International Journal of Research Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 07
March 2018

# Raising Mathematical Achievement and Retention Through Co-Operative Learning Strategies (Stad and Tai)

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## Abstract

The aim of co-operative learning for learners is to maximize their own and each other's learning, with members striving for joint benefit. Co-operative learning due to its influential aspects is the most prevalent teaching-learning technique in the modern world. Therefore as a prelude, the investigators aimed at studying the effect of co-operative learning strategies i.e. Team Assisted Individualisation (TAI) and Student Teams Achievement Division (STAD) on the Mathematics achievement and retention among ninth graders at two levels of intelligence. This is an experimental study with 3x2 factorial design. Students of ninth standard of the schools affiliated to Haryana Board in Rohtak city situated in Haryana State of India constituted the population of the study. 144 students of ninth standard with high and low intelligence selected through multi-stage random sampling technique were taken as a sample for the study out of which 52 students taught through TAI formed Experimental group-1 ($E_1$ ); 46 students taught through STAD formed Experimental Group-2($E_2$) and 46 students taught through conventional method of teaching formed control group(C ). Sample of the students were also equated on the basis of socio-economic status and achievement in the subject concerned. The investigators applied General Intelligence Test (GIT) by S. M. Mohsin and Socio-Economic Status Scale Questionnaire (SESSQ) by S.D. Kapoor to measure the intelligence and the socio-economic level of students respectively. Achievement test in Mathematics developed and standardized by the investigators was used to assess the achievement of the subjects. Lesson plans, Worksheets, Check-outs and Formative tests were developed for both the strategies TAI and STAD separately to carry out the teaching and learning process in all the three groups for ten weeks only. At the end of the experiment, achievement test in Mathematics was given to the subjects. After a gap of twenty days, achievement test was again administered on the same students of all the three groups to assess the retention of learned material. Data were analyzed by using ANOVA and t-test to determine the performance by comparing the mean scores of all the groups. Data analysis revealed that experimental group-1 and experimental group-2 outscored significantly the control group on post-test showing the obvious supremacy of co-operative learning over conventional method of teaching. However, it was also revealed that students taught through TAI showed significant improvement in their achievement as well as retention in Mathematics than the students taught through STAD. Further, high and low intelligent students taught through co-operative learning strategies TAI and STAD performed and retained better than their counterparts taught through conventional method of teaching. Hence, the ultimate result of the study indicated that co-operative learning was more effective instructional paradigm for mathematics as compared to conventional method of teaching. Furthermore, co-operative learning appeared favourable for both high intelligent and low intelligent students but low intelligent students benefitted more when they taught through co-operative learning strategies. It was concluded that co-operative learning is an effective approach which need to be incorporated in teaching Mathematics.

**Key Words: Co-operative Learning Strategies, Achievement, Retention, Intelligence**

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e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 07
March 2018

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## Introduction

In the ideal classroom, all students would learn how to work cooperatively with others, compete for fun and enjoyment, and work autonomously on their own. The teacher decides which goal structure to implement within each lesson. The most important goal structure, and the one that should be used the majority of the time in learning situations, is cooperation. The researches done by Johnson, Johnson, and Stanne (2000) showed that co-operative learning is essential for maximizing learning and ensuring healthy cognitive and social development as well as many other important instructional outcomes. Academic achievement of students has been found to be enhanced by the use of co-operative learning (Lampe, Rooze & Tallent-Runnels, 1998; Johnson & Johnson, 1989; Slavin, 1990, 1991; Webb, 1989). Changing the way we teach and what we teach in Mathematics is a continuing professional concern. Many educators have recognized "co-operative learning" as a beneficial teaching-learning technique for teaching Mathematics.

Co-operative learning represents the most carefully structured end of the collaborative learning continuum, where instruction involves small groups of students who work together to maximize their own and each other's learning with the group's learning being structured around precisely defined tasks or problems (Smith & MacGregor, 1992). Co-operative learning is based on the theory of social interdependence, which focuses on the effect of various types of co-operative, competitive and individualistic goal structures (Johnson & Johnson, 1999; Johnson, Johnson, & Smith, 1998; Slavin, 1996). The type of social inter-dependence created by goal specification determines how individuals act and interact in a situation which in turn affects the outcome of that interaction. Social inter-dependence can be positive, negative, or neutral. Positive goal inter-dependence exists where learning is co-operative. Students cooperate and perceive that their own chance of success is increased by the success of other students. In contrast, negative inter-dependence is created in competitive learning environment where students compete with each other and perceive that their chances of success are diminished by the success of fellow students. Neutral inter-dependence is when students learn in an individualistic manner such that success in one student is independent of success in other students. Johnson and Johnson (1999) presented five essential features that define co-operative learning as an instructional activity. First, co-operative learning involves face-to-face interaction where students actively participate with one another in contributing to group performance. The second element is individual accountability which involves participants being responsible for their share of the work and helps to prevent unequal individual contribution. Third, students must possess interpersonal and small-group skills that are necessary for quality co-operative learning and must be motivated to use these skills. Group processing, the fourth key element, requires members to monitor goal achievement and can be fostered by instructors who set specific rather than vague goals, allow sufficient time for group

work, and issue clear expectations about group performance. The last and most important feature is positive inter-dependence which involves students cooperating, supporting, and helping one another to be successful. This element can be accomplished through the setting of mutual learning goals, with students learning the assigned material and making sure their peers do the same (goal interdependence), having students share resource materials (resource inter-dependence), establishing group rewards (reward interdependence), or any combination of these.

Johnson, Johnson and Stanne (2000) stated that the combination of theory, research, and practice makes co-operative learning a powerful learning procedure. Different types of co-operative learning methods are being used in teaching different subjects. Student Teams Achievement Divisions (STAD), Teams-Games-Tournaments (TGT), and Jigsaw-II are general co-operative learning strategies adaptable to most subjects and grade levels. However Co-operative Integrated Reading and Composition (CIRC) for reading and writing instruction and Team Assisted Individualization (TAI) for Mathematics are comprehensive curricula designed strategies. All the five methods incorporate team rewards, individual accountability, and equal opportunities for success, but in different ways. In the present investigation, only two strategies of co-operative learning i.e. Student Teams Achievement Divisions (STAD) and Team Assisted Individualization (TAI) have been employed.

**Student Teams Achievement Divisions (STAD)** is a good model to begin with for teachers who are new to the co-operative approach. The main purpose of student team achievement divisions is to motivate students to encourage and help each other to master skills presented by the teacher. Students work together after the teacher's lesson. They work with their teammates, assessing their strengths and weaknesses to help them succeed on the quizzes. Individual accountability motivates students to do a good job explaining to each other, as the only way for the team to succeed is for all team members to master the information or skills being taught. Because team score are based on students' improvement over their own past records (equal opportunities for success), all students have the chance to be a team "star" in a given week, either by scoring well above their past record or by getting a perfect paper which always produces a maximum score regardless of students' past averages. Iqbal (2004) investigated the positive impact of the student teams achievement division (STAD) on students' Mathematics achievement and retention in high schools. Krishanaraj and Kalaiyarsan (2004) studied the 'STAD approach with reward' more effective than the traditional approach in developing self-esteem of learners whereas Sharma & Sharma (2009) too revealed that performance of students was found better through the use of co-operative learning method STAD. Gupta & Pasrija (2011) also revealed the efficacy of cooperative learning on achievement in mathematics. Ling, Ghazali & Raman (2016) depicted that STAD cooperative learning techniques play important roles as an active pedagory to increase Mathematics achievement. STAD encourages the students and teachers to be

innovative and creative to improve teaching and learning of Mathematics in the classroom. These benefit the students and enable them to compete healthily with the other students from urban areas in Mathematics.

**Team Assisted Individualization (TAI)** is specifically designed to teach Mathematics. Individual accountability, equal opportunities for success and motivational dynamics are the main features of this method. Individualization is an important part of TAI which makes it quite different from others. Students enter an individualized sequence according to a placement test and then proceed as their own pace. In mathematics, most concepts build on earlier ones. If the earlier concepts were not mastered, the later ones will be difficult or impossible to learn; a student who cannot subtract or multiply will be unable to master long division, a student who does not understand fractional concepts will be unable what a decimal is, and so on. In TAI students work at their own levels, so if they lack prerequisite skills they can build a strong foundation before going on. Also, if students can progress more rapidly, they need not wait for the rest of the class. Oishi, Slavin, and Madden (1983) found positive effects of TAI on cross-racial nominations on two sociometric scales. In a similar study, Oishi (1983) found significantly positive effects of TAI on cross-racial ratings of smart and on reductions in ratings of not nice. The two TAI studies conducted by Slavin, Leavy, and Madden (1984) used teacher ratings of students classroom behaviour and found significant higher ratings for TAI students. Gupta & Pasrija (2011) also revealed the effectiveness of Team Assisted Individualisation (TAI) on achievement and retention in mathematics.

Bramlett (1994), Megnin (1995) and Webb, Trooper, and Fall (1995) in their contributions noted that co-operative learning activity engages the student in the learning process and seeks to improve the critical thinking, reasoning, and problem-solving skills of the learner. While research efforts on co-operative-learning indicated that it enhances student achievement (Johnson & Johnson 1989; Slavin 1990; 1991; Webb 1989). Lampe, Rooze and Tallent-Runnels (1998) stated that peer interaction is central to the success of co-operative learning as it relates to cognitive understanding. Lampe et al (1998) emphasized that learners, some of who might normally "turn out" or refuse to speak out in a traditional setting, become actively involved in the learning process through group interaction. Stahl and Vansickel (1992) reported that every co-operative-learning strategy, when used appropriately, can enable students to move beyond the text, memorization of basic facts, and learning lower level skills. This method which results in cognitive restructuring leads to an increase in understanding of all students in a co-operative group. Apart from academic benefits, co-operative learning has been found to promote self-esteem, interpersonal relationship and improved attitude toward school and peers (Johnson & Johnson, 1996).The powerful effects of co-operative learning on so many important outcomes separate it from other instructional methods and make it one of the most important tools.

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 07
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Research has shown that co-operative learning techniques promote student learning and academic achievement, increase student retention, enhance student satisfaction with their learning experience, help students develop skills in oral communication, develop students' social skills. Most students feel anxious when taking Mathematics classes. Mathematics anxiety, as in any other subject, is multifaceted. Fiore (1999) explained that inter-connectivity of personal, social, environmental and pedagogical factors causes an individual to develop mathematics anxiety. While social and environmental factors play a role in the development of mathematics anxiety, the way mathematics is taught and the content of mathematics lessons are the two major areas that most directly affect mathematics learning and teaching in schools (Martinez and Martinez, 2003). However co-operative learning creates an environment that decreases mathematics anxiety and fear of failure by encouraging them to take appropriate risks since learning mathematical concepts and skills is not a passive process. In co-operative learning environment, students tend to enjoy mathematics and this motivates them more to learn mathematics (Johnson and Johnson, 1989).

Although a number of empirical studies have been conducted on co-operative learning abroad, a very few have been conducted in classrooms of India. So, the purpose of the present study is to help bridge this gap in this research literature by investigating the effect of co-operative learning on achievement and retention in mathematics among ninth grade students in relation to intelligence.

## Objectives of the Study

The study asserts to meet the following objectives:

1. To compare the achievement scores in mathematics of three groups ($E_1$, $E_2$ and C) of ninth graders to be taught through co-operative learning strategies TAI, STAD and conventional method before experimental treatment.
2. To compare the achievement scores in mathematics of three groups of high intelligence ($HIE_1$, $HIE_2$ and HIC) and three groups of low intelligence ($LIE_1$, $LIE_2$ and LIC) of ninth graders to be taught by co-operative learning strategies TAI, STAD and conventional method before experimental treatment.
3. To compare the achievement scores in mathematics of three groups ($E_1$, $E_2$ and C) of ninth graders taught through co-operative learning strategies TAI, STAD and conventional methods after experimental treatment.
4. To study the effectiveness of three instructional treatments on three groups ($E_1$, $E_2$ and C) of ninth graders in mathematics at the two levels (high and low) of intelligence after experimental treatment.

5. To compare the gain achievement and retention scores in mathematics of three groups ($E_1$, $E_2$ and C) of ninth graders taught through co-operative learning strategies TAI, STAD and conventional method.
6. To study the effectiveness of co-operative learning strategies on three groups ($E_1$, $E_2$ and C) of ninth graders in mathematics at the two levels (high and low) of intelligence in terms of gain achievement and retention scores.

## Design of the Study

The present study is an experimental study with 3x2 factorial designs. Achievement and retention of students in mathematics were treated as dependent variables while instructional treatment and intelligence were treated as independent variables in this study. Instructional treatment was studied at three levels namely experimental group-1 ($E_1$) which was taught mathematics through co-operative learning strategy-Student Teams Achievement Division (STAD), experimental group-2 ($E_2$) which was taught mathematics through co-operative learning strategy-Team Assisted Individualization and control group (C) which was taught mathematics through conventional method. Further, intelligence was studied at two levels viz. high intelligence (HI) and low intelligence (LI).

## Sample

Initially, a sample of 297 students was selected through multistage random sampling which constituted the successive random sampling of regions, schools and students (three stages). All the 297 students were divided on basis of their intelligence (high, moderate and low). 52 students (29 of high intelligence and 23 of low intelligence) formed experimental group-1 ( $E_1$ ), 46 students (18 of high intelligence and 28 of low intelligence ) formed experimental group-2 ( $E_2$ ), and 46 students (16 of high intelligence and 30 of low intelligence ) formed control group (C) . In this way, 144 students having IQ > 113 and IQ < 100 were considered as high and low intelligent students respectively. Keeping in view the basic requirement of co-operative learning strategies, 153 students of moderate intelligence were also taught in the classes. However, the sample was also equated on the basis of socio-economic status and achievement in the subject concerned.

## Tools used

- **General Intelligence Test (GIT) by Mohsin** was used to measure the intelligence of students. It is verbal intelligence test made for students of age group 9-15 years. It consists of 156 items under 6 sub-tests. These items pertain to logical reasoning, analogies, similarities, odd-one out and language ability. The time limit for this test is 40 minutes. The reliability of the test by split-half method is 0.95 and by test-retest method is 0.89.The validity of this scale was determined by finding correlation of scores with those on the standardized tests.

- **Socio-Economic Status Scale Questionnaire (SESSQ) by S.D. Kapoor** was used to measure the socio-economic level of students. The reliability calculated by test-retest method was found to be 0.89. For determining the validity, correlation of scores on this scale with other standardized scale was found to be 0.92.
- **Mathematics Achievement Test:** To measure academic achievement, the investigators developed a mathematics achievement test. The items in this test were determined according to the topics (Co-ordinate Geometry, Probability and Statistics). The coefficient of reliability of the test measured by test-retest method was found to be 0.90. The test was found to possess content validity as there was correspondence between the table of specifications and test items.
- **Instructional Material:** Co-operative Learning Lesson Plans, Worksheets, Check-outs and Formative Tests in mathematics were developed to execute the Instructional Treatment. All the instructional material was subjected to two types of evaluation, self evaluation and expert appraisal. Self evaluation was carried out to check the relevance of the content matter to the objectives of the study. In the expert appraisal, comments and suggestions of mathematics experts were taken. All the experts had a close agreement that selected content matter was according to objectives of the study.

## Procedure for Data Collection

The whole experiment was conducted in the four phases which is shown below in the tabular form.

**Table-1**
**Schematic Procedure of the Experiment**

| Phase | Experimental Group-1 | Experimental Group- 2 | Control Group |
|---|---|---|---|
| Pre-Test Phase | Measurement of<br>1. Intelligence<br>2. SES<br>3. Achievement in Mathematics | Measurement of<br>1. Intelligence<br>2. SES<br>3. Achievement in Mathematics | Measurement of<br>1. Intelligence<br>2. SES<br>3. Achievement in Mathematics |
| Treatment Phase | Teaching Mathematics through STAD for 10 weeks | Teaching Mathematics through TAI for 10 weeks | Teaching Mathematics through Conventional Method for 10 weeks |
| Post-Test Phase | Measurement of Achievement in Mathematics | Measurement of Achievement in Mathematics | Measurement of Achievement in Mathematics |
| Retention Test Phase | Measurement of Achievement in Mathematics after 20 days | Measurement of Achievement in Mathematics after 20 days | Measurement of Achievement in Mathematics after 20 days |

## Statistical Techniques Used

1. Descriptive statistics such as mean and S.D. were worked out on the scores of achievement and retention.
2. Two way Analysis of variance ( ANOVA) with 3x2 factorial design was employed to study the main effects and interactional effects of independent variables (treatments and intelligence) on dependent variables (achievement and retention) supplemented by t-test. To test the assumption of homogeneity of variance for ANOVA, Hartley's test was employed.

## Results and Discussion

In order to examine the effects of co-operative learning strategies TAI and STAD on the achievement and retention in mathematics among the ninth graders in relation to intelligence, two way analysis of variance (ANOVA) was employed. For testing the homogeneity of variance, Hartley's Test was applied which revealed that all the concerned groups were having similar or equal variances. The summary of ANOVA for pre test scores, post test scores, gain scores and retention scores has been presented below.

### Comparison of Achievement Scores in Mathematics (Before Experimental treatment)

ANOVA was applied to find out the difference in the achievement test scores of the students of the three groups Experimental Group-1 ($E_1$), Experimental Group-2 ($E_2$) and Control Group (C) before giving the experimental treatment. The results are given in Table-2.

**Table-2**

**F-value for Pre-Test Achievement Scores in Mathematics for the groups $E_1$, $E_2$, and C**

| Sources of Variance | df | SS | MS | F- value |
|---|---|---|---|---|
| Between | 2 | 177.86 | 88.93 | 1.78 (NS) |
| Within | 141 | 7044.36 | 49.96 | |
| Total | 143 | 7222.22 | | |

NS: Not Significant

F-value (1.78) vide Table-2 for the difference in pre-test achievement scores of the three treatment groups $E_1$, $E_2$ & C (15.5, 16.23, 15.8) was found to be not significant which clearly shows that initially the three groups were similar in their performance.

### Comparison of Achievement Scores in Mathematics of the three Groups of High Intelligence and three Groups of Low Intelligence (before Experimental Treatment)

ANOVA was applied to find out the difference in the achievement scores of the three groups of high intelligence ($HIE_1$, $HIE_2$, and HIC) and three low intelligence groups ($LIE_1$, $LIE_2$, and LIC) of

Experimental Group-1 ($E_1$), Experimental Group-2 ($E_2$) and Control Group (C) before experimental treatment.

**Table-3**
**F-value for the Pre-Test Achievement Scores in Mathematics for the three Groups of High Intelligence(HI) and three Groups of Low Intelligence(LI)**

| Sources of Variation | df | | SS | | MS | | F-value | |
|---|---|---|---|---|---|---|---|---|
| | HI | LI | HI | LI | HI | LI | HI | LI |
| Between Groups | 2 | 2 | 31.24 | 3.22 | 15.62 | 1.61 | 1.37 | 0.16 |
| Within Groups | 54 | 84 | 615.6 | 844.7 | 11.4 | 10.05 | (NS) | (NS) |
| Total | 56 | 86 | 646.84 | 847.92 | | | | |

F-value 1.37 & 0.16 vide Table-3 for the difference in pre-test scores of achievement in mathematics for three groups of high intelligence $HIE_1$, $HIE_2$ , HIC (19.34, 21.08, 20.52) and three groups of low intelligence $LIE_1$, $LIE_2$, LIC (11.66, 11.38, 11.08) to be taught through co-operative learning strategies TAI, STAD and conventional method before experimental experiment was found to be not significant.

## Effect of Co-operative Learning Strategies TAI and STAD on Achievement (After Experimental Treatment)

After giving experimental treatment, the three groups were again administrated achievement test in mathematics. The scores were treated as post-test scores and subjected to two way ANOVA with 3x2 factorial design which is reported in Table-4.

**Table-4**
**Summary of ANOVA for Post-Test Achievement Scores in Mathematics**

| Sources of Variation | df | SS | MS | F-value |
|---|---|---|---|---|
| Treatment | 2 | 9173.58 | 4586.79 | 330.6** |
| Intelligence | 1 | 102.36 | 102.36 | 7.38** |
| Treatment x Intelligence | 2 | 4410.31 | 2205.15 | 158.98** |
| Error | 138 | 1914.3 | 13.87 | |

** Significant at 0.01 level

## Main Effect

### Treatment

F-ratio vide Table-4 for the difference in post-test scores of the three groups is 330.6 which is highly significant at 0.01 level leading to the inference that experimental treatment yielded difference in achievement scores in mathematics. To investigate further, the 't'-values were computed and have been given in Table-5.

Table-5
't'-values for the Post-Test Achievement Scores of $E_1$ , $E_2$ and C

| Group | N | | Mean | | S.D. | | 't'- value |
|---|---|---|---|---|---|---|---|
| $E_1$ vs $E_2$ | 52 | 46 | 46.81 | 42.22 | 3.78 | 3.55 | 6.28** |
| $E_1$ vs C | 52 | 46 | 46.81 | 28.14 | 3.78 | 2.91 | 27.86** |
| $E_2$ vs C | 46 | 46 | 42.22 | 28.14 | 3.55 | 2.91 | 21.01** |

*Significant at 0.01 level

Table-5 reveals that 't'-values (6.28, 27.86, 21.01) for the different groups are significant at 0.01 level. Whicker et al. (1997) investigated the effects of co-operative learning on students' achievement and attitude in secondary mathematics classroom. It was found that students in co-operative learning group had significant higher test scores than students in the comparison group. Kaul (2010) also revealed that co-operative learning method is more effective than traditional teaching methods while Chabra and Tabassum (2010) revealed about efficacy of the co-operative learning as knowledge building situations in the Indian higher education classroom. Nurhayati, D.M. *and* Hartono (2017) concluded, the ability of understanding mathematical concepts students who use the cooperative learning model type STAD with RME approach better than students using the regular learning.

**Intelligence**

F-value 7.38 vide Table-4 for the difference in post-test scores on achievement of students with high and low intelligence (42.74, 35.37) is significant at 0.01 level. It means that high intelligent group performed better than low intelligent group after being exposed to experimental treatments, which is in accordance with the common truth that intelligence affects the achievement. It would be possible to argue that high intelligent could be held back by having to explain material to their low intelligent group mates. However, it would be equally possible to argue that because students who give elaborated explanations typically learn more than those who receive them.

**Interaction Effect (Treatment X Intelligence)**

The F-value (Table-4) for the interaction between treatment and intelligence for post-test achievement scores is 158.98 which is highly significant at .01 level leading to the inference that two variables interact with each other. To investigate further, the 't'-values were computed.

Table-6

't'-values for the Post-Test Achievement Scores in Mathematics of Different Combination Groups for Treatment x Intelligence

| Group | N | Mean | S.D. | 't'- values |
|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| $HIE_1$ vs $LIE_1$ | 23 | 29 | 48.23 | 45.4 | 4.48 | 3.08 | 2.56* |
| $HIE_2$ vs $LIE_2$ | 16 | 30 | 43.75 | 40.7 | 4.95 | 2.15 | 2.36* |
| HIC vs LIC | 18 | 28 | 36.25 | 20.03 | 3.20 | 2.63 | 17.9** |
| $HIE_1$ vs $HIE_2$ | 23 | 16 | 48.23 | 43.75 | 4.48 | 4.95 | 2.9** |
| HIC vs $HIE_1$ | 18 | 23 | 36.25 | 48.23 | 3.20 | 4.48 | 9.9** |
| $HIE_2$ vs HIC | 16 | 18 | 43.75 | 36.25 | 4.95 | 3.20 | 5.17** |
| $LIE_1$ vs $LIE_2$ | 29 | 30 | 45.4 | 40.7 | 3.08 | 2.15 | 6.8** |
| LIC vs $LIE_1$ | 28 | 29 | 20.03 | 45.4 | 2.63 | 3.08 | 32.94** |
| $LIE_2$ vs LIC | 30 | 28 | 40.7 | 20.03 | 2.15 | 2.63 | 32.96** |

* Significant at 0.05 level ** Significant at 0.01 level

A look at table-6 indicated that't'-values for difference of post-test achievement scores between high and low intelligent students of all the three groups( $E_1$ , $E_2$ & C) are found to be significant. When the mean scores of high intelligence sub-groups/low intelligence sub-groups of ($E_1$ , $E_2$ & C) are compared, 't'-values are found to be highly significant .

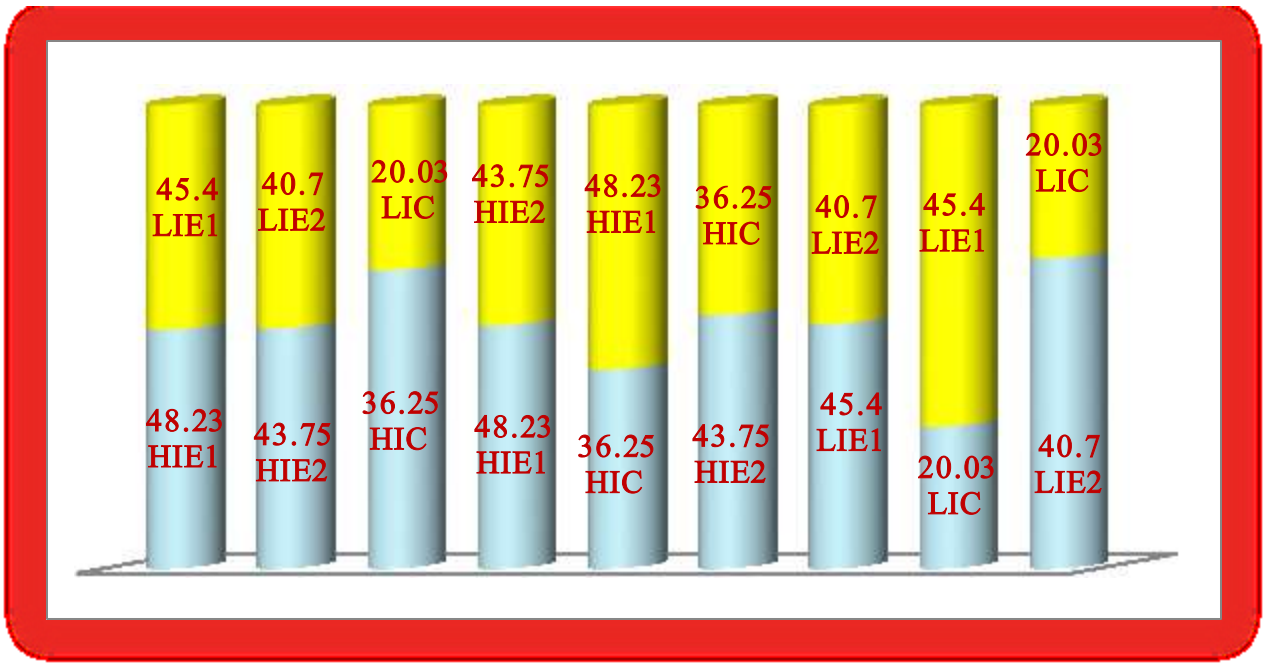


Fig.1: Mean Post-Test Achievement Scores in Mathematics of Different Combination Groups for Treatment x Intelligence

Effect of Co-operative Learning Strategies TAI and STAD on Achievement (After Experimental Treatment in Terms of Gain Achievement Scores)

The gain achievement scores in mathematics were subjected to two way Analysis of Variance with 3x2 factorial designs, the summary of which has been presented in Table-7.

**Table-7**

**Summary of ANOVA for Mean Gain Achievement Scores in Mathematics**

| Sources of Variation | df | SS | MS | F-values |
|---|---|---|---|---|
| Treatment | 2 | 2277.60 | 1138.8 | 215.7** |
| Intelligence | 1 | 41.18 | 41.18 | 7.8** |
| Treatment x Intelligence | 2 | 372.76 | 186.38 | 35.3** |
| Error | 138 | 728.64 | 5.28 | |

** Significant at 0.01 level

## Main Effect

### Treatment

F-value (215.7) vide Table-7 for the difference in the mean gain scores of three groups ($E_1$, $E_2$ and C) was found to be highly significant at 0.01 level. To investigate further, 't'-values were computed.

**Table-8**

**'t'-values for the Mean Gain Achievement Scores in Mathematics of $E_1$ , $E_2$ and C**

| Group | N | | Mean | | S.D. | | 't'- values |
|---|---|---|---|---|---|---|---|
| $E_1$ vs $E_2$ | 52 | 46 | 26.14 | 20.49 | 4.83 | 4.70 | 5.89** |
| $E_1$ vs C | 52 | 46 | 26.14 | 16.72 | 4.83 | 3.37 | 11.4** |
| $E_2$ vs C | 46 | 46 | 20.49 | 16.72 | 4.70 | 3.37 | 4.48** |

**Significant at 0.01 level

It is evident from Table-8 that't'- values for the difference between gain achievement scores of three groups( $E_1$ , $E_2$ & C) are significant at 0.01 level. This shows that Experimental Group-1 subjected to co-operative learning strategy TAI has achieved more than the Experimental Group-2 subjected to co-operative learning strategy STAD. Further the subjects exposed to co-operative learning strategy TAI & STAD attained higher than the subjects taught by conventional method of teaching. It is also concluded that TAI method is more effective than conventional method in raising the achievement level in Mathematics. Mehra and Thakur (2008) found that students exposed to co-operative learning yielded better gain in achievement scores as compared to those taught through conventional group learning. Wyk (2010) determined the positive effects of the co-operative learning approach on the achievement of content knowledge, retention, and attitudes of Economic education students toward the teaching method. Zakaria, Chin and Daud (2010) concluded that co-operative learning is an effective

approach, which Mathematics teachers need to incorporate in their teaching. Whereas Topping, Thurston, Tolmie, Christie, Murray and Karagiannidou (2011) established that use of co-operative learning increases pupil formulation of propositions, explanations.

### Intelligence

F-value (7.8) vide Table-7 for the difference in the mean gain scores on achievement of students with high and low intelligence (23.2 & 19.01) was found to be significant at 0.01 level. This shows that high intelligent students are more benefited by co-operative learning strategies. It may be argued that they worked as explainers and profited more. Studies have also shown that the students who gained the most from cooperative activities were those who provided elaborated explanations to others. The student who served as explainers learned more than those who received elaborated explanations.

### Interaction Effect ( Treatment x Intelligence )

The F-value (Table-7) for the interaction between treatment and intelligence for mean gain achievement scores is 35.3 which is significant at 0.01 level, leading to the inference that two variables interact with each other. To investigate further, t-test was applied to find out the difference in mean gain achievement scores of different combination groups.

**Table-9**

**'t'-values for the Mean Gain Achievement Scores in Mathematics of Different Combination Groups for Treatment X Intelligence**

| Groups | N | | Mean | | S.D. | | 't'-value |
|---|---|---|---|---|---|---|---|
| $HIE_1$ vs $LIE_1$ | 23 | 29 | 27.84 | 24.45 | 4.97 | 4.7 | 2.51* |
| $HIE_2$ vs $LIE_2$ | 16 | 30 | 22.34 | 18.65 | 4.6 | 4.81 | 2.52* |
| HIC vs LIC | 18 | 28 | 19.5 | 13.95 | 3.94 | 2.79 | 5.23** |
| $HIE_1$ vs $HIE_2$ | 23 | 16 | 27.84 | 22.34 | 4.97 | 4.6 | 3.57** |
| $HIE_1$ vs HIC | 23 | 18 | 27.84 | 19.5 | 4.97 | 3.94 | 6.04** |
| $HIE_2$ vs HIC | 16 | 18 | 22.34 | 19.5 | 4.6 | 3.94 | 1.93 (NS) |
| $LIE_1$ vs $LIE_2$ | 29 | 30 | 24.45 | 18.65 | 4.7 | 4.81 | 5.79** |
| $LIE_1$ vs LIC | 29 | 28 | 24.45 | 13.95 | 4.7 | 2.79 | 12.7** |
| $LIE_2$ vs LIC | 30 | 28 | 18.65 | 13.95 | 4.81 | 2.79 | 4.2** |

*Significant at 0.05 level ** Significant at 0.01 level NS: Not Significant

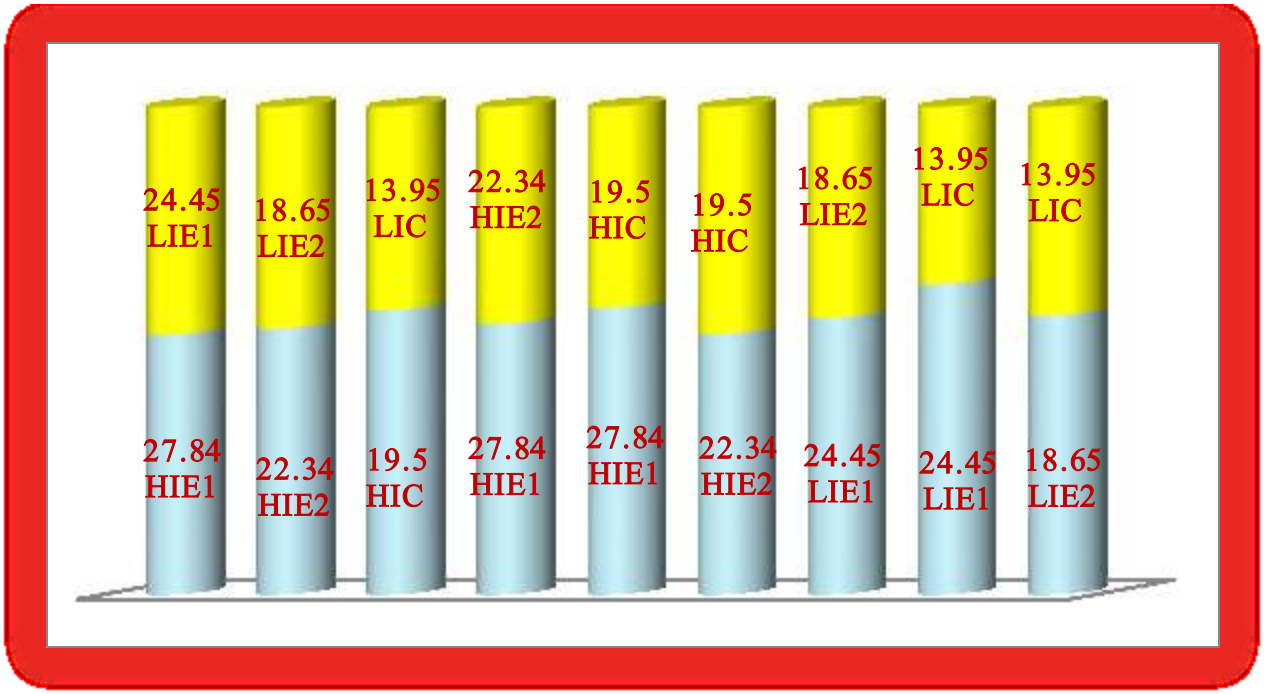


**Fig.2: Mean Gain Achievement Scores in Mathematics of Different Combination Groups for Treatment X Intelligence**

It can be inferred from table-9 that 't'-values for difference between mean gain achievement scores of high and low intelligent students of all the three groups( $E_1$ , $E_2$ & C) are found to be significant. When we compare high intelligence sub-groups/low intelligence sub-groups of ($E_1$ , $E_2$ & C), 't'-values are found to be significant except one case ($HIE_2$ vs HIC) for gain achievement scores.

## Effect of Co-operative Learning Strategies TAI and STAD on Achievement in Terms of Retention Scores

After 20 days, the achievement test in mathematics was again administrated on the three groups. The scores obtained on this test were treated as retention scores which were subjected to two way Analysis of Variance, the Summary of which has been presented in Table-8.

**Table-10**
**Summary of 3x2 ANOVA for Mean Retention Scores in Mathematics**

| Sources of Variation | Df | SS | MS | F-ratio |
|---|---|---|---|---|
| Treatment | 2 | 2543.5 | 1271.75 | 187.02** |
| Intelligence | 1 | 303.9 | 303.9 | 44.6** |
| Treatment x Intelligence | 2 | 565.8 | 282.9 | 41.6** |
| Within Subjects | 138 | 948.2 | 6.8 | |

** Significant at 0.01 level

## Main Effect

### Treatment

F-value ( 187.02) vide Table-10 for the difference in the mean retention scores of the three groups ($E_1$, $E_2$ and C) was found to be highly significant. To investigate further,'t'-values were computed.

**Table-11**

**'t'-values for the Mean Retention Scores in Mathematics of $E_1$ , $E_2$ and C**

| Group | N | | Mean | | S.D. | | 't'- value |
|---|---|---|---|---|---|---|---|
| $E_1$ vs $E_2$ | 52 | 46 | 40.52 | 37.82 | 3.58 | 3.04 | 4.03** |
| $E_1$ vs C | 52 | 46 | 40.52 | 27.3 | 3.58 | 3.06 | 19.6** |
| $E_2$ vs C | 46 | 46 | 37.82 | 27.3 | 3.04 | 3.06 | 16.5** |

****Significant at 0.01 level**

Table-11 exhibits that 't'- values for the difference between mean retention scores of three groups( $E_1$ , $E_2$ & C) are significant at 0.01 level. This shows that Experimental Group-1 subjected to co-operative learning strategy TAI has retained more than the Experimental Group-2 subjected to co-operative learning strategy STAD. Further the subjects exposed to co-operative learning strategy TAI & STAD retained higher than the subjects taught by conventional method of teaching. It can also be concluded that TAI method is more effective than conventional method in raising the retention level in Mathematics. The result is in consonance with the findings of researchers in other subjects: general chemistry (Daugherty, 1995) and IT introductory course (Whittington, 2006). Daugherty (1995) found that students retained more when exposed to co-operative learning and enhanced communication than the traditional classroom students. Similarly Whittington (2006) gave the result that there was increase in retention and satisfaction in IT introductory programme courses using co-operative learning. Instructional strategies that actively involve students in lessons contribute to long-term retention (Slavin, 1997). Students retained more when taught through advance organizer model and inductive thinking model (Mehra and Khare, 2001), through hypermedia learning (Yildrin, Ozden and Aksu, 2001), through traditional instruction followed by peer tutoring (Mondal, 2002). Gupta, Jain & Pasrija (2014) also revealed that co-operative learning was found more effective instructional paradigm for mathematics as compared to conventional method of teaching.

### Intelligence

F-value 44.6 vide Table-10 for the difference in retention scores on achievement of students with high and low intelligence (38.24 & 32.18) is significant at 0.01 level. It leads to the conclusion that high intelligence group retained more than low intelligence group. High intelligent students have to explain the methods of solving questions to low intelligent group mates, so they retained more than their counterpart mates. Research in cognitive psychology has found that if information is to be retained in memory and related to information already in memory, the learner must engage in some sort of cognitive restructuring, or elaboration of the material (Wittrock 1978). Noreen Webb (1985)

investigated that the students who retained the most from co-operative activities were those who provided elaborated explanations to others.

**Interaction Effect ( Treatment X Intelligence )**

The F-value (Table-10) for the interaction between treatment and intelligence for mean retention scores is 41.6 respectively which is significant at 0.01 level, leading to the inference that two variables interact with each other. t-test was applied to find out the difference in retention scores of different combination groups.

**Table-12**

**'t'-value for the Mean Retention Scores in Mathematics of Different Combination Groups for Treatment X Intelligence**

| Group | N | | Mean | | S.D. | | 't'-value |
|---|---|---|---|---|---|---|---|
| $HIE_1$ vs $LIE_1$ | 23 | 29 | 42.28 | 38.76 | 4.48 | 2.68 | 3.25** |
| $HIE_2$ vs $LIE_2$ | 16 | 30 | 39.18 | 36.47 | 4.08 | 2.01 | 2.5* |
| HIC vs LIC | 18 | 28 | 33.27 | 21.33 | 3.83 | 2.3 | 11.9** |
| $HIE_1$ vs $HIE_2$ | 23 | 16 | 42.28 | 39.18 | 2.68 | 4.08 | 2.67* |
| $HIE_1$ vs HIC | 23 | 18 | 42.28 | 33.27 | 2.68 | 3.83 | 8.5** |
| $HIE_2$ vs HIC | 16 | 18 | 39.18 | 33.27 | 4.08 | 3.83 | 4.3** |
| $LIE_1$ vs $LIE_2$ | 29 | 30 | 38.76 | 36.47 | 2.68 | 2.01 | 3.71** |
| $LIE_1$ vs LIC | 29 | 28 | 38.76 | 21.33 | 2.68 | 2.3 | 24.6** |
| $LIE_2$ vs LIC | 30 | 28 | 36.47 | 21.33 | 2.01 | 2.3 | 26.65** |

*Significant at 0.05 level ** Significant at 0.01 level NS: Not Significant

It is depicted through table-12 that't'-values for difference between mean retention scores of different combination groups for high and low intelligent students of all the three groups( $E_1$ , $E_2$ & C) are significant. Gupta & Pasrija (2012) disclosed the positive effect of cooperative learning on high school students' mathematical achievement and retention by using TAI and STAD methods. Parveen, Yousuf & Mustafa (2017) induced that understudies taught through cooperative learning showed better results for their scholastic accomplishment on the post-test than those instructed through traditional techniques

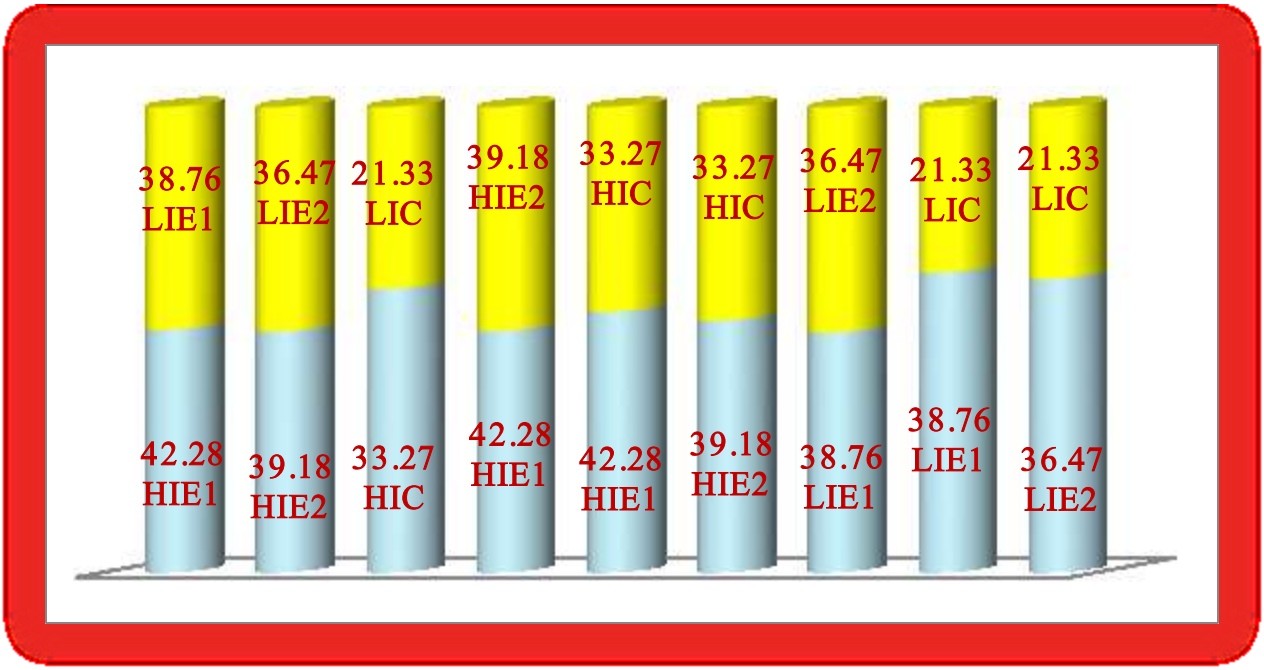


Fig.3: Mean Retention Scores in Mathematics of Different Combination Groups For Treatment x Intelligence

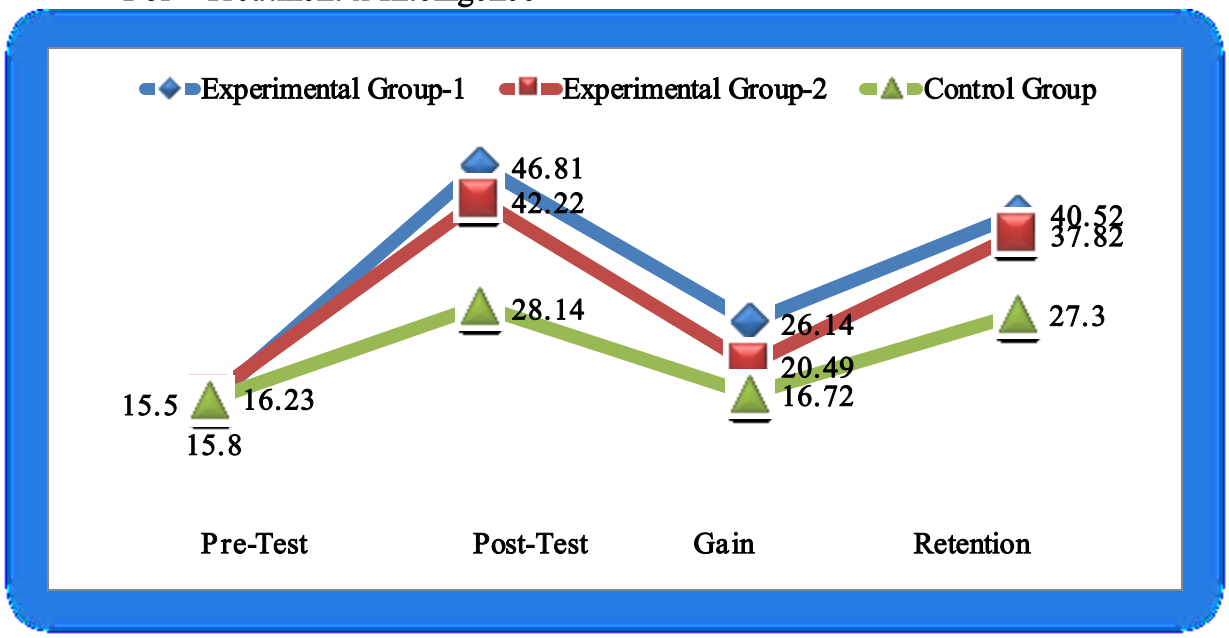


Fig.4: Mean Achievement Scores of Three Groups at Pre-test, Post-test, Gain and Rentention Level

Fig.4 has been drawn to give an overview to reveal the difference in performance of the three groups at four phases which exihibits that Experimental Group-1 that was taught through co-operative learning stretegy TAI has given the best performance out of all the three groups.

## Findings of the Study

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 07
March 2018

- No significant differences were found in the achievement scores of three groups ($E_1$, $E_2$ and C) before giving the experimental treatment i.e. initially experimental group-1, experimental group-2 and control group were similar in their performance. The difference in pre-test scores of achievement in mathematics for three groups of high intelligence ($HIE_1$, $HIE_2$ , HIC) and three groups of low intelligence ($LIE_1$, $LIE_2$, LIC) taught through co-operative learning strategies TAI, STAD and conventional method was found to be non significant.
- The post-test achievement scores in mathematics of experimental group-1, experimental group-2 and control group of ninth graders differ significantly in favour of experimental group-1 and experimental group-2. This implies that students who were taught mathematics through co-operative learning strategy TAI and students taught through co-operative learning strategy STAD showed significant improvement in their achievement than the students who received instructions through conventional method of teaching.
- Significant difference was found in the post-test achievement scores of two sub-groups of intelligence (high and low) taught through co-operative learning strategy TAI & STAD and conventional method of teaching showing the favour of high intelligence group.
- The mean gain achievement & retention scores in mathematics of experimental group-1, experimental group-2 and control group of ninth graders differ significantly in favour of experimental group-1 and experimental group-2. This leads to the conclusion that students taught mathematics through co-operative learning strategy TAI and STAD benefitted more in retaining the learning material than the students who received instructions through conventional method of teaching.
- The difference between mean gain achievement scores and retention scores of high and low intelligent students of all the three groups (E1 , $E_2$ & C) are significant. When we compare high intelligence sub-groups/low intelligence sub-groups of ($E_1$, $E_2$ & C), significant differences are found in mean gain achievement scores and retention scores.

## Educational Implications

- Efforts should be made by the teachers to create suitable TAI learning environment especially in mathematics classes for enhanced achievement and greater retention of the concepts.
- Sometimes students are not able to understand what teacher is explaining to them due to some reasons and they don't ask again due to hesitation. But in groups, they can get explanation of the same topic in simple words and attains greater on achievement and retention.

- Teachers should be given proper orientation to co-operative learning strategies or in-service training from time to time. School authorities or teacher educators should organize refresher courses, seminars or workshops so that teachers can be trained in different methods of teaching-learning to generate the desired level of learning among the students. Pre- service and in-service teachers should understand how to structure and monitor meaningful experience for students.
- One of the most effective means of elaboration is explaining the material to someone else. So in our classroom, high intelligent students must take the role of recallers, therefore peer-tutoring should be practiced.
- Purpose of the cooperative groups is to make each member stronger as an individual. Individual accountability ensures that all group members take responsibility for their share of the work. Therefore feeling of accountability is developed among the students in cooperative learning environment.
- Students should be given some incentive or reinforcement in terms of praise, encouragement and prizes to bring rapid progress in achievement.
- Important skills such as critical thinking, creative problems solving and synthesis of knowledge can easily be accomplished through co-operative group activities.
- Co-operative learning assigns a new role to the teacher. It is the teacher who converts the passive listeners in the class into active members and achievers by implementing co-operative learning strategies in perfect way, thus becoming a facilitator in learning process to actively encourage the student to help each other and learn from each other, participate in discussions, and engage in problems solving in a free democratic way.
- While constructing the curriculum, all learning experiences including co-operative learning behaviours should be added so that students can be more benefitted and enjoy the learning.
- While reporting on a child's progress in class, remarks rather than grades should interpret the child's performance. The learner's areas of strengths must be highlighted and strategies to overcome his weaknesses must be suggested. This will end competition to achieve the first rank in class and will definitely boost the child to perform better. A conducive environment with no threat of competition will allow the child to blossom and achieve his full potential in a relaxed atmosphere.

## Conclusion

It appears that co-operative learning, as described in this study, with strong empirical support for it and the fact that it makes sense for students' achievement and retention of their studies is a very viable option among other instructional methods for teaching mathematics in secondary schools. We must, however, be careful not to over generalize since the method has the potential of making

students believe that instructional problems cannot be tackled independently. The research into co-operative learning does not show that having students work together in a co-operative manner is a magic device that will solve all classroom problems. What it does say is that those problems probably have a better chance of being solved in co-operative than in competitive or an individualized learning environment.

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