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Gender Related Effects of Co-Operative Learning Strategies (Stad And Tai) on Mathematics Achievement

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Abstract The purpose of this study was to determine how the adoption of cooperative learning as an instructional strategy for teaching mathematics influences students' achievement. The study also determined how moderating variables like gender affect students' achievement in mathematics when cooperative learning is used as an instructional strategy. so, 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 among ninth graders in relation to gender. This is an experimental study with 3x2 factorial designs. Students of ninth standard of the schools affiliated to Haryana Board in Rohtak city constituted the population of the study. 144 students of ninth standard (74 boys and 70 girls) 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. 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. 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 boys and girls students taught through co-operative learning strategies TAI and STAD outscored significantly the control group on post-test

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showing the obvious supremacy of co-operative learning over conventional method of teaching. Hence, the ultimate result of the study indicated that co-operative learning was found more effective instructional paradigm for mathematics as compared to conventional method of teaching.

Keywords : Co-operative Learning Strategies, Achievement, Gender

INTRODUCTION

Co-operative learning is an umbrella term used to describe a variety of educational approaches involving joint intellectual effort by students or students and teachers. 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.

Writings from the Stone Center (Jordan, Walker, & Hartling, 2004) conceptualize women's sense of self as being rooted in connections and relatedness, whereas men's self-concepts are based more on separation and autonomy. Some research supporting this view has shown women to be higher in affiliation, cooperative attitude, and interdependence (Fultz & Herzog, 1991; Markus & Kitayama, 1991). It is possible to perceive learning as a social activity that can be moderated by social interdependence and independence. If women have more positive attitudes than men toward cooperation and social interdependence, then it follows that learning methods for the development of trusting and interdependent relationships among students and between students and teachers should be more effective for women than for men. Thus where interdependence, cooperative attitudes, and desire for affiliation exist, competitive teaching methods may not create the most effective learning environments for women. Fultz and Herzog (1991) reported a gender-by-construct interaction whereby women were higher than men in affiliation, whereas men were higher than women in instrumentality (independence and goal achievement). Research by Inglehart, Brown, and Vida (1994) has

supported this belief. They found that the more competitive women perceived the environment to be, the less well they achieved, probably because they tended to focus more on interpersonal aspects of competition. Inversely, the more competitive men perceived the environment to be, the better they performed, probably because they tended to focus on achievement-related aspects of competition. Similarly, Ellison and Boykin (1994) reported that their sample of university women achieved better following cooperative learning than individualistic learning, and the cooperative learning was significantly related to more time on task, more positive attitudes toward the learning experience, and more perceived ability. More recent studies on affiliation and cooperative learning in postsecondary education (Brewer et al., 2003; Klein & Schnackenberg, 1999), however, did not examine gender differences on affiliation. Finally, Golbeck and Sinagra (2000) randomly assigned boys and girls students to same-sex and mixed-sex collaborative groups and in an individual learning control condition and found no differences among the three groups in learning a Piagetian spatial task. Because of these mixed results, more research is needed to clarify the interaction among gender, affiliation, and cooperative learning. Klein and Pridemore (1993) did such an aptitude-treatment-interaction (ATI) study investigating affiliation in relation to cooperative versus competitive teaching effects on academic achievement, time on task, and satisfaction in a university sample that was 85% women. Results showed that participants who worked cooperatively spent more time on the practice exercises than people who worked individually, and the high-affiliation group who learned cooperatively experienced superior achievement in the application section of the test, whereas high-affiliation students who worked alone showed the lowest level of achievement. Because the mean affiliation score for this predominantly girls sample was higher than the norm, these results suggest that a gender-related aptitude-treatment interaction (ATI) may have been present.

An aptitude-treatment interaction provides another basis for predicting gender differences in cooperative versus competitive learning. Gender differences in affiliation, interdependence, and instrumentality could potentially interact with effectiveness of teaching method, but this remains to be demonstrated. Many studies have examined the effectiveness of cooperative learning in specific disciplines such as psychology (Baer, 2003), business (Kunkel & Shafer, 1997), education (Rittschof & Griffin, 2001), and science and mathematics (Springer, Stanne, & Donovan, 1999, Gupta & Pasrija 2011, 2012), as well as with specific populations such as university athletes (Dudley, Johnson, & Johnson, 1997) or reentry adults

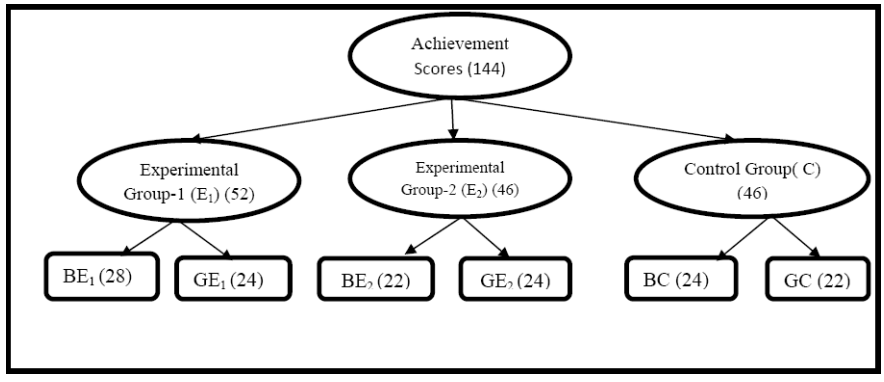
(Brewer, Klein, & Mann, 2003). However, few studies have examined gender differences in the effectiveness of cooperative learning. With girls now constituting the majority of students, it is important to understand learning approaches that may be particularly well suited to them. To address this gap in the research literature, the current study focused on possible gender differences in school students who were taught in a traditional learning environment versus an alternative, cooperative learning environment. The using of cooperative learning might be a source of excitement, motivation, enhanced achievement and retention to our students in their mathematical courses (Gupta & Pasrija 2013). So, the purpose of the present study is to investigate the effect of co-operative learning strategies (STAD and TAI) on achievement in mathematics among high school students in relation to gender. Accordingly, it was hypothesized that cooperative teaching methods would result in better achievement than competitive teaching methods for girls, whereas cooperative teaching methods would result in equal or lower achievement than competitive teaching methods for boys.

OBJECTIVES OF THE STUDY

1. To find out the difference in the achievement scores of three groups (E_1, E_2 and C) of ninth graders in mathematics due to three instructional treatments(TAI, STAD and conventional method) and gender before experimental treatment.
2. To find out the difference in the achievement scores of three groups (E_1, E_2 and C) of ninth graders in mathematics due to three instructional treatments(TAI, STAD and conventional method) and gender after experimental treatment.

DESIGN OF THE STUDY

The present study is an experimental study with 3x2 factorial designs. Achievement of students in mathematics was treated as dependent variable while instructional treatment and gender 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. This can be shown pictorially:



BE_1-Boys of Experimental Group-1, **GE_1-**Girls of Experimental Group-1
BE_2-Boys of Experimental Group-2, **GE_2-**Girls of Experimental Group-2
BC-Boys of Control Group, **GC-**Girls of Control Group

SAMPLE

A sample of 144 students was selected through multistage random sampling which constituted the successive random sampling of regions, schools and students (three stages). All the 144 students were divided on basis of their gender. 52 students (28 boys and 24 girls) formed experimental group-1 (E_1), 46 students (22 boys and 24 girls) formed experimental group-2 (E_2) and 46 students (24 boys and 22 girls) formed control group (C). However, the sample was also equated on the basis of socio-economic status and achievement in the subject concerned.

Tools Used

- **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 for ninth class students. 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 three 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 SES Achievement in Mathematics	Measurement of SES Achievement in Mathematics	Measurement of SES 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

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 gender) on dependent variables (achievement) 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 gender, 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.

To obtain the first objective, means and standard deviation of the students' achievement on the pre-test were calculated due to treatment (Experimental-1, Experimental-2 and Control) and gender (Boys and Girls) variables as shown in Table-2.

Table 2 : Means and Standard Deviation of the Students' Achievement on the Pre-Test due to Treatment (Experimental-1, Experimental-2 and Control) and Gender (Boys and Girls)

Treatment	Gender	Mean	S.D.	N
	Boys	19.34	3.64	28
Experimental Group-1	Girls	21.89	4.85	24
	Total	**20.62**	**4.25**	**52**
	Boys	18.75	3.93	22
Experimental Group-2	Girls	20.57	5.36	24
	Total	**19.66**	**4.65**	**46**
	Boys	19.58	4.52	24
Control Group	Girls	21.37	6.27	22
	Total	**20.48**	**5.39**	**46**

Table-2 indicates that there are slight differences in the means of the pre-achievement test due to treatment and gender variables. For the experimental group-1, the boys and girls means were 19.34 and 21.89 respectively, for the experimental group-2, the boys and girls' means were 18.75 and 20.57 while for the control group it was 19.58 and 21.37 respectively for boys and girls subjects. To find out whether there are statistically significant differences in these means, two way ANOVA was conducted as shown in Table-3.

Table 3 : Two Way ANOVA Results for the Effect of Treatment and Gender and Interaction between them on Pre-Test Achievement Scores

Source	Sum of Squares	Df	Mean Square	F-value
Treatment	35.54	2	17.770	1.782(NS)
Gender	12.59	1	12.590	1.26(NS)
Treatment X Gender	20.986	1	10.493	1.052(NS)
Error	1376.136	138	9.972	
Corrected Total	1445.252	143		

NS: Not Significant

Table-4 shows the following:

1. There are no statistically significant differences due to treatment variable.
2. There are no statistically significant differences due to gender variable.

3. There are no statistically significant differences due to the interaction between gender and treatment variables.

This result indicates that the groups are equivalent according to treatment, gender and interaction between gender and treatment variables. Initially the three groups were similar in their performance.

To obtain the second objective, means and standard deviation of the students' achievement on the post-test were calculated due to treatment (experimental-1, experimental-2 and control) and gender (boys and girls) variables as shown in Table 4.

Table 4 : Means and Standard Deviations of the Achievement of Boys and Girls on the Post-Test Scores

Treatment	Gender	Mean	S.D.	N
	Boys	44.40	4.91	28
Experimental Group-1	Girls	45.56	5.83	24
	Total	**44.98**	**5.37**	**52**
	Boys	41.57	3.83	22
Experimental Group-2	Girls	43.99	4.67	24
	Total	**42.78**	**4.25**	**46**
	Boys	40.02	4.54	24
Control Group	Girls	41.05	4.73	22
	Total	**40.53**	**4.63**	**46**

Table 4 indicates that there are slight differences in the means of the post-achievement test due to treatment and gender variables. These mean scores have also been presented in fig 1.

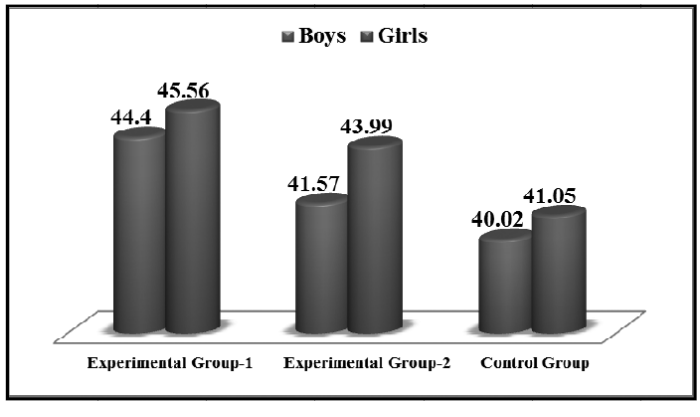


Figure 1: Mean Post-Test Achievement Scores in Mathematics of Boys and Girls of all the three Groups.

Table 5 : Two Way ANOVA Results for the Effect of Treatment and Gender and their Interaction on Post-Test Achievement Scores

Source	Sum of Squares	Df	Mean Square	F-value
Treatment	176.710	2	88.355	4.234*
Gender	19.725	1	19.725	1.35(NS)
Treatment X Gender	18.867	2	15.345	1.05(NS)
Error	2009.694	138	14.563	
Corrected Total	2224.996	143		

*Significant at 0.05 Level

To find out whether there are statistically significant differences in these means, ANOVA with 3x2 factorial design was conducted as shown in Table 5.

Table 5 shows the following:

- There are statistically significant differences due to treatment variable, in favour of experimental group.
- There are no statistically significant differences due to gender variable.
- There are no statistically significant differences due to the interaction between gender and treatment variables.

Treatment

F-ratio vide Table 5 for the difference in post-test scores of the three groups is 4.234 which is significant at 0.05 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 6.

Table 6 : 't'-values for the Post-Test Achievement Scores of E_1 , E_2 and C

Group	N		Mean		S.D.		't'- values
E_1 vs E_2	52	46	44.98	42.78	5.37	4.25	**2.26***
E_1 vs C	52	46	44.98	40.53	5.37	4.63	**4.41****
E_2 vs C	46	46	42.78	40.53	4.25	4.63	**2.53****

****Significant at 0.01 level *Significant at 0.05 level**

Table 6 reveals that't'-values (2.26, 4.41, 2.53) for the different groups are significant. 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. Gupta and Pasrija (2012, 2013) also reported the positive effects of co-operative learning methods STAD and TAI on mathematical achievement and retention.

Gender

F-value 1.35 vide Table-6 for the difference in post-test scores on achievement of boys and girls is not significant. This means that boys and girls were having equivalent performance in Mathematics after being taught through co-operative learning methods. However, when the mean scores of girls and boys are compared, it was found that girls are attaining somewhat more marks than boys in all the three groups as it is very clear from table-4 and fig-1. As in earlier research (Golbeck & Sinagra, 2000), no gender differences were found in the co-operative and competitive learning condition. Although no differences were found on the multiple-choice test, on the mini-assignment women scored significantly higher in the cooperative than in the competitive condition, whereas men performed about equally in both conditions (Rodger, Murray and Cummings 2007). Ajaja & Eravwoke (2010) also reported a non-significant difference in achievement test scores between the male and female students in the cooperative learning group. Findings of the study conducted by Shihab (2011) indicated that there was no statistically significant difference in the students' achievement due to gender.

Interaction Effect (Treatment X Gender)

The F-value (Table-6) for the interaction between treatment and gender for post-test achievement scores is 1.05 which is not significant leading to the inference that two variables do not interact with each other. There was no statistically significant difference due to the interaction between gender and method (Ajaja & Eravwoke 2010 & Shihab 2011). However, an examination of mean scores from table-4 further reveals that in each group, girls are achieving more than boys. While in group wise comparison, it was found find that girls and boys of group E_1 taught through TAI were better achiever than that of group E_2 and group C.

Fig.2 has been drawn to give an overview of the difference in performance of the three groups at two phases(pre-test and post-test) which exihibits that Experimental Group-1 that was taught through co-operative learning strategy TAI has given the best performance out of all the three groups. It is also revealed

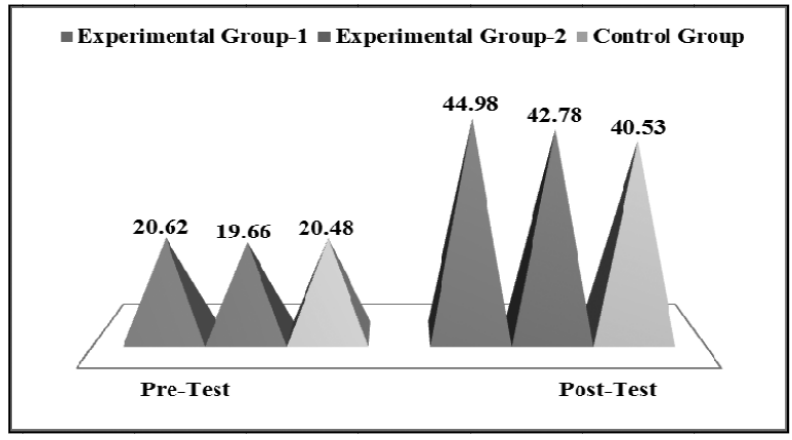


Fig. 2 : Mean Achievement Scores of Three Groups at Pre-Test and Post-Test Phase

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. So, it is concluded that co-operative learning is an effective approach which need to be incorporated in teaching mathematics in our classrooms.

Findings of the Study

- 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 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.
- No significant difference was found in the post-test achievement scores of boys and girls taught through co-operative learning strategy TAI & STAD and conventional method of teaching. There are no statistically significant differences due to the interaction between gender and treatment variables.

Educational Implications

The results of the study revealed that teaching mathematics by using cooperative learning has positive effect on the student's achievement. It seems reasonable to consider using this technique in today's classroom. Inglehart et al. (1994) addressed this concern by offering recommendations for educators including providing female students with more social support in their academic pursuits through cooperative teaching methods and the use of mentors. Teachers' objections to cooperative techniques may come from the perceived increase in time and effort required, the loss of feeling in control in the traditional lecture-style classroom, or the fear that all the required material will not be covered. These objections may be overcome by designing lessons around learning objectives, not around the mastery of chunks of material. 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

Statistically, no significant difference was in students' scores due to their gender but mean examination reveals that girls are superior to boys in their achievement in Mathematics when taught through co-operative learning strategies. Girls have more positive attitudes than boys toward cooperation and social interdependence, then it follows that learning methods for the development of trusting and interdependent relationships among students and between students and teachers should be more effective for girls than for boys.

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. 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. Also, a cooperative learning environment does not require a great deal of expertise on the part of the instructor or much time to prepare and implement. In conclusion, cooperative

teaching methods can make a significant difference in achievement for female students without negatively affecting the performance of male students. Given this finding, the provision of cooperative learning opportunities to all students may be reasonable for students, educators, and administrators.

CONCLUSION

Cooperative learning is a popular instructional arrangement for teaching mathematics to students. Coupled with direct instruction, cooperative learning holds great promise as a supplement to textbook instruction by providing students opportunities to apply math skills and concepts, reason and problem solve with peers, use mathematical language to discuss concepts, and make connections to other skills and disciplines. Carefully constructed lessons, using the "lesson preparation," "lesson instruction," and "lesson evaluation" components can offer students rich learning opportunities in mathematics instruction. 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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