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EFFECT OF THINK-PAIR-SHARE STRATEGY ON ACHIEVEMENT IN MATHEMATICS IN RELATION TO MATHEMATICAL CREATIVITY

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Abstract

The present study investigates the effect of think-pair-share on achievement in mathematics in relation to mathematical creativity. The sample consisted 84 students of class 6th selected from three different schools of Amritsar (Punjab). Instructional material based on think-pair-share was prepared and utilized to teach the experimental group. The tools was used for data collection were on achievement in mathematics developed by the investigator and mathematical creativity developed by Sharma and Sansanwal (2012) was also administered. After pre- testing and post-testing on all the students, gain scores were computed. The mathematical creativity test was also administered. Mean, SD, Analysis of Variance (2×3) and t- ratio were used to arrive at the conclusions – (i)The achievement in mathematics of high mathematical creativity experimental group was found significantly higher as compared to the control group. (ii) The achievement in mathematics of average mathematical creativity experimental group was found significantly higher as compared to the control group. (iii) The achievement in mathematics of low mathematical creativity experimental group was found significantly higher as compared to the control group. (iv) No significant interaction effect was found between the two variables.

KEYWORDS: - Think-Pair-Share, Achievement, Mathematical Creativity

Introduction

Mathematics has been recognized as one of the central strings of human intellectual activity throughout the centuries. From the very beginning, mathematics has been a living and growing intellectual pursuit. It has its roots in everyday activities and forms the basic structure of our highly advanced technological developments. It also offers opportunities for opening the mind to new lies of creative ideas. It exhibits connection between things which can be visualized only through agency of human reason by various means. Mathematics has entered into our life and daily activities so much that our existence would become impossible without it. Its achievement in almost all spheres is marvelous (Dhawan, 2012).

With long years of attempt to minimize poor students' achievement in mathematics by both researchers and mathematics educators, many students continue to fail this subject woefully. Many teaching strategies have being used but students' still experience difficulty in this great subject. Due to this failure many students based on the researchers' long years of experience as teachers, are noticed to have retreated and restrained themselves from actively participating in mathematics class activity especially when fraction is taught. Therefore the poor achievement situation and ineptitude in mathematics class has greatly affected students' level of academic self-esteem as regards to mathematics (Chianson, 2015).

Think-Pair-Share is a learning model that helps teachers with cooperative learning in pairs, where each pair of learners is given the opportunity to discuss with partner learning. TPS can also provide opportunities for learners to learn and ask from their friends freely and can optimize student participation. So that the learners are not ashamed to ask their teachers. Think-Pair-Share type learning, this learning model requires students to work with each other in small groups and more characterized by cooperative awards rather than individual rewards (Asfaroh & Hidayati, 2014). The purpose of Think-Pair-Share is that with its use, students will be better able to process information and communicate, as well as develop thinking skills. Research shows that Think-Pair-Share helps students develop conceptual understanding, develop the ability to sort information and draw conclusions, and develop the ability to form and support opinions as well as consider the other points of view (Baumeister, 1992).

According to Lyman (1981), Think-Pair-Share technique as one of the cooperative language learning models has some advantages. They are as follows:

1) The Think-Pair-Share technique is quick and does not take much preparation time.
2) The Think-Pair-Share technique makes classroom discussions more productive, as students 1 have already had an opportunity to think about their ideas before sharing with the whole class.
3) Students have opportunity to learn higher-level thinking skills from their peers, and gain self confidence when reporting ideas to the whole class.
4) The pair step ensures that no student is left out of the discussion.
5) Students are able to rehearse responses mentally and verbally, and all students have an opportunity to talk.
6) Both students and teacher have increased opportunities to think and become involved in group discussion.
7) The Think-Pair-Share technique is applicable across all grade levels and class sizes.

In mathematics achievement, the classroom level has an explicit influence on the individual achievement. In three classrooms showing the lowest performance, all students except one scored less than half of the possible points. There were no high-achieving students in these classrooms. In high achieving classrooms we found a wide range of individual achievement

results. The basic tasks of the first competence level were solved satisfactorily or very well by the high-achieving classes though the weaker classes answered satisfactorily as well. The important differences with respect to performance were caused by items requiring students' argumentative abilities. With respect to these items, students of low-achieving classrooms showed hardly any correct solutions (Reiss, Hellmich, & Thomas, 2002).

As students progress through the educational system their interest in mathematics diminishes. Yet there is an ever increasing need within the workforce for individuals who possess talent in mathematics. Mathematical talent is most often measured by speed and accuracy of a student's computation with little emphasis on problem solving and pattern finding and no opportunities for students to work on rich mathematical tasks that require divergent thinking. Such an approach limits the use of creativity in the classroom and reduces mathematics to a set of skills to master and rules to memorize. Doing so causes many children's natural curiosity and enthusiasm for mathematics to disappear as they get older. Keeping students interested and engaged in mathematics by recognizing and valuing their mathematical creativity may reverse this tendency (Mann, 2005).

Ervynck (1991) described mathematical creativity in terms of three stages. The first stage (Stage 0) is referred to as the preliminary technical stage, which consists of "some kind of technical or practical application of mathematical rules and procedures, without the user having any awareness of the theoretical foundation". The second stage (Stage 1) is that of algorithmic activity, which consists primarily of performing mathematical techniques, such as explicitly applying an algorithm repeatedly. The third stage (Stage 2) is referred to as creative (conceptual, constructive) activity. This is the stage in which true mathematical creativity occurs and consists of non-algorithmic decision making. "The decisions that have to be taken may be of a widely divergent nature and always involve a choice".

The identification of creative potential is challenging. Prior research into the identification of mathematical creativity has focused on the development of measurement instruments. Scoring of these instruments is time consuming and subject to scorer interpretation due to the variety of possible responses. Thus, their use in schools has been very limited, if used at all, since their creation (Mann, 2005). Treffinger (2003) offered general roles for creativity measurement i.e. (i) Help to recognize and affirm the strengths and talents of individuals and enable people to know and understand themselves, and (ii) Help instructors, counselors, or individuals discover unrecognized or untapped talents.

Emergence of the problem

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 think-pair-share strategy. Think-pair-share teaching practices in mathematics classrooms intended to produce challenging instructions for students and thus, produce improved meaningful learning. Think-pair-share strategy is a logical learning strategy that helps to develop students' capacity to learn mathematics independently (Mehar & Kaur, 2015). The proper teaching strategy helps teachers in solving learners' problems and brings remarkable improvement in their overall behavior. Review of the literature shows that use of various teaching strategy gave quite positive results in comparison to traditional teaching methodology. Investigator decided to conduct research study by using think-pair-share strategy for teaching experimental group and conventional method for control group of students and investigate whether the use of think-pair-share strategy is effective or not. Mathematical Creativity also affects the achievement of students. Thus, the present study will give wider range of knowledge regarding the effect of think-pair-share strategy and relationship with student's creativity 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 think-pair-share strategy and break the monotony of the conventional teaching methods. The investigator has made an attempt to enquire into the effect of think-pair-share strategy on achievements in mathematics in relation to mathematical creativity.

Objectives

1. To compare the achievement in mathematics of high mathematical creativity groups taught through think-pair-share strategy and conventional teaching strategy.
2. To compare the achievement in mathematics of average mathematical creativity groups taught through think-pair-share strategy and conventional teaching strategy.
3. To compare the achievement in mathematics of low mathematical creativity groups taught through think-pair-share and conventional teaching strategy.
4. To examine the interaction effect between think-pair-share and mathematical creativity groups on achievement in mathematics.

Hypotheses

1. There is no significant difference in the achievement in mathematics of high mathematical creativity groups taught through think-pair-share strategy and conventional teaching strategy.

2. There is no significant difference in the achievement in mathematics of average mathematical creativity groups taught through think-pair-share strategy and conventional teaching strategy.
3. There is no significant difference in the achievement in mathematics of low mathematical creativity groups taught through think-pair-share strategy and conventional teaching strategy.
4. There is no significant interaction effect between think-pair-share strategy and mathematical creativity groups on achievement in mathematics.

Sample

The present study is conducted on a random sample of 84 students of 6th class mathematics students of Amritsar district affiliated to P.S.E.B. It includes 42 students from the D.A.V. Senior Secondary School, Amritsar and 42 students from the B.K.E & I. Girls High School, Amritsar. The study is conducted on two intact groups viz. one is experimental group and other is control group in each school. The two schools are randomly selected from the total school of Amritsar district and from each school the two intact sections of 42 students are selected.

Design of the study

The present study was designed to see the "Effect of think-pair-share strategy on achievement in mathematics in relation to mathematical creativity among 6th grade students". The experimental method of investigation was employed in the present study. Experimental studies are designed to obtain information concerning the current status of phenomenon and whenever possible, to draw and general conclusions from the facts discovered. It is restricted not only to fact finding but may often result in the formulation of important principles of knowledge and solution of significant problems concerning local, state, national and international issues.

Tools used

The following tools are used for the collection of data:

1. A mathematical creativity test by Sharma and Sansanwal (2012) is used.
2. An achievement test in mathematics is prepared by investigator.
3. Instructional material in mathematics based on think-pair-share strategy and conventional teaching strategy prepared by the investigator.

Procedure

After the selection of the sample and allocation of students to the two instructional strategies, the experiment was conducted. The experiment was conducted in five phases. Firstly**,** students were randomly assigned to control and experimental group. Secondly, the test of

mathematical creativity was administrated in each school, in order to identify mathematical creativity 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 Think-Pair-Share and control group was taught through conventional teaching strategy by the investigator. 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 Analysis of Variance (2×3) was used to test the hypotheses related to think-pair-share, conventional teaching strategy and mathematical creativity levels. The mean and standard deviation of different sub groups have been presented in table- 1, 2 ,3,4 & 5.

Table- 1: t ratio gain scores of high mathematical creativity group between experimental and control group

Variables	Experimental group			Control Group			SE_D	t- value
	N	Mean	SD	N	Mean	SD		
Gain Scores	11	15.23	2.51	11	12.13	1.32	0.85	3.65**

*Significant at 0.05 level **Significant at 0.01 level
(Critical Value 2.09 at 0.05 and 2.84 at 0.01 levels, df 20)

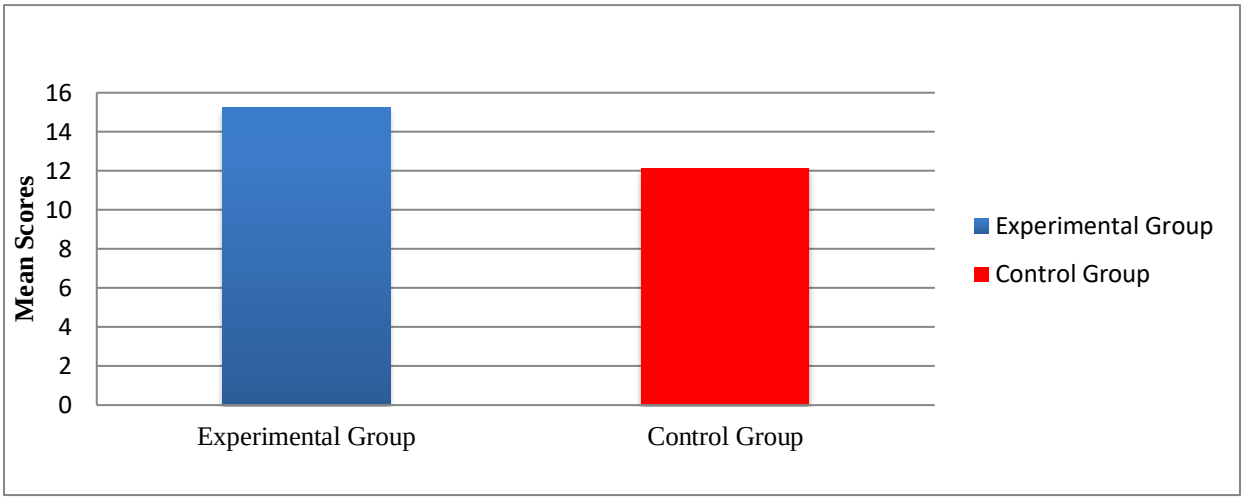

Fig 1: Showing mean gain scores of high mathematical creativity group between experimental and control group

Table 1 and figure 1 observes that mean gain score of high mathematical creativity group of experimental is 15.23 which is higher than high mathematical creativity group of control group is 12.13. The t- value testing the significance of mean differences of think- pair- share strategy and conventional teaching strategy is 3.65 which is comparison to the table value is significant at 0.01 level of significance. The results indicates that hypothesis 1, there is no significant difference in the achievement in mathematics of high mathematical creativity groups taught through think- pair- share strategy and conventional teaching strategy is rejected at 0.01 level of significance.

Table- 2: t- ratio of gain scores of average mathematical creativity group between experimental and control group

Variables	Experimental group			Control Group			SE_D	t- value
	N	Mean	SD	N	Mean	SD		
Gain Scores	20	16.12	3.21	20	12.25	1.38	0.78	4.96**

*Significant at 0.05 level **Significant at 0.01 level
(Critical Value 2.02 at 0.05 and 2.71 at 0.01 levels, df 38)

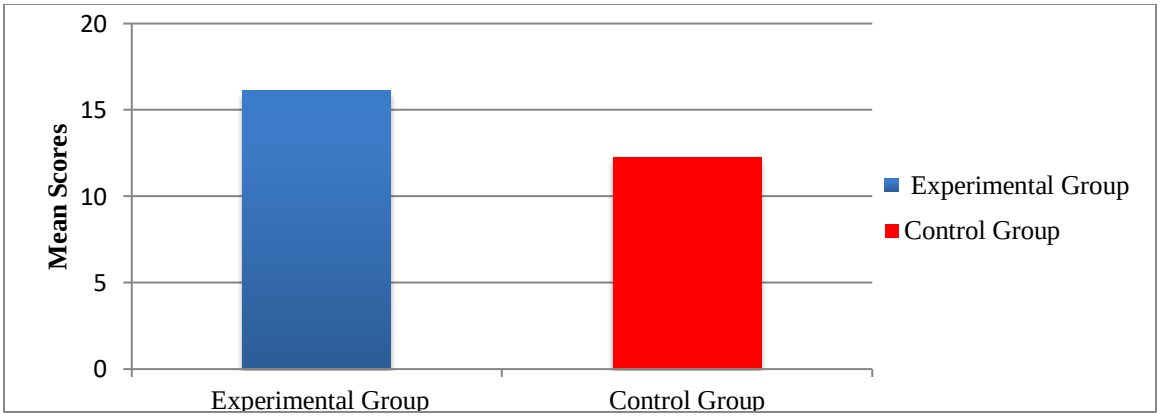

Fig 2: Showing mean gain scores of average mathematical creativity group between experimental and control group

Table 2 and figure 2 observes that mean gain score of average mathematical creativity group of experimental is 16.12 which is higher than average mathematical creativity group of 12.25 of control group. The t- value testing the significance of mean differences of think- pair- share strategy and conventional teaching strategy is 4.96 which is comparison to the table value is significant at 0.01 level of significance. The results indicates that hypothesis 2, there is no significant difference in the achievement in mathematics of average mathematical creativity

groups taught through think- pair- share strategy and conventional teaching strategy is rejected at 0.01 level of significance.

Table- 3: t- ratio of gain scores of low mathematical creativity group between experimental and control group

Variables	Experimental group			Control Group			SE_D	t- value
	N	Mean	SD	N	Mean	SD		
Gain Scores	11	13.12	2.16	11	11.23	1.85	0.85	2.22*

*Significant at 0.05 level **Significant at 0.01 level
(Critical Value 2.09 at 0.05 and 2.84 at 0.01 levels, df 20)

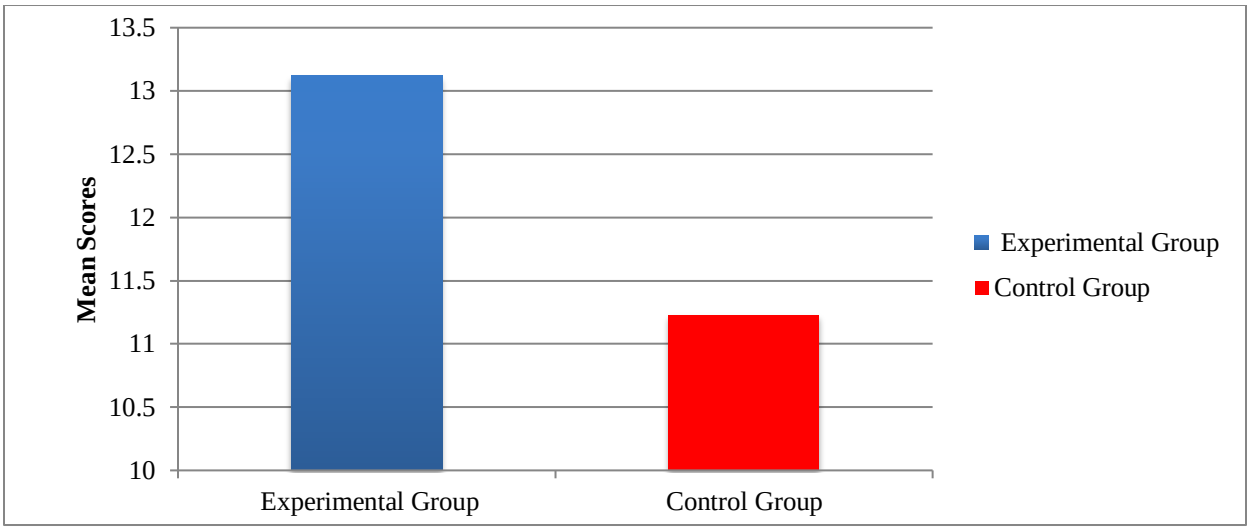

Fig. 3: Showing mean gain scores of low mathematical creativity group between experimental and control group

Table 3 and figure 3 observes that mean gain score of low mathematical creativity group of experimental is 13.12 which is higher than low mathematical creativity group of 11.23 of control group. The t- value testing the significance of mean differences of think- pair- share strategy and conventional teaching strategy is 2.22 which is comparison to the table value is significant at 0.05 level of significance. The results indicates that hypothesis 3, there is no significant difference in the achievement in mathematics of low mathematical creativity groups taught through think- pair- share strategy and conventional teaching strategy is rejected at 0.05 level of significance.

Thus it may be concluded that the use of think- pair- share strategy in mathematics attributed to the development of differences in mean gain achievement scores in mathematics.

ANALYSIS OF VARIANCE

Table- 4: The mean of different sub groups, sum of squares, degree of freedom, mean of sum of squares and F- ratio have been presented

Source of variance	Sum of Squares	df	Mean sum of squares	F- ratio
Think- Pair- Share Strategy (A)	102.01	1	102.01	14.51**
Mathematical Creativity (B)	45.73	2	22.86	3.25*
Interaction (AxB)	15.02	2	7.51	1.07
Error	548.32	78	7.03	

*Significant at 0.05 level **Significant at 0.01 level
(Critical Value 3.96 at 0.05 and 6.96 at 0.01 levels, df 1/78)
(Critical Value 3.11 at 0.05 and 4.88 at 0.01 levels, df 2/78)

Main Effect
Think- Pair- Share Strategy (A)

Table 4.4 reveals that the F- ratio for difference in mean gain scores of think- pair- share strategy and conventional teaching strategy group is 14.51, which in comparison to the table value is found significant at 0.01 level of significance. It shows that the groups are not different beyond the contribution of chance. The results indicates that the performance of think- pair- share strategy is more effective than that of the conventional teaching strategy group in mathematics.

In order to probe deeper, F- ratio is followed by t- test to compare the achievement of group taught through think- pair- share strategy and conventional method. The achievement scores of students in both the group have been described in table 4.5

Table- 5: t- ratio of gain scores of experimental and control group

Variables	Experimental group N Mean SD	Control Group N Mean SD	SE_D	t- value
Gain Scores	42 14.82 2.63	42 11.87 1.52	0.46	6.41**

*Significant at 0.05 level **Significant at 0.01 level
(Critical Value 1.99 at 0.05 and 2.64 at 0.01 levels, df 82)

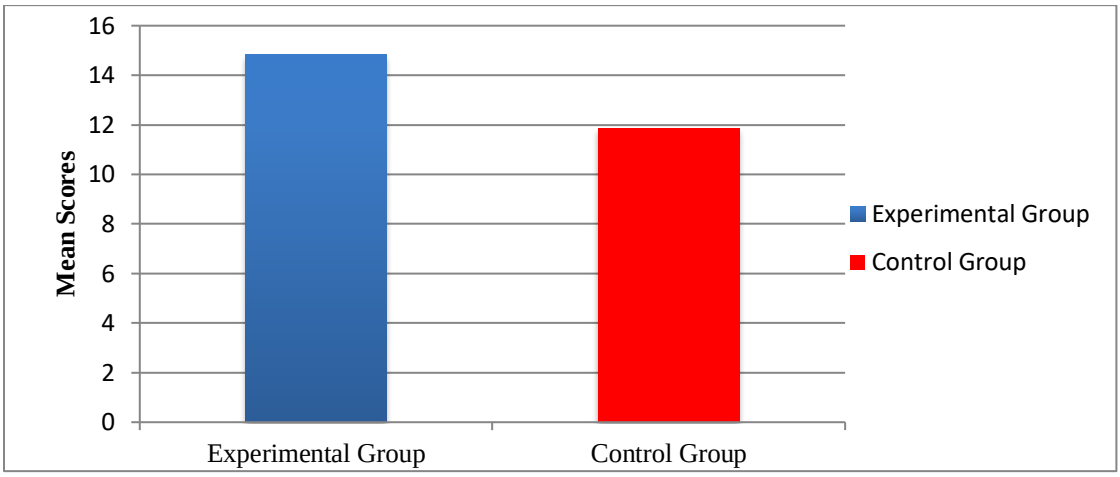

Fig. 4: Showing mean gain scores of experimental and control group

Mathematical Creativity (B)

Table 4 shows that F- ratio for difference in mean gain scores of the three groups of mathematical creativity 3.25, which in comparison to the table value is found significant at 0.05 level of significance. It suggests that the three groups of mathematical creativity are different with respect of achievement scores. The results indicates that the performance of students in mathematics taught through think- pair- share strategy has significant differences for high, average and low mathematical creativity groups.

In order to probe deeper, the F- ratio was followed by t- test. The value of the t- ratio for different combinations of mathematical creativity level have been given in table- 6

Table- 6: t- ratio for different combinations of mathematical creativity levels

Mathematical Creativity Level	**High Mathematical Creativity**			**Average Mathematical Creativity**			**Low Mathematical Creativity**		
	N	Mean	SD	N	Mean	SD	N	Mean	SD
	22	13.68	2.07	40	14.18	2.46	22	12.17	1.70
High Mathematical Creativity N Mean SD 22 13.68 2.07	-			0.86			2.69*		
Average									

Mathematical Creativity N Mean SD 40 14.18 2.46	-	-	3.79*
Low Mathematical Creativity N Mean SD 22 12.17 1.70	-	-	

*Significant at 0.05 level **Significant at 0.01 level
(Critical Value 2.00 at 0.05 and 2.66 at 0.01 levels, df 60)
(Critical Value 2.02 at 0.05 and 2.71 at 0.01 levels, df 42)
(Critical value 1.99 at 0.05 and 2.64 at 0.01 levels, df 78)

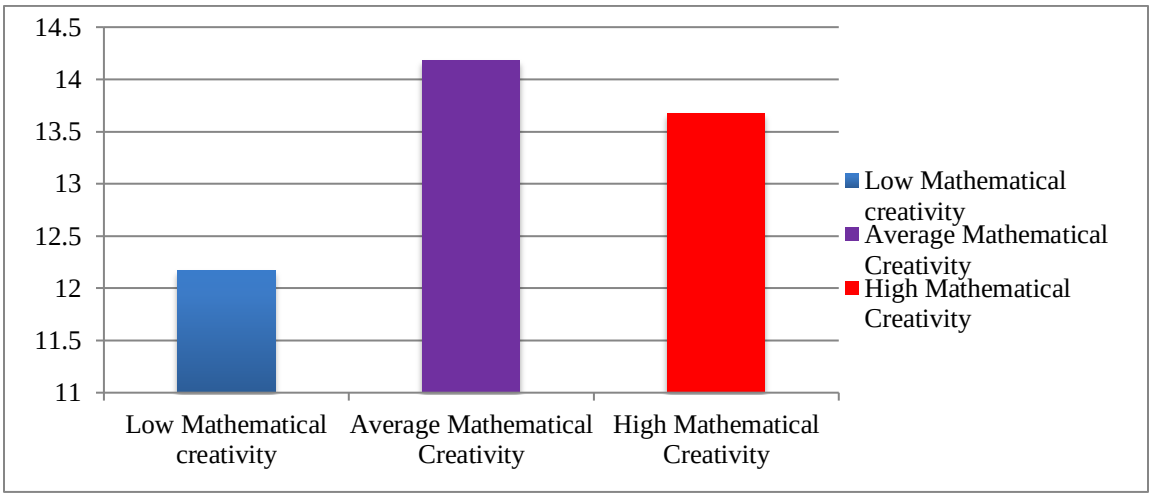

Fig. 5: Showing mean gain scores for different levels of Mathematical Creativity

Table - 6 and figure 5 shows that the t-ratio for the difference in gain mean scores of high and average mathematical creativity groups is 0.86, which in comparison to the table value is not found significant even at 0.05 level of significance. Hence, the hypothesis of significant differences is accepted in case of high and average mathematical creativity irrespective of grouping across other variable. The result indicates that high mathematical creativity and average mathematical creativity group was not significantly different with respect of gain scores.

Table - 6 and figure 5 shows that the t-ratio for the difference in gain mean scores of high and low mathematical creativity groups is 2.69, which in comparison to the table value is found significant at 0.05 level of significance. Hence, the hypothesis of significant differences is rejected in case of high and low mathematical creativity irrespective of grouping across other variable. This infers that high mathematical creativity group performs significantly better than

that of low mathematical creativity group on achievement in mathematics with respect of gain scores.

Table - 6 and figure 5 shows that the t-ratio for the difference in gain mean scores of average and low mathematical creativity groups is 3.79, which in comparison to the table value is found significant at 0.05 level of significance. Hence, the hypothesis of significant differences is rejected in case of average and low mathematical creativity irrespective of grouping across other variable. This infers that average mathematical creativity group performs significantly better than that of low mathematical creativity group on achievement in mathematics with respect of gain scores.

Interaction Effect (A × B)

Table - 4 reveals that the F- ratio for the interaction effect between think- pair- share strategy and mathematical creativity groups is 1.07, which in comparison to the table value is 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 is no significant interaction effect between think-pair- share strategy and mathematical creativity groups on achievement in mathematics* is accepted. The result indicates that the think- pair- share strategy group and mathematical creativity group does 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 think- pair- share strategy yields that higher levels of achievements in mathematics as compared to the conventional teaching strategy groups. The findings of Althelab and Omar (2013) aimed at knowing the impact of (think – pair – share) strategy on the achievement of second grade intermediate female students in mathematics and their reasoning thinking. the results have revealed the following: the superiority of the experimental group who studied according to (think – pair – share) strategy to the control group in achievement and reasoning think. Awaid and Abood (2014) the research aims to know the effect of (Think-pair-share) strategy on the students' achievement and the improvement of students' attitude toward chemistry. Salman (2015) aims to know the effectiveness of the strategy (think-pair-share) in improving the collection of the pupils and retaining them and instilled in their minds through individual reflection and sharing with others and put the researcher some proposals and recommendations that are described by the research. Ahmad (2016) identified the effect of (think Pair Share) and (Sequenced Questions) Strategies on Fifth Primary Students Achievement and retention at Sciences. Gok (2018) investigated the effects of think pair share (TPS) instructional strategy on students' conceptual learning and epistemological beliefs on physics and physics learning. Gafoor (2012) concluded that the strategy of (Think-Match-Participate) participated in student’s acquisition for mathematical concepts and this strategy participated in students’ participation in problem solving during the lesson.

The findings of Kim and Lee (2001) examined the importance of developing creativity in mathematics class by examining the theoretical base of creativity and its relationship to mathematics. Mann (2009) explored the relationship between mathematical creativity and mathematical achievement, attitude towards mathematics, self-perception of creative ability, gender, and teacher perception of mathematical talent and creative ability. Githua and Njubi (2013) determined the effects of using mathematical creativity enhancing learning/teaching strategy on learners' mathematics achievement by gender. The researchers concluded that MCETS is an effective teaching/learning strategy which mathematics teachers need to incorporate in their teaching.

Findings

1. The performance of high mathematical creativity group taught through think-pair-share was found more effective than that taught through conventional teaching strategy group in mathematics**.**
2. The performance of average mathematical creativity group taught through think-pair-share was found more effective than that taught through conventional teaching strategy group in mathematics**.**
3. The performance of low mathematical creativity group taught through think-pair-share was found more effective than that taught through conventional teaching strategy group in mathematics**.**
4. There was no significant interaction effect was found between think-pair-share and mathematical creativity groups.

Conclusion

The present study has reached to the conclusion that through think-pair-share, achievement in mathematics is enhanced. Particularly high and average mathematical creativity students are more prone to involve through think-pair-share in mathematics. It proves that this instructional strategy is more effective for average and high mathematical creativity students. While using conventional teaching strategy, average mathematical creativity group is more involved in mathematics.

Educational Implications

Think- pair- share strategy plays an important role to improve the achievement of students in mathematics because:

1. This method helps students to increase their confidence in their mathematics abilities and ability to contribute in class discussion.
2. This technique makes students more comfortable with the content they enjoy more and this is easier for them to understand.
3. The fluid nature of group formation makes this technique very effective and popular for use by instructors of large classes.

4. Full class discussion is generally more fruitful after a think-pair-share and throughout the semester as the frequent use of such activities generally improves student comfort levels and willingness to participate throughout a class period.
5. This technique can be more useful for high mathematical creativity group and average mathematical creativity group.
6. This technique is successful for the students of secondary level.
7. Teacher should be motivated by the head of the institutes to use think- pair- share strategy.
8. Teacher should be given training in the proper use of think- pair- share strategy by organizing seminars/workshops as think- pair- share strategy has shown better results than conventional teaching.
9. Think- pair- share strategy helps the teacher to increase their efficiency in teaching.
10. Teacher should use think- pair- share strategy in class room teaching to make learning more effective.

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