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## **Creating constructivist learning environment through jigsaw cooperative learning technique: A benevolence in mathematics**

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### **Abstract**

Cooperative Learning (CL) includes all structures and processes of 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 technique JIGSAW in the teaching of Mathematics for school students of XII standard. The Post-test only Control Group Design followed by a systematic random sampling technique was adopted to select the sample for the present study. The experimental group and Control group of 20 students each were formed, out of 87 Normal and Bright Normal intelligent students. Experimental group and control groups were instructed with cooperative techniques JIGSAW and Traditional Method respectively. A post-test on Constructivist Learning Environment (CLE) was administered. The findings revealed that JIGSAW cooperative technique is better in developing Constructivist Learning Environment than Traditional Method.

**Keywords:** jigsaw, constructivist learning environment, traditional method

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### **Introduction**

Learning is an active process of constructing rather than acquiring knowledge and instruction is a process of supporting that construction rather than communicating 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) <sup>[15]</sup>. In teacher dominated and content centered classroom teachers are regarded as repositories of subject knowledge and their role is simply to pour into the empty minds. Students are not trusted to learn on their own. Research on student's thought processes is based on the belief that teaching is mediated by the student thought processes and teachers influence student's achievement not directly but by facilitating students to think and behave in certain ways (Wittrock, 1986) <sup>[14]</sup>. This infers that student's performance can also be enhanced by enabling them to learn at their own pace by guiding 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 to be used which emphasis the elements essential for increasing the likelihood of success of a cooperative learning endeavour as Positive Interdependence, Face-to-face interaction, Individual accountability, Social Skills, and Group processing (Johnson *et al.*, 1998) <sup>[8]</sup>.

Positive interdependence refers to gain for one student is associated with gains for the other students. Face-to-Face Interaction involves students enhancing each other's goals by using techniques such as supporting, praising, encouraging and scaffolding. Individual Accountability Involves being responsible for completing one's share of the work or master 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 4 and individualistic learning on achievement, social support, and self-esteem was compared on 7th-grade students who participated for 90 min for 6 instructional days during 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 the other conditions (Bertucci *et al.*, 2010) <sup>[2]</sup>.

One of the CL techniques coined as JIGSAW is discussed as follows Jigsaw method of cooperative learning technique that reduces racial conflict among school children, promotes better learning improves student motivation and increases the enjoyment of the learning experience. In JIGSAW each student has to participate actively for his or her group to be successful. The cooperative goal is for each member to ensure that everyone in their 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 is divided into parts equal to the number of students in each group so that each group member gets one part of the materials. Students need to have direct access only to their segment. Students would be given time in Home Group to read over their segment at least twice to become familiar with it.

In the 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 students have moved from Home Group to the

Expert Group and have two tasks as learning and becoming an expert on their part of the learning materials and planning how to teach their part to the other members of their own Home Group team.

After an appropriate amount of time, the students regroup with their Home Groups, one by one they teach their expertise part of the content to other members of their own Home Group what they have learned in Expert Group. The teacher observes each group and acts as a facilitator, helping poor, quieter students and intervening when students are too talkative and monopolizing.

A quiz or test is given at the end to make sure that they have attained mastery over the content, followed by knowledge of performance to each team and felicitation of the winner team. Cooperative learning, especially the JIGSAW pattern is very effective for the conceptualization of Mathematics in a collaborative atmosphere at the upper primary level. Students were found to benefit from each other by sharing ideas and teach together (Thomas, 2009) <sup>[17]</sup>.

Most of the classroom teachings are teacher dominated and centered. The teachers are thought to be repositories of subject knowledge and their role is simply to pour a huge reservoir of information into the open, empty and willing minds of students. Learners are considered as builders and creators of meaning and knowledge. Three common elements context, collaboration, and construction are fundamental to the environment which are key processes instead of products. A context for learning is meaningful that uses information constructed by things situated within the real world and supported on authentic tasks required for an understanding of both problem-solving methods and thinking processes. The collaboration of both student-student and student-teacher where the teacher becomes a mentor instead of the holder of the information who encourages social negotiation and supports mental modeling through internal negotiation (Jonassen, 1994) <sup>[9]</sup>. The traditional perspective of education views learning as the process of direct provision of knowledge from teachers to students whereas the constructivist perspective views learning as a process in which students are active in constructing their knowledge (Huang, 2006) <sup>[7]</sup>. Constructivist learning theory defines knowledge as a cognitive structure that is to know something is to know how to create it (Glaserfeld, 1989). The constructivist theory has made a significant contribution to student-centered learning and cooperative learning follows student-centered learning methods. Therefore, Compiling two constructs cooperative learning and constructivist learning environment enables learners to construct their meaning in an active way (Almala, 2005) <sup>[1]</sup>. The four key features of a theory of instruction involve; providing the experiences which most effectively implant in a particular type of learning; knowledge be structured in a way so that it can be most readily grasped by the learner; the materials to be learned should be presented in the most effective sequence and the nature of rewards and punishment in the process of learning and teaching should be positively reinforced (Bruner, 1966) <sup>[4]</sup>. These four features of constructivist learning instruction are consistent with the cooperative learning principles. If the learning material is well designed, it needs the necessary theoretical support for applying cooperative learning in the class effectively. Therefore, students in cooperative learning groups are expected to learn more when they are in control of constructing their knowledge through interaction with group members.

Constructivism is defined by relevance to four principles of learning, firstly what one already knows secondly, new ideas occur as one adapt and alter old ideas thirdly, learning involves inventing ideas instead of mechanically accumulating facts and fourthly, meaningful learning occurs through rethinking old ideas and coming to new conclusions about new ideas which conflict with our old ideas (Fosnot, 2005) <sup>[5]</sup>. Five aspects have emerged from the basic ideas about constructivism (Bognar, Gajger, & Civic, 2015) <sup>[3]</sup>; (1) Learning is a process of interaction between what we know and what we need to learn. In the process of learning, previous knowledge and student's cognitive structure have to be taken into account. (2) Learning is a social process and a congenial environment is required for its development. (3) Learning is a situational process that occurs through participation in certain social and cultural circumstances. (4) Learning is a metacognitive process that includes the understanding of the skills and strategies that enable successful resolutions of the problems. (5) Learning is based on the student's activity and autonomy. Constructivist learning environment (CLE) for developing writing classes examined by using observation notes, interviews for two semesters, and as a result, CLE has enhanced the student's problem-based learning (PBL) processes and research ability particularly problem awareness, information literacy, reasoning and research designing (Peiya, 2020).

Constructivist ideas are found in manifold works including ideas of theorists Dewey, Piaget, Vygotsky, Candy, Driver, Merizow and Boud. It is also evident that Mathematics education is more influenced by Piaget, Vygotsky, and von Glasersfeld's ideas. Piaget's works have a great influence on Mathematics education. Piaget's ideas were considered a new field in Mathematics education, which encourage the development of cognitive knowledge. According to Piaget's theory of cognitive development, it is not possible to provide information that will be immediately understood and used, but the students build their knowledge as a result of assimilation and accommodation processes (Piaget, 1977) <sup>[10]</sup>. Among the foremost reasons for student's failures and difficulty in Mathematics learning includes Mathematics teacher's inappropriate and ineffective teaching approaches that overemphasize rote-learning instead of an understanding of concepts.

The advantage of the constructivist learning approach is enhancing the learner's understanding and classroom achievement over the conventional approach (Fernando & Marikar, 2017; Samsudin, *et al.*, 2016). The long-term effects of instructing Cantor set theory using a constructivist learning approach on student knowledge retention are explored by dividing two classes one of which is taught via traditional lecture and the other using the active learning constructivist approach. Conducting a test named Minimum Requirements Identification test the concepts such as set, relation and function which are required to be able to teach Cantor set theory revealed that a constructivist learning environment develops better retention for all of the concepts related to Cantor set theory than the traditional class (Narli, 2011) <sup>[11]</sup>.

The constructivist approach has the potential impact on the development of mathematical competencies and proved that the constructivist approach radically changes the method of teaching and learning by connecting it with the lifestyle instead of teaching abstract formulas. It is revealed that using a constructivist approach to the teaching of Mathematics, the competencies

needed for sustainable development are boosted (Vintere, 2018) [13]. Thus from the above discussion, it is evolved that Mathematics education requires a congenial environment with certain specifications to lead Mathematics as a favourite and interesting subject.

### Significance of the Problem

Mathematics as a branch of knowledge has been an inevitable ingredient of the 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. The 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 the 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) [12].

Thus, after reviewing existing information investigator urged to explore the difference in the influence of cooperative technique and Traditional Method in developing a Constructivist Learning Environment.

### Research Objective

The main objective of the present study was to find the effectiveness of cooperative learning technique. Its specific objective would be.

To compare the effectiveness of JIGSAW and Traditional Method in developing Constructivist Learning Environment.

### Hypotheses

Converting the objectives in terms of hypotheses would emerge as probable to be tested for their statistical significance. JIGSAW cooperative techniques play a significant role in developing Constructivist Learning Environment (CLE) than the Traditional Method(TM).

### Research Tools

The following scales were used for testing:

1. Verbal Intelligence Test by R.K.OJHA and K.RAY CHOWDHURY for the age group of 13 to 20 years was administered.
2. Constructivist Learning Environment (CLE) constructed and standardized by the Investigator.

### Method and Procedure

Two 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. One experimental group and one Control group each of 20 students were formed randomly out of 87 normal and bright normal intelligent students. The experimental group and Control group

were taught for 24 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 the prescribed syllabus of PSEB were taught to experimental groups. The Post-test Constructivist Learning Environment (CLE) scale of the experimental and control group was taken and results were interpreted as follows.

### Analysis and Interpretation

For conducting this study Verbal Intelligence Test was applied on 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:** 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 shows that the mean of intelligence test is 79.78 with median of 80 and standard deviation of 1.1507. As the values of mean, median and mode are nearly the same, it is evident from frequency distribution that the distribution of data is normal. The value of kurtosis is 0.067 which is quite close to the normal value of 0.263. Further to proceed for the investigation, the scores obtained were analyzed based on the Verbal Intelligence Test as shown in table 2.

**Table 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 2 explores that 8.94% of 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. A total of 87 subjects comprising 70.73% were found to be lying in the normal and bright normal range. Therefore experimental group and control group of 20 subjects each were formed randomly from normal and bright normal subjects. The experimental group was described as JIGSAW and Control group as TM.

### Level of Constructivist Learning Environment (CLE) developed using cooperative learning techniques for Senior Secondary School Students of Mathematics

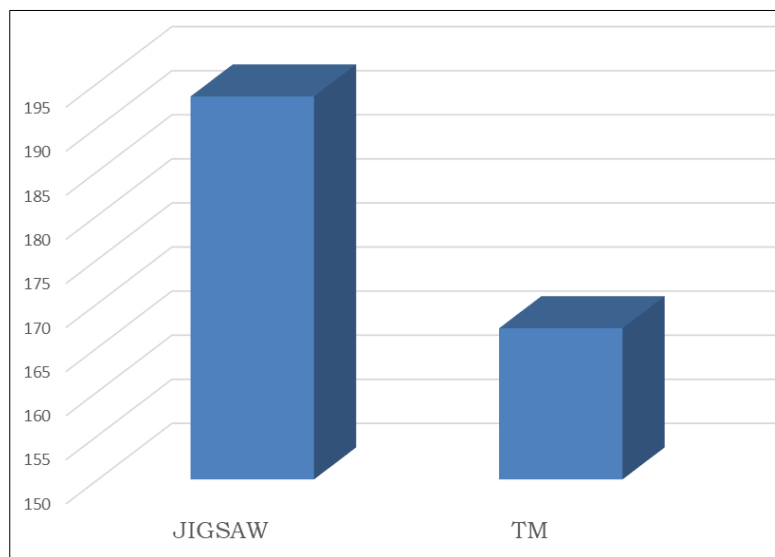
The objective of the current study was to create and measure the constructivist learning environment for senior secondary school

students of Mathematics through cooperative learning technique. To manifest this objective experimental group was taught with the Cooperative learning technique JIGSAW embedded with the constructivist approach, and the control group was taught with the Traditional Method. A scale on the constructivist learning environment was applied at the post-test stage after giving treatments to find the level of constructivist learning environment thus developed among the experimental group and control group. Mean scores attained by different groups are described in table 3.

**Table 3:** Post-test CLE scores of Experimental and Control group

	JIGSAW Experimental Group	Traditional Method
Mean	193.45	167.15
S.D.	8.3443	13.5424
N	20	20

It has been revealed by the above table 3 that the mean score of post-test CLE score of JIGSAW technique of cooperative learning is 193.45 and that of the control group is 167.15. This can be presented in figure 1 as follows



**Fig 1:** Post-test CLE scores of Experimental and Control group

To measure significance difference, the t-test is applied to test the separate differences in groups as shown in table 4.

**Table 4:** Difference in Constructivist Learning Environment among JIGSAW and TM Groups

	Mean	SD	N	t-Stat
JIGSAW Vs TM	193.45	8.3444	20	7.3941
	167.15	13.54	20	

0.05=2.024, 0.01=2.712

Table 4 indicates that the mean score and SD of JIGSAW and Traditional Method are 193.45, 167.15 and 8.344, 18.795 respectively. t-value being 7.3941 has been found to be significant at 0.01 level of significance which shows that there is a significant difference between the level of constructivist learning environment between JIGSAW cooperative learning technique and Traditional method of learning.

It can be inferred that the JIGSAW technique of cooperative learning is better in developing CLE than the Traditional Method of learning. The hypothesis of the study stated that cooperative techniques play a significant role in developing a constructivist learning environment than learning through the traditional method stands accepted.

Turkey adopted a constructivist curriculum with radical changes in programs to measure the level of CLE developed by using the constructivist approach and the self-efficacy of teachers. The Scale of Self-efficacy and Constructivist Learning Environment Scale followed by simple and multiple regression analyses

revealed that the constructivist approach positively predicted the level of making a constructivist learning environment (Lutfi, 2015) [16]. With the best knowledge of the investigator, no evidential study was found which directly measure the effect of CL techniques in developing a Constructivist Learning Environment. The possible reason for the findings may be the appropriate environment provided by the JIGSAW technique of cooperative learning which enables students to construct knowledge. Moreover, JIGSAW enhances all aspects of the constructivist learning environment as compared to the Traditional Method.

**Conclusions**

Following conclusions have been reported on the basis of quantitative analysis of data:

1. The level of Intelligence among senior secondary school students of Mathematics is moderate.
2. Cooperative technique JIGSAW is better in developing Constructivist Learning Environment (CLE).

**Limitations**

Limitations are the influences that the researcher cannot control. All research studies have some inherent limitations. Although this research is carefully prepared, still the investigator is aware of its limitations which are as follows:

1. The only students of the 10+2 class of Punjab School Education Board were taken which might affect in generalizing results to the population.

2. Selecting students of Mathematics both streams of Non-Medical and Arts were taken which might have affected uniformity in output.

### Suggestions

Any research can be carried out with many techniques and by making associations with many areas and variables. Every research work has scope to explore more dimensions. Following suggestions have been made by the investigator which can be helpful for conduction of research in a similar area:

1. Comparison on different school boards can be conducted on similar areas of research.
2. Gender difference and socio-economic factor can also be analyzed as a variable in the study
3. Two subjects or subjects other than Mathematics can also be taken for further studies.

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