

Enhancing Academic Achievement in Mathematics through JIGSAW, Group Investigation and Student Team Achievement Division Techniques of Teaching

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ABSTRACT

Cooperative Learning (CL) includes all structures and processes related to teaching learning where students achieve learning goals by helping each other in a small social setting. This paper provides an exploration of the effectiveness of cooperative learning techniques JIGSAW, Student Team Achievement Division (STAD) and Group Investigation (GI) of school students of XII standard studying Mathematics. Three experimental groups consisting of 20 students in each, were made randomly out of 87 Normal and Bright Normal intelligent students. The experimental groups were instructed for 22 days with cooperative techniques JIGSAW, STAD and GI respectively and post-test on Academic Achievement was administered. The findings revealed that the three cooperative techniques i.e. JIGSAW, Group Investigation and Student Team Achievement Division are equally effective in enhancing academic achievement.

Keywords: JIGSAW, Group Investigation, Student Team Achievement Division, Academic Achievement.

INTRODUCTION

Learning is an active process of constructing rather than acquiring knowledge and instruction is a process of supporting the construction rather than communicating the knowledge. Knowledge is not only a representation of what exists, but it is a mapping in the light of human experience, of what is feasible (Duffy and Cunningham, 1996). In teacher dominated and content centered classrooms, teachers are regarded as repositories of content knowledge and their role is simply to pour into the empty minds. The students are not trusted to learn on their own. Research on student thought processes is based on the belief that teaching is mediated by the student thought processes and teachers influence students' achievement not directly but by facilitating students to think and behave in certain ways (Wittrock, 1986). This infers that students' performance can also be enhanced by enabling them to learn at their own pace by providing guidance by the mentors.

Co-operative learning (CL) is a successful teaching strategy in which small teams each with students of different levels and ability use a variety of learning activities to improve their understanding. The five-component theory is preferred because it emphasizes the elements essential for increasing the likelihood of success of a cooperative learning endeavor such as Positive Interdependence, Face-to-face interaction, Individual accountability, Social Skills and Group processing (Johnson et al., 1998).

Positive interdependence refers to a gain of one student associated with gain for the other students. Face-to-Face Interaction involves students to enhance each other's goals through supporting, praising, encouraging and scaffolding. Individual Accountability Involves responsibility for completing one's share of the work or mastering the task assigned within the group. Social skills are involved throughout the learning process at each level. Group processing exists when the overall performance of the group is assessed and the results are given back to all group members to compare against a standard of performance. The effect of cooperative learning in groups of four and individual learning on achievement, social support, and self-esteem was compared on 7th-grade students, who participated for 90 min for 6 instructional days during a period of about 6 weeks. Cooperative learning promoted higher achievement and greater academic support than individualistic learning. Students working in groups developed a higher level of social self-esteem than students learning in other conditions (Bertucci et al., 2010).

Some of the CL techniques coined as JIGSAW, Student Team Achievement Division (STAD) and Group Investigation (GI) are discussed here.

JIGSAW method of cooperative learning technique that reduces racial conflict among school children, promotes better learning, improves student motivation and increases enjoyment of the learning experience. In JIGSAW, each student has to participate actively in order for his or her group to be successful. The cooperative goal is to ensure that everyone in the group learns all the assigned material. The structure of Jigsaw Classroom includes Home Group, Expert Group and Re-

Group.

Students were divided into small teams with 5 or 6 members known as Home Groups. The day's content was divided into equal parts to all students in each group so that each group member gets one part of the material. The students had direct access to their own segment. They were given time in the Home Group to read over their segment at least twice to become familiar with it.

As a next step, each student meets with the members of the other teams who have the same assigned content and they form an expert group. Here the students moved from Home Group to the Expert Group and have two tasks for learning and becoming an expert of their part of the learning material and they plan to teach their part of content to the other members of their own Home Group team.

After an appropriate amount of time, the students regrouped with their Home Groups, one by one and taught their part of the content to other members of their own Home Group what they learnt in the Expert Group. The teacher observed each group and acted as a facilitator, helping poor, quieter students and intervening when students were too talkative or monopolizing.

A quiz was given at the end to make sure that they have attained mastery over the content, followed by the felicitation of the winning team. Cooperative learning, especially jigsaw pattern, is very effective for conceptualization of Mathematics in a collaborative atmosphere at upper primary level. Students were found to benefit from each other by sharing ideas and learning together (Thomas, 2009). Cooperative learning strategies enhanced achievement motivation and declined anxiety of class eight students. Cooperative learning is superior to conventional teaching in promoting achievement motivation and effective in reducing anxiety (Pushpanjali et al., 2010).

Student-Teams Achievement Divisions (STAD) method was founded by DeVries and Slavin. It has five components such as class presentation, team's formation, quizzes, individual improvement scoring system and team recognition. The material to be learnt is initially presented by the teacher to the whole class by using explanation method or audio-visual presentation. The presentation covers the opening, development, and guided-practice components of the total lesson, students are told what they were about to learn and why it was important to arouse student's curiosity with a puzzling demonstration, real-life problem, or other means. The team members worked together in a peer-tutoring mode to master the material of the learning unit. Mostly, the team members quizzed each other, working from worksheets consisting of problems or information to be mastered. Individual test were to be conducted followed by discussion of the performance of each team and recognition of the winning team.

The effectiveness of Student-Team Achievement Divisions (STAD) and Jigsaw methods of cooperative learning is measured in terms of scholastic achievement and enhancement of self-concept of the students of VII class. Experimental groups were taught in cooperative learning settings involving STAD and Jigsaw methods, and the control group was taught through traditional approach. STAD and Jigsaw contributed towards increasing the academic achievement and self-concept of students in contrast to traditional methods. The group of students who were taught Mathematics through STAD and Jigsaw methods showed a higher gain on the academic achievement and self-concept. Jigsaw showed significantly higher achievement than STAD method under cooperative learning. It suggests that STAD and Jigsaw are equally effective in enhancing the self-concept of students.

The impact of STAD as a cooperative learning teaching strategy and direct instruction in teaching learning contemporary economics issues revealed that STAD as a teaching strategy increased learners knowledge of contemporary economics as compared to the direct instruction classes (Micheal, 2013).

GROUP INVESTIGATION (GI): The most extensively researched and successful of the task specialization methods is Group Investigation, a form of cooperative learning that takes back to John Dewey (1970), but has been refined and researched in more recent years by Shiomu and Yael Sharan and Rachel Hertz-Lazarowitz in Israel. In Group Investigation, students' progress through six stages. Firstly, identifying the topic and organizing the students into groups, students scan sources, propose topics and categorize suggestions. The students join the group studying the topic of their choice. A recorder in each group writes down all ideas and then reports them to the whole class. A short class discussion results in a shared list of suggestions for subtopics to be investigated.

The next step is to make all the suggestions available to the whole class, the teacher does this by writing all the suggestions on the board. Groups are formed based on student's interests where each student joins the group studying the subtopic of his or her choice. The teacher may wish to limit the number of students in a group. This stage is basically a planning of the learning task, students plan together, what to study, how to study, who does what, for what purpose or goals do they investigate through this topic. After joining their respective research groups, students turn their attention to

the subtopic of their choice. The third stage is carrying out the investigation, students gather and exchange information, discuss, clarify, and synthesize ideas. This is the longest stage, although students may be given a time limit, it is not always possible to see the exact number of sessions they will need to complete their investigation. This presentation of summaries becomes a problem-solving discussion.

The fourth stage is preparing a Final Report, this stage is a transition from the data gathering and clarifying stage to the stage where the group reports the results of its activities to the class. Fifth stage is presenting the final report, the presentation is made to the entire class in a variety of forms. The audience evaluates the presentation according to the criteria determined in advance by the whole class. In sixth stage, evaluation is carried out as students share feedback about the topic, about the work they did and about their affective experiences.

STAD and Group investigation (GI) under cooperative learning improved the scores of students of experimental group in their achievement in physics, it showed that the method of cooperative learning is much more crucial to the inculcation of values of cooperative living and healthy cooperation rather than the dry bones of sheer competition that narrows down the process of education to self-directed individual learning by matching on their intelligence and socio economic status (Meenakshi, 2011).

Mathematics as a branch of knowledge has been an inevitable ingredient of core curriculum at basic stages in every society since ancient times. It is so essential in our life that we cannot expect our existence without it. Cooperative learning is a powerful tool for learning. Majority of the mathematics teachers follow the traditional methods of instruction in schools. There is a need to create effective learning strategies in the classroom that enable learners to actively participate in the instructional process. Co-operative learning is one strategy that can enable all learners in the classroom to learn or work together. This can contribute to intellectual, social and psychological development of learners unlike other methods of instruction, it improves academic achievement, behaviour and attendance, increases self-confidence, motivation and increases the liking for school and classmates (Toumasis, 2004).

Mathematics students of secondary class in the co-operative learning groups have increased their test scores in comparison with other groups. Favourable responses were acknowledged towards the cooperative learning procedure. Students indicated that they liked working in groups and appreciated getting help from other students, especially for learning difficult concepts (Whicker et al., 1997). Thus, after reviewing existing information, the difference in the impact of three cooperative techniques JIGSAW, STAD and GI on academic achievement of secondary school students of Mathematics was explored.

The main objective of the present study was to find the effectiveness of cooperative learning techniques. Its specific objective was to compare the effectiveness of STAD, JIGSAW and Group Investigation on achievement of students in Mathematics. Converting the objectives in terms of hypotheses would emerge as probable to be tested for their statistical significance. It was hypothesized that Achievement of secondary school students in Maths will be higher using JIGSAW cooperative techniques than GI and STAD.

The following scales were used for testing:

1. Verbal Intelligence Test by R.K.OJHA and K.RAY CHOWDHURY for age groups of 13 to 20 years was administered.
2. Academic Achievement Test constructed and standardized by the Investigator.

Three groups, Randomized subjects, Post –test-only Design was adopted to execute the study. One of the schools was selected randomly by drawing a lottery from the list of government senior secondary schools of Patiala district of Punjab. A sample of 123 students of 10+2 class of Mathematics was taken, intelligence test was administered and on the basis of results obtained students with average intelligence was selected for the present study. Three experimental groups each of 20 students were formed randomly out of 87 normal and bright normal intelligent students.

Experimental groups were taught for 22 days by using cooperative learning techniques JIGSAW, GI and STAD. Four topics of 10+2 namely

(a) Differentiability (b) LPP (c) Probability (d) Three Dimensional Geometry of prescribed syllabus of PSEB were taught to experimental groups. Post test Academic achievement of each experimental were taken and results were interpreted as follows:

To conduct this study, Verbal Intelligence Test was applied to 123 senior secondary school students of Mathematics of 10+2. To find out the type of distribution of data for level of intelligence, Mean, Median, Mode, S.D., Kurtosis and Skewness were computed and results have been presented in table 1.1

Table 1.1:
Frequency Distribution for Scores of Intelligence Test

N	123
Mean	79.78
Median	80.00
Mode	76.00
Standard deviation	1.1507
Kurtosis	0.067
Skewness	0.096

Table 1.1 shows that the mean of intelligence test is 79.78 with median of 80 and a standard deviation of 1.1507. The values of mean, median and mode are nearly the same, and it is evident from the frequency distribution that the distribution of data is normal. The value of kurtosis is 0.067 which is quite close to normal value of 0.263.

Further to proceed with the investigation, the scores obtained were analyzed on the basis of Verbal Intelligence Test as shown in table no.1.2

Table 1.2
Classification of Data on Level of Intelligence

Range of Raw Score	Classification	No. of subjects	Percentage
107 & above	Very superior	00	0
99 to 106	Superior	11	8.94%
91 to 98	Bright – normal	07	5.69%
73 to 90	Normal	80	65.04%
65 to 72	Dull- normal	15	12.20%
57 to 64	Borderline	06	4.88%
56 to below	Defectives	04	3.25%
TOTAL		123	

Table 1.2 explore that 8.94% subjects were found to be superior intelligent, 12.19% were dull normal, 4.87% were on borderline while 3.25% were found to be defective. Total of 87 subjects comprising 70.73% were found to be lying on the normal and bright normal range.

Therefore three experimental groups of 20 subjects were formed randomly from normal and bright normal subjects. The experimental groups were described as JIGSAW, Group Investigation (GI) and Student Team Achievement Division (STAD)

Achievement of Senior Secondary School Students of Mathematics using cooperative learning techniques

To compare the effectiveness of cooperative techniques of learning on achievement, mean score of post test on achievement in mathematics of experimental groups was computed in table no 1.3.

Table 1.3
Achievement Among Secondary School Students of Mathematics Using JIGSAW, GI and STAD

Types of Cooperative Techniques	N	Mean	S.D.	Std. Error
G.I.	20	38.40	8.06	1.802
JIGSAW	20	40.50	5.853	1.308
STAD	20	38.21	4.73	1.057
Total	60	114.81	20.61	4.607

It is revealed from the table that the mean score of GI, JIGSAW and STAD have been found to be 38.40, 40.50 and 38.21 respectively. The standard deviation of post test scores on achievement of senior secondary school students of Mathematics of GI, JIGSAW and STAD are 8.06, 5.853 and 4.73 respectively. By comparing the means among post test scores of three cooperative techniques, it can be interpreted that there is a mean difference between JIGSAW with GI and STAD.

To find the variance in the effectiveness of cooperative techniques one-way ANOVA was computed on post test scores of three experimental groups taught by using GI, JIGSAW and STAD techniques of cooperative learning. The results are presented in the table no. 1.4.

Table 1.4
Variance in Achievement in Experimental and Control Groups

Source of variation	Sum of Squares	df	Mean Square	F
Between Groups	68.4	2	34.2	0.84258
Within Groups	2313.6	57	40.5895	
Total	2382	59		

0.05=3.16, 0.01=5.00

Table 1.4 shows that when the three experimental group all together were compared, the sum of squares between groups and within groups have been found to be 68.4 and 2313.6 whereas mean squares between groups and within groups have been found to be 34.2 and 40.5895. The calculated F-value was found to be 0.84258 which is not significant at 0.05 level of significance. It has been explored that there is no significant difference between the post test scores of achievement of experimental groups. It suggests that all treatments are equally effective in developing academic achievement of senior secondary students in Mathematics. The hypothesis of the study stated that Achievement of secondary school students in Mathematics will be higher using cooperative technique JIGSAW than GI and STAD stands rejected.

The effect of cooperative learning on attitudes, achievement and social skills with different cognitive levels divided into field-independent and field dependent students who attained comparably on achievement showed that changing from a traditional competitive classroom to a cooperative improves achievement. Thus the positive effect on achievement and retention in mathematics supports usefulness of cooperative learning for improving student's achievement in Mathematics (Kalpana 2008).

The possible reason may be due to the interest generated by the cooperative techniques in Mathematics as it emphasizes and enhances the student- teacher and student-student relation that creates a healthy environment of learning and has increased the achievement of students of secondary school students of Mathematics.

It is concluded that the level of Intelligence of senior secondary school students of Mathematics is moderate and Cooperative techniques JIGSAW, GI and STAD are equally effective in developing their academic achievement.

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