy part of our lives, it can be counterproductive when not managed well. Academic anxiety is a common issue that students cannot ignore if they want to succeed in school. It often leads to problems concentrating while studying and remembering information while completing tests, which makes the student, feel helpless and like a failure. Academic anxiety in children and adolescents can be challenging to recognize since it can have much in common with other disorders. According to Cornell University, "Academic anxiety is the result of biochemical processes in the body and the brain that make your attention level increase when they occur. The changes happen in response to exposure to a stressful academic situation, such as completing school assignments, presenting a project in class, or taking a test. When the anxiety becomes too great, the body recoils as if threatened, which is a normal fight-or- flight reaction"(Banga,2014).

The word 'Achievement' implies the act of attaining a desired end or aim. Educationally the word 'Achievement' refers to an individual's performance up to a desired level in a particular field. Achievement of a child is the focus of attention of parents, teachers, head of the institutions and society. People evaluated on the quality of their success from the very beginning when the child enters the school, and throughout his school, college, and university life. Parents and teachers are more concerned about his achievement level. Achievement is the vital factor, which affects the emotional state of mind of students. A person may be satisfied or dissatisfied with his achievement. Thus

Many of the view that academic success depends on a number of factors such as intelligence, motivation, interest, attitude, values, study habits, socio-economic status, personality characteristics etc. In order to find solutions to this huge and important problem of student's failure and low achievement, it becomes necessary to locate the various factors causing low achievement. The society and parents find fault with the teachers and educational system as a whole (Parveen, 2010).

There are many possible reasons as to why students fail in mathematics. Most of the reasons related to curriculum and methods of teaching rather than the students' lack of capacity to learn. Airasian and Walsh (1997) argue that the existing mode of teaching of mathematics in schools has not fulfilled the needs of the vast majority of our students, and that not nearly enough instructional stress put on the higher order skills. Traditional methods of teaching makes the learner to memorize information, conduct well-organized experiments, and perform mathematical calculations using a specific algorithm and makes them submissive and rule-bound. The traditional teacher as information giver and the textbook guided classroom have failed to bring about the desired outcomes of producing thinking students (Young & Collin, 2003). A much-heralded alternative is to change the focus of the classroom from teacher dominated to student-centered using a Problem solving strategy. Problem solving teaching practices in mathematics classrooms intended to produce challenging instructions for students and thus, produce improved meaningful learning. Problem solving strategy is a logical learning strategy that helps to develop students' capacity to learn mathematics independently.

Need and Significance

The proper teaching strategies help teachers in solving learners' problems and bring remarkable improvement in their overall behavior. Review of the literature shows that use of various teaching strategies gave quite positive results in comparison to traditional teaching methodology. Investigator decided to conduct research study by using Problem solving strategy for teaching experimental group and conventional method for control group of students and investigate whether the use of Problem solving strategy is effective or not. Academic anxiety also affects the achievement of students. Thus, the present study will give wider range of knowledge regarding the effect of problem solving strategy and relationship with student's academic anxiety in mathematics. The findings of the present study will also be helpful to assist the students to improve their learning skills in mathematics. The results of the present study will also be helpful for teachers in understanding and adopting the problem solving strategy and break the monotony of the conventional teaching methods. The investigator has made an attempt to enquire into the effect of problem solving strategy on achievements in mathematics in relation to academic anxiety.

Objectives

- To compare the performance of groups taught through problem solving strategy and conventional teaching strategy.
- To study the performance of high, average, and low academic anxiety groups.
- To examine the interaction effect between problem solving strategy and academic anxiety groups.

Hypotheses

- H_1: The performance of problem solving strategy group is higher than that of conventional teaching strategy in mathematics.

- H_2: The performance of low academic anxiety group is higher than that of average and high academic anxiety group.
- H_3: There exists significant interaction effect between problem solving strategy and academic anxiety groups.

Sample

The present study was conducted on a random sample of 100 students of 10th class mathematics students including 50 students from the Harkrishan Public School and 50 students from the Manav Public School, Amritsar (Punjab). 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 Amritsar and from each school the two intact sections of 25 students were selected.

Design

For the purpose of present investigation a pre and post-test factorial design was employed. In order to analyze the data, mean, S.D, analysis of variance (2×3) and t-ratio were used for the two independent variables viz. instructional treatment and academic anxiety levels. The impact of teaching strategy was examined at two levels, namely problem solving strategy and conventional teaching strategy. The classification of academic anxiety group was done at three levels viz. high, average, and low academic anxiety. The main dependent variable was the performance gain, which was calculated as the difference in post-test and pre-test scores for subject.

Tools used

The following tools were used for the collection of data:

- Academic Anxiety Scale for Children by Singh and Gupta (2009) was used.
- An achievement Test in Mathematics was prepared by investigators.
- Four Lessons in Mathematics (such as arithmetic progression, trigonometry, menstruation, and coordinate geometry) based on problem solving strategy and conventional teaching prepared by the investigators.

Procedure

After the selection of the sample and allocation of students to the two instructional strategies, the experiment was conducted. Firstly, students were randomly assigned to control and experimental group. Secondly, the test of academic anxiety was administrated in each school, in order to identify academic anxiety levels of the students. Thirdly, a pre-test was administered to the students of experimental and control groups. The answer-sheets were scored to obtain information regarding the previous knowledge of the students. Fourthly, one group was taught through problem solving strategy and control group was taught through conventional teaching strategy by the investigators. Fifthly, after the completion of the course, the 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 two-way analysis of variance was used to test the hypotheses related to strategies of teaching and academic anxiety levels. The mean and standard deviation of different sub groups have been presented in table- 1, 2 & 3.

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

Academic Anxiety Level	Teaching						Total		
	Problem Solving Strategy			Conventional Teaching Strategy					
	N	Mean	SD	N	Mean	SD	N	Mean	SD
High Academic Anxiety	13	3.30	2.13	13	2.15	1.51	26	2.73	1.93
Average Academic Anxiety	24	4.00	3.43	24	2.16	1.75	48	3.08	2.87
Low Academic Anxiety	13	6.15	2.66	13	2.85	1.99	26	4.50	2.86
Total	50	4.38	3.14	50	2.34	1.78	N= 100		

Source: Field Study, 2015

Table-1 observes that the mean gain scores of problem solving strategy (M=4.38) is higher than the conventional teaching strategy (M=2.34). This shows that problem solving strategy is more effective than the conventional teaching strategy. It is also confirmed that the mean of the three groups' i.e. high, average, and low academic anxiety group is 2.73, 3.08, and 4.50 respectively. It is concluded that the gain mean scores with problem solving strategy has shown significant differences for high, average, and low academic anxiety students. These differences are also found with respect of the different academic anxiety group taught through conventional teaching strategy.

Analysis of Variance on Gain Achievement Scores

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

Table-2: Summary of Analysis of Variance (2×3) Factorial Designs

Source of Variance	Sum of Squares	df	Sum of Squares Mean	F- ratio
Problem Solving Strategy (A)	104.04	1	104.04	16.59**
Academic Anxiety (B)	47.75	2	23.87	3.81*
Interaction (AB)	16.06	2	8.03	1.28
Error	589.19	94	6.27	

Significant at 0.05 level
* *Significant at 0.01 level*

(Critical Value 3.95 at 0.05 and 6.92 at 0.01 levels, df 1/94)

(Critical Value 3.10 at 0.05 and 4.85 at 0.01 levels, df 2/94)

Main Effect
Problem Solving Strategy (A)

Table -2 reveals that that the F-ratio for difference in mean gain scores of problem solving strategy and conventional teaching strategy group is 16.59, 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_1: The performance of problem solving strategy group is higher than that of conventional teaching strategy group in mathematics, is accepted .The result indicates that the performance of problem solving strategy group was more effective than that of the conventional teaching strategy group in mathematics. **Academic Anxiety Level (B)**

Table-2 shows that the F-ratio for difference in mean gain scores of the three groups of academic anxiety are 3.81, which in comparison to the table value was found significant at 0.05 level of significance. It suggests that the three groups were different with respect of achievement scores. Hence, the hypothesis H_2 : The performance of low academic anxiety group will be higher than that of average and high academic anxiety group in mathematics, is accepted. The result indicates that the performance of students in mathematics taught through problem solving strategy has significant differences for low, average, and high academic anxiety groups.

In order to probe deeper, the ratio was followed by t-test. The value of the t-ratio for the different combinations of academic anxiety level have been given in table-3

Table-3: t-ratio for different combinations of self-efficacy levels

Academic Anxiety Level	High Academic Anxiety		Average Academic Anxiety		Low Academic Anxiety	
	N 26	Mean 2.73	SD 1.93	Average N 48	Mean 3.08	SD 2.87	Low N 26	Mean 4.50	SD 2.86
High Academic Anxiety N 26 Mean 2.73 SD 1.93	--		0.63		2.62*	
Average Academic Anxiety N 48 Mean 3.08 SD 2.87	--		--		2.04*	
Anxiety Low Academic N 26 Mean 4.50 SD 2.86	- -		--		--	

Significant at 0.05 level
**Significant at 0.01 level*
(Critical Value 2.00 at 0.05 and 2.65 at 0.01 levels, df 72)
(Critical Value 2.01 at 0.05 and 2.68 at 0.01 levels, df 50)

Table -3 shows that the t-ratio for the difference in gain mean scores of high and average academic anxiety groups is 0.63, 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 academic anxiety irrespective of grouping across other variable. The result indicates that high academic anxiety group and average academic anxiety group was not significantly different with respect of gain scores.

Table -3 shows that the t-ratio for the difference in gain mean scores of high and low academic anxiety groups is 2.62, which in comparison to the table value was found significant at 0.05 level of significance. Hence, the hypothesis of significant differences is accepted in case of high and low academic anxiety irrespective of grouping across other variable. This infers that low academic anxiety group performs significantly better than that of high academic anxiety group on achievement in mathematics with respect of gain scores.

Table-3 shows that the t-ratio for the difference in gain mean scores of average and low academic anxiety groups is 2.04, which in comparison to the table value was found significant at 0.05 level of significance. Hence, the hypothesis of significant differences is accepted in case of average and low academic anxiety irrespective of grouping across other variable. This infers that low academic anxiety group performs significantly better than that of average academic anxiety group on achievement in mathematics with respect of gain scores.

Interaction Effect (A × B)

Table-2 reveals that the F- ratio for the interaction effect between problem solving strategy and academic anxiety groups is 1.28, 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, hypothesis H_3: There exist significant interaction effect between problem solving strategy and academic anxiety, is rejected. The result indicates that the problem solving strategy group and academic anxiety group did not interact with each other on achievement in mathematics with respect of gain scores.

Discussion

The result of the present investigation have lead to the conclusion that problem solving strategy yields higher levels of achievement in mathematics as compared to the conventional teaching strategy group. The hypothesis H1 was accepted. The finding of Nuzum (1991), Farooq (1980) and Chang, Kaur, Koay and Lee (2001) 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) found that contrary to traditional teaching methods, problem-posing instruction produces significantly positive results in students' attitudes toward word problems and mathematics achievement.

The performance of students in mathematics taught through problem solving strategy has shown significant differences for high, average, and low-level academic anxiety groups. Hence, the hypothesis H2 was accepted. The results are consistent with the findings of Ashcraft and Faust (1994) reported that individuals with high math anxiety were significantly slower and less accurate on performing complex added addition problems than individuals without math anxiety. Oludipe (2009) concluded that low-test anxious students performed better than high test-anxious students on both numerical and non-numer-

ical tasks in Physics. Nadeem, Ali, Maqbool and Zaidi (2012) shows that when anxiety increases, academic achievement decreases both in male and female students.

The performance of problem solving strategy was not found interacting with each other at different levels of academic anxiety. Hence, hypothesis H_3 was rejected.

Findings
- The performance of students taught through problem solving strategy group was significantly higher than that taught through conventional teaching strategy group in mathematics.
- The mean gain scores of low academic anxiety group were higher than that of average, and high academic anxiety group in mathematics.
- No significant interaction effect was found between problem solving strategy group and academic anxiety group.

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