Prospects and Challenges of Cooperative Learning Approach in Mathematics Education

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Abstract- This research based paper has discussed the significance of cooperative learning approach guided by constructivist theory of learning mathematics. It has provided a model of implementing cooperative learning approach in classroom practices with required tools. As it used a quasi-experimental research design, it has compared the achievements of control and experimental groups of the students by statistical analysis of quantitative data. There was a higher achievement of the treatment-group compared to the control group demonstrating a significant effect of the cooperative learning approach on students' performance. The results of delayed post-test demonstrated that the treatment applied to experimental group was found to have a longer period of retention memory than the control group. The qualitative analysis of interview data highlighted some problems faced by teachers to implement cooperative learning in the classroom. Some pedagogical and theoretical implications of findings have been discussed at the end.

Index Terms- Cooperative learning, constructivism, quasi-experimental design, friendship group in learning

I. Introduction

It is a common experience of mathematics teachers that when students get an interactive situation, it provides them an opportunity to deconstruct misconceptions and construct, reconstruct and modify their mathematical understanding (Yackel, Cobb & Wood, 1991, as cited in Kshetree, 2011). Students get the opportunity to communicate and share ideas about mathematics when they solve problems in peer groups (Artzt & Armour, 1992). Cooperative learning process may enable students to engage actively in group interaction and discussion among the peers. The cooperative learning may increase the level of task-based discussion and negotiation of meanings for effective learning. However, the effective learning through cooperative approach is not an involuntary method. Therefore, it may require a task with a common objective, a mechanism of face-to-face interaction, cooperative environment, individual responsibility and team accountability (Johnson & Johnson, 2000).

The teachers can have choices of conducting classroom teaching/learning (T/L) practices either competitively or individualistically or cooperatively. These decisions may directly affect the quality of students' learning. In a competitive T/L situation, the students may struggle in a win-lose state to prove them as the best ones (ibid). In an individual attempt, students may work on mathematics problems by themselves to accomplish their own objectives which many not be related to those of other students. Whereas, in a cooperative learning classroom, students may learn together to achieve both individual and group's learning objectives. In this classroom structure, students discuss the subject matters, help each other and learn from each other, and provide encouragement to the members of the group, which are some of the basic ingredients for making mathematics learning meaningful.

It has been observed, in one hand, that a lecture method or direct instruction is adopted in a large classroom with a limited time and resources and a fixed deadline to complete the course. Then, there may be no effort to value students' prior knowledge though students might relate it to the content of direct instruction. In the other hand, a discussion method is applied when the class size is small with adequate resources and enough time to cover the course materials. The teachers may have opportunity to value the pre-existing knowledge and skills of the students through motivational interactions, group works, and think-pair-share. To make the student learning more effective, inductive and problem-solving methods are used in which the students get more opportunities to use their potential to develop their creativity and critical thinking (Johnson & Johnson, 2006). At the same time, the cultural capital of the students should also get proper place to make the T/L meaningful. The cooperative method is one that gives significant role to cultural capital of the students to make their learning comfortable, joyful, meaningful and creative (Bourdieu, 1998, as cited in Kshetree, 2009).

The cooperative learning is generally understood as learning that takes place in a small group where students share ideas and work cooperatively to complete a given task. There are several models of cooperative learning approach that may vary considerably from each other (Slavin, 1995). In this method, the students work within their groups to make sure that all of them mastered the content. The cooperative learning approach also transforms teacher-centric approach to student-centric approach in their peer-groups in which they create group synergy to solve the given problems. Duffy and Cunningham (1996, cited in Kshetree, 2011) added that in the new education landscape, there are many pathways to arrive at the many peaks on the mountain range of talents over the past decade. The recent development in the field of educational technology has endorsed cooperative learning as a suitable referent for the development and meaningful use of appropriate software in education. Therefore, in this study, learning was viewed from the cooperative learning perspective.

A combination of theory, research and practice has made cooperative learning a powerful learning procedure. Therefore, the

cooperative learning process was designed and implemented to get all group members to participate in meaningful learning of mathematics. The purpose of this study was to design, implement, and assess the effectiveness of cooperative learning of mathematics through the real classroom practices. Thus, the materials and methods for this approach were framed to implement and examine in the natural setting of classrooms for both the qualitative and quantitative assessment of the phenomenon. In this study, the major research questions intended to be answered in Nepalese context were as: How does cooperative T/L approach get hold of better achievement than conventional T/L system? What are the problems being faced by teachers while adopting the cooperative learning approach in T/L mathematics?

II. THEORETICAL FRAMEWORK OF COOPERATIVE LEARNING

In the decade of 1980, the constructivist theory was widely accepted. There was a great contribution of Jean Piaget who established constructivism as a leading theory of learning mathematics which emerged an alternative conceptions movement in science education (Duit, 1995 cited in Ernest, 2010). Many scholars have attempted to develop a form of social or radical constructivism based on a Piagetian or neo-Piagetian constructivist theory of mind.

There are four philosophies of constructivist learning - trivial constructivism, enactivism, radical constructivism, and social constructivism (Ernest, 2010). The trivial constructivism argued that knowledge is built up actively by cognizing subject instead of passively receiving it. It accepts that true representation of the empirical and experiential worlds is achievable. The principle of enactivism claims that the individual continually changes schematic structure which determines its own actions and its orbit. It is about spontaneous self-organization based on the interaction of an individual and the situation (Reid et al. 2000, cited in Ernest, 2010). Actually, it is a process of construction of lived world through own active action and reaction revealed in learner's own circumstances.

In radical constructivism, learners build up their knowledge based on their pre-existing knowledge and personal interpretation of their experiences. It includes the individual construction of various affective responses along with their attitudes, feelings, beliefs and values. There is a great role of schemas as well. Nonetheless, in social constructivism, the construction of knowledge takes place in the social phenomena. According to Earnest (1995), there are two types of social constructivism. They are - Piagetian theory of mind which is attached on some social and developmental aspects (Piaget, 1976, cited in ibid) and Vygotskian theory of mind in which social contexts are more shared in the forms-of-life through conversation and learners' zone of proximal development (ZDP) (Vygotsky, 1978).

The different versions of constructivism imply that the knowledge is constructed based on learner's pre-existed knowledge, social interactions, dialogues, revised conversations, self-reflection, and contextual and situated environment. The basic principle of constructivist theories is that all knowledge is constructed by the individual through active construction of meanings of experiences. It is formed in the mind which cannot simply be transmitted from teacher to students. Thus, mathematics teachers and educators must understand the learning phenomenon of students on the basis of which they can prepare and use different methods that may work well (Kshetree, 2009). In this regard, mathematics teachers need to think about a method guided by constructivism to provide maximum support to students for their effective learning. The cooperative learning method, inherited in the theory of constructivism, is a body of techniques for facilitating students to optimize the learning benefits.

The main theoretical base of cooperative learning is constructivism. In this regard, constructivism has properly outlined the creative role of students, teachers and organization along with the creation of cooperative learning environment in the classrooms. The cooperative learning is based on four major perspectives - motivational, social cohesion, cognitive and developmental. Motivational perspective focuses primarily on the reward or goal structures under which students work successfully (Slavin, 1995). According to Johnson and Johnson (2006), the reward is based on group performance which is the sum of individual performances. It may create an interpersonal reward structure in which the peers withhold encouragement in response to peers' task-related efforts. However, in social cohesion perspective, the students help their peers learn and remove the misconceptions because they care about the group (Slavin, 1995). The main characteristic of social cohesion is to conduct team building activities so that the group learning becomes effective.
The cognitive perspective grasps cooperative norms and feeling among students which may increase students' learning achievement (Johnson & Johnson, 2006). It is done with cognitive processing of information which helps in meaningful learning. Similarly, the developmental perspective emphasizes the interaction among students around appropriate tasks to increases their mastery of concepts. In this regard, Vygotsky (1978) introduced the idea of Zone of Proximal Development (ZDP). In his view, collaborative activities promote students' progress by challenging and shifting one another's ZPD.

For such a cooperative group work, they need to be internally motivated, socially cohesive, cognitively interactive and developmentally shifting their cognitive and affective level with an encouragement to enjoy in their trustworthy peer-groups even to attempt and solve the mathematical problems. Further, the cooperative learning is based on students' group work with certain principles such as positive interdependence, equal participation, face-to-face interaction, structured investigation, individual accountability, team accountability, and forming and processing small groups (Stahl, 1994 cited in Kshetree, 2012).

III. METHODOLOGY

Research Design

As per the nature of the study, the research design was a mixed method with qualitative and quantitative both. The purpose of this study was to determine the effects of the cooperative learning approach by implementing it among the small groups of students. Its' effect was measured through the achievements of the students through three different tests (pretest, posttest and retention test). It also collected the opinions and attitudes of students and teachers toward this T/L approach. In order to measure the effect of cooperative learning method, it was

compared with non-cooperative (conventional) T/L method in the classroom environment by using a quasi-experimental design.

Sampling

The study was conducted in two public schools of Kathmandu Valley. The sample schools were chosen among the ten schools by administering the pre-tests on the basis of the similar achievements made by the students in pretest. Similarly, qualification and teaching experiences of teachers along with schools' physical facilities, school environment, school management system, and SLC (School Leaving Certificate) results were also taken in to consideration while selecting the schools. Both of these public schools had 34(control group) and 40 (experimental group) numbers of sample students studying in third grade. To specify an experimental school, it was selected simple random method by a lottery system. The school of the control group has been given the name "X" whereas "Y" for the school of the experimental group. The teachers were selected based on their teaching periods in the selected grades of those schools.

Development of Research Tools

The researcher prepared the following research tools and then consulted with senior researchers, subject experts, trainers and teachers for feedback, suggestions and necessary modifications. Some of the tools were adapted from other researches with some modifications as per the need of the research.

Observation checklist for classroom T/L practices. In order to maintain the norms and values of CL (Cooperative Learning) approach, it was most important to observe the attitudes, behaviors and practices of both teachers and students. Further, it was equally important to observe students' 5Es (Engage, Explore, Explain, Elaborate, and Evaluate) in their small peer groups. Thus, an observation checklist was prepared and used it by the researcher while observing classroom practices under CL approach.

Preparation of cooperative lesson plans. The researcher developed cooperative-lesson plans as per the learning philosophy of cooperative T/L approach based on the models given by Ask ERIC (1994 & 1998, cited in Kshetree, 2009). For its preparation, the researcher used the textbooks of different authors of the same grade written in both Nepali and English languages. The researcher also used the curriculum, teachers' guide, subject elaboration and exercise booklet. It also followed the principles and standards of school mathematics (NCTM, 2000).

Construction of T/L aids. The researcher emphasized on, as far as possible, construction of the T/L materials with no cost, low cost and from the locally available materials including creative use of already developed materials found in and around the schools. On the basis of cooperative-lesson plans, the main T/L materials developed were-- different geometrical shapes, blocks of papers, worksheets, weight boxes, vessels of liquid measurement, and different tools of length measurement such as tape, strings, graph papers etc.

Development of test items. Focusing the cognitive domain of learning, the researcher developed and standardized the examining tools. For this, he prepared the test items by using textbook, specification grid-chart, curriculum and teacher's guidebook developed and prescribed by the Curriculum Development Center (CDC). Moreover, the test items were consulted with subject experts, senior teachers and trainers. The test items included three categories of questions (knowledge for concept, comprehension for process and application for behavioral skills) as per the Bloom's Taxonomy. The test items prepared, in this way, were piloted in one of the public schools in Kathmandu district.

Before finalizing the test items, the difficulty level of each item was analyzed and readjustment was made for very easy and very difficult items. To identify whether the students of control and experimental groups of the selected schools would be justified to implement the cooperative learning approach or not, a pretest was administered. Similarly, to see the immediate learning achievement and retention effect under the cooperative learning approach, the post-test and retention test were administered. The retention test was conducted after a month of the post-tests. The test items were parallel but different for pretest, post-test and retention test.

Interview guideline. In order to collect the qualitative data regarding teaching experiences of mathematics teachers in conventional methods and classroom setting along with new T/L approach of cooperative learning, an interview guideline was prepared and administered among the mathematics teachers of the sampled schools.

Training for the teachers. The teachers were provided a week-long training to understand and implement the basic principles of cooperative learning approach, develop and implement the lesson plans of CLA, use of T/L aids, and facilitate the group works. A second session of the second last day in the training was managed for a model school-visit program in one of the reputed private schools of Kathmandu valley where the child-centered learning methods were adapted with various activities conducted among the small groups of children. In the last day of the training, the trainees presented their project works of the previous days, and then they were subjected to discuss and provide feedbacks on their field observation reports.

IV. IMPLEMENTATION OF CL APPROACH IN SCHOOLS

Administration of pretest. A short and simple guideline was provided to them regarding the way of appearing and responding to the pretest. The time duration for the test was of 45 minutes. The main objectives of pretest were to compare the level of achievements of the students of two groups (control and experimental) and benchmark their level of learning after implementing new learning approach in the experimental group.

Orientation for students. In the sample schools, the researcher oriented students regarding the implementation of the new pedagogy of learning i.e. cooperative learning (CL) approach and its conduction in different modality. He interacted with them regarding the classroom setting, rules to follow along the learning steps and introducing them to a new way of learning. They were found to be happy when they knew the role of the teachers would be changed from talking and describing to listening and guiding them in small peer groups.

Cooperative lesson plans. The CL treatment was given to the students of experimental group by using the cooperative lesson plans in their classrooms. The students of control groups were let to remain under as usual conventional process of teaching with similar T/L aids. In this way, two different T/L processes were going on which were evaluated by assessing their learning outcomes with the same test items. These scores were subjected to statistical analysis. The cooperative learning approach was adopted in three stages:

The first stage. The teacher introduced the preliminary concept of teaching topic or any task of mathematics through either relevant open-ended question, storytelling, relating with real life situation, or any news items, etc. whilst s/he might code a few challenges faced by students with clues. The estimated time, for this session, used to be of five to ten minutes.

Second stage. The second stage was actual T/L and peer/group work stage. It went through setting/arrangement, distribution of T/L aids, working on tasks, sharing and feedbacking sessions.

Classroom setting: It consisted of students' group division, sitting arrangement and distribution of T/L aids among them. After dividing the students in groups, they used to undergo for group works. The groups formed were of moderate size consisting of around four students.

The distribution of T/L aids: The T/L materials, though optional, used to be distributed among the groups. It became more effective when the teacher instructed in plenary about different problems, put the T/L materials in desks/tables and allowed the students to join the desks according to their interest.

Five working steps: The students went under five successive working steps (5E-Engaging, Exploring, Explaining, Elaborating and Evaluating) in peer groups with the help of four successive skills (4F- Forming, Functioning, Formulating and Fermenting) to follow up the phenomena of cooperative learning approach as suggested by Johnson & Johnson (2000).

Plenary session: After spending the allocated time under the proper guidance of teacher, the groups reached the conclusion and aftermath they presented their way of doing, used strategies and formulae, findings and conclusions in plenary session. However, it was not needed after every item/activity of group work.

Third stage. The students presented their group works, turn by turn, in the plenary. The peers and teacher provided the essential feedbacks if any. Moreover, the teacher reviewed the works, carried out formative evaluation, and went for briefing and debriefing, then wrapped up the class with conclusion.

Field works and test administration. The opinions were collected while visiting and working in the sample schools. The collected opinions were of cooperative-teacher, math-teachers, head teacher and other subject teachers.

Administration of post-test and retention test. After the completion of the specified time of experiment, a posttest was administered by using those questions which were prepared by considering cognitive domain (knowledge, comprehension and application) and grade wise outputs specified by the CDC, Nepal. To see the retention impact of cooperative T/L approach, there was a provision of taking delayed post-test, which was conducted after a month of the completion of the experiment in both the sample schools.

V. ANALYSIS AND INTERPRETATION OF THE DATA

The researcher analyzed and interpreted the quantitative data of students' performance in pretest, posttest and retention test by using a SPSS (version 20) which dealt with mean, standard deviation, coefficient of variation, dependent and independent t-tests. Similarly, the quantitative findings were presented in tables, diagrams, graphs and charts. The qualitative data collected with the help of checklists of observation of classroom activities and guidelines of interactions and interviews were analyzed by thematic analysis that generated major themes related to problems and challenges of implementing cooperative learning in mathematics classroom.

Analysis of the Data

The quantitative and qualitative data of the study have been analyzed and presented separately.

Quantitative Findings

The analysis and interpretation of the quantitative data was based on the marks obtained in pretest, posttest and retention test by the students. These marks were also further analyzed according to the different cognitive domains (knowledge, comprehension and application levels). The table wise data and their interpretations have been given below.

Table 1. *Achievements of students in both groups in three different tests*

Tests (FM. 100)	X - School (Control Group)				Y - School (Experimental Group)			
	No.	Mean	S. D.	Coeff. of Var.	No.	Mean	S. D.	Coeff. of Var.
Pretest	34	27.91	12.03	0.43	40	26.55	10.52	0.39
Posttest	34	44.56	14.52	0.33	40	61.93	19.28	0.31
Retention	34	35.03	12.66	0.36	40	46.97	14.23	0.30

It was found that the mean scores and coefficient of variations of pretests of both the groups (control and experimental) were almost similar. The mean score of control group was 27.91 with standard deviation 12.03 and coefficient of variation 0.43. Similarly, the mean score obtained by experimental group was 26.55 with standard deviation 10.52 and coefficient of variation 0.39. It showed that both the groups were found to be similar to implement the treatment.

To measure their immediate learning outcome, there was a provision of post-test after completing the lesson activities. The researcher got the increment of mean marks from pretest 27.91 to posttest 44.56 in control group whereas in experimental group it increased to 61.93 from 26.55. The achievement made by the

students of experimental group was greater by 17.37 marks (Table 1). It showed that the learning achievement in the conventional type of teaching method was quite low compared to the cooperative learning. In addition, the coefficient of variation showed that the experimental group had more consistency in achievements than that of the control group. Though the progress in immediate learning had taken place in both the methods, a more substantiated learning achievement was found in the cooperative learning approach than in the conventional one.

In the same way, the retention tests were also administered (after a month of the post-tests) in order to measure their effectiveness for long-term memory. Regarding their retention power, it showed a decrease in marks in both the groups. The marks of the control and experimental groups were found to be 35.03 and 46.97, respectively in the retention test (Table 1). It was revealed that the learning achievement was found to last longer in the students of experimental group than in the control group. On the basis of coefficient of variation, the experimental group showed more consistency in the achievements as well.

Further statistical test were administered, turn by turn, to examine the significant differences among the variables between the control and experimental groups. To see the homogeneity of two groups that was how the initial differences of mean scores existed between them, Levene's test was administered. According to Levene's test of equality of variance, the researcher found F-value 0.967 and the significance value 0.329. The significance value 0.329 is greater than the level of significance i.e. α-value 0.05, indicating that the groups were homogeneous (Table 2).

Table 2. ***Levene's test for equality of means for scores of pretests***

Pretests	Levene's Test for Equality of Variance		T-test for Equality of Means		
	F	Sig. value	t	D. f.	Sig. (2-tailed)
Equal variances assumed	0.967	0.329	0.519	72	0.605
Equal var. not assumed			0.514	66.16	0.609

As the variances of two groups were homogeneous (equal), it was found t-value as 0.519 with significance value 0.605. The significance value was greater than the level of significance value i.e. $\alpha = 0.05$, so, the null hypothesis was accepted (Table 2). It meant there was no significant difference between the achievements of the students in both the groups in pretests. They can be treated as similar groups though their difference of mean marks was 1.35 (27.91 – 26.55) (Table 1). This difference was not large enough to challenge the null hypothesis and so, it was not significant. So, both the groups were found to be homogenous in which the investigator could apply the treatment for either of the groups.

The study had evaluated and compared students' achievements by administering post test and retention test. Further, the net gain in learning mathematics was also obtained. The data were statistically processed and interpreted as provided below.

(i) Comparative Study of Posttest-scores of Both the Groups

The comparative study of posttests of both the groups has been depicted below in table 3.

Table 3. *Levene's test for equality of means for scores of post-tests*

Posttests	Levene's test for Equality of Variance		T-test for Equality of Means		
	F	Sig. value	t	D. f.	Sig. (2-tailed)
Equal var. assumed	4.58	0.036	-4.31	72	0.000
Eq. var. not assumed			-4.41	71.038	0.000

According to Levene's test of equality of variance, the researcher found F-value as 4.58 and the significance value 0.036, the latter one was smaller than the level of significance i.e. α-value 0.05, which implied that the variances of two groups were not assumed equal. So, it was taken t-value as -4.41 with significance value 0.000. The significance value was smaller than the level of significance value i.e. $\alpha = 0.05$, so, the null hypothesis was rejected (Table 3). It meant there was a significant difference between the achievements of the students in both the groups. The mean mark of the experimental group was 61.93, which was greater by 17.37 than that of the control group's mean marks 44.56 (Table 1). It showed that the treatment given to experimental group was found to be significant to produce immediate enhanced learning outcomes.

(ii) Comparative Study of Retention Test-scores of Both the Groups

The comparative study of retention tests of both the groups has been given below in table 4.

Table 4. *Levene's test for equality of means for the scores of retention tests*

Posttests	Levene's test for Equality of Variance		T-test for Equality of Means		
	F	Sig. value	t	D. f.	Sig. (2-tailed)
Equal var. assumed	0.24	0.63	-3.78	72	0.000
Eq. var. not assumed			3.82	71.84	0.000

According to Levene's test of equality of variance, the researcher found F-value as 0.24. The significance value 0.63 which was greater than the level of significance i.e. α-value 0.05, so, the equal variances assumed. It was found t-value as -3.78 with significance value 0.000. The significance value was smaller than $\alpha = 0.05$. So, it rejected the null hypothesis. It meant there was a significant difference between the achievements of the students in both the groups in the retention tests. The mean mark of the experimental group was 46.97, which was greater by 11.94 than that of the control group's mean marks 35.03 (Table 1). This implied that the treatment applied to experimental group was found to be useful for a longer memory as well. This finding corroborates Johnson and Johnson (2006) in which they found cooperative learning activities supported students to increase their extensive thinking and explanation skills through sharing the ideas which facilitated more understanding, increased the level of reasoning and accuracy of last longer memory.

(iii) Comparison of Net-gain in Learning of Two Groups

The table 5 (a) shows that the mean score of the difference of pretest and retention test of X- School (Control group) and Y-School (Experimental group) were 7.0 and 20.4 respectively.

Table 5(a). ***Scores differences of pretest and retention tests of both the groups***

Difference of pretest & retention test scores	N	Mean	Std. Deviation
X - School (Control group)	34	7.0	5.7
Y-School (Experimental group)	40	20.4	8.8

Its significance was tested as follows.

Table 5 (b). ***Independent Samples Test***

Diff. of pretest and retention test scores	Levene's test for Equality of Variance		T-test for Equality of Means		
	F	Significance (p)	t	D. f.	Sig. (2-tailed)
Eq.var. assumed	3.63	0.061	7.641	72	0.000
Eq. var. not ass.			7.909	67.19	0.000

According to Levene's test of equality of variance, the researcher found F-value as 3.63 with significance value 0.061 (Table 5b). The significance value is greater than α-value 0.05 so, the researcher went for the p-value 0.000 of the row of equal variances assumed. Again, the p-value 0.000 was found to be smaller than α-value 0.05, which meant the rejection of null hypothesis. Hence, there was a significance difference in the net gain in experimental and control groups. The mean score of experimental group (20.4) was found to be significantly higher than that of control group (7.0). Thus, the researcher concluded that the effect of treatment was significantly in the favor of experimental group for net gain in learning of mathematics by using cooperative learning approach.

VI. FINDINGS OF THE STUDY

The quantitative and qualitative findings of the study have been presented separately.

Quantitative Findings

The statistical tools applied in this study for the analysis of the quantitative data of this study have drawn the following conclusions.

1. On the basis of pretest scores, the students of both the groups were found to be of same standard. After the use of cooperative learning approach, the students of experimental group were found to be significantly better in regard to their immediate learning achievements.
2. The statistical tool applied for retention tests implied that the treatment effect produced a longer memory in the students of experimental group than those of control group.
3. The students of experimental group stood significantly better than the students of control group regarding the net gain in learning.

Qualitative Findings

In the form of qualitative data, the study incorporated the experiences, opinions and observations of students, teachers, and subject experts. These conclusions have further been analyzed and made consistent with the conclusions of review of literatures, pre-existed theories and researcher's own reflections. All of these informative data and records were triangulated and verified to make the findings more consolidated.

In order to dig out the different types of problems being faced by the cooperative teachers, according to the principle of cooperative learning approach, they were interviewed. Moreover, the interview was also administered to head teachers and other mathematics teachers. They reported that, there were big problems of classroom setting having limited space and fixed furniture, which created obstructions to have group activities. The classrooms were small without enough light, the dilapidated walls and ceilings. There was no conducive environment, no proper management of T/L materials, and no raw materials (even card boards and sheet papers, colors, scissors etc) for preparation of T/L materials. Though, the students were managed in groups by making them to sit face-to-face manner pairs of benches and desks and they were provided the materials for the period of carrying out research by the researcher.

Similarly, there was lack of training to the teachers (if they had any trainings that were always of stereotype), low remuneration and motivation, no cooperation of school administration, no support of other colleague-teachers, teacher centric teaching where front benchers only seemed learning, other students were left isolated and inactive, examination system based on paper and pencil tests, and there was overload to teachers.

In addition, they reported that in traditional method, the teachers could not be the good and trustworthy friend to the students, there was a communication and generation gap as well between the students and mathematics teachers. There was no availability of curricula, reference books, teachers' guides, exercise books and elaborations of the subject. The commonly adopted T/L method was lecture method without group works and project works. The teachers could not give feedbacks and comments to the students' homework. The academic culture was degrading and blaming tradition was common among the students. There were no proper mechanisms to deal with the diversity of students' background and individual difference of the students. There was a communication gap among the teachers and also with the parents. In such situation, any effective teaching learning methods along with the cooperative learning one could not work much.

VII. REFLECTION AND DISCUSSION OVER THE RESULTS

At the beginning of the research, I had many obstacles and challenges viz getting similar status of schools, training to the teachers, teachers used to think that the course may not be completed on time, class may not be under the control of the teacher, good students may not follow the rules, implementation of different evaluation system, right way of conducting ,different tests etc. However, all of these problems came under the shadow by virtue of CL approach and zeal of the good research. Actually, the teachers not only successfully completed the research phase, but continued using the cooperative learning approach in their schools even after the experiment was over. At the time of taking the retention test after a month, students were found to be satisfied and they provided me the credit upon it. In this way, though, I could not generate the new theories, but all of the findings were found to be consistent with the relevant theories and literature.

An effective learning may take place in friendship groups where the members can share their knowledge and skill without any hesitation in a cooperative group. Mathematics learning can be viewed as a social process, in which each individual learns mathematics through social interaction, meaning negotiation, and shared understanding (Vygotsky, 1978). According to Perry and Greenberg (2006, as cited in Kshetree, 2012), there are four benefits of cooperative learning approach - social, psychological, academic and assessment (evaluation of group and individual both and providing instant feedback). The cooperative learning environment is a virtue of team responsibility in learning in spite of individualistic and competitive as claimed by Johnson and Johnson (2000), and democratic behaviors as argued by Saxena (2001) who stated as in pairs; the empathetic cooperation, freedom of expression and publicity, resourcefulness and self-administration, individual and the collective development. So, it was intuitional effort to appraise democratic norms and values in cooperative learning-approach because it was a space for connecting teachers with students, self-expression, debating and dialoguing, searching archived knowledge and learning in a structured manner. Along with these best practices, the cooperative learning system was also found to be aware of students' cultural capital as Bourdieu (1998, cited in Haralambos & Hearld, 2006) claimed, those children whose home culture is similar to the school T/L system, they can cope easily with the system and learn effectively.

In this regard, Maria (2016) claimed that the teachers' works and culture in the post modernism reviewed that for enhancing the classroom environment for universal access to learning, strengthening cooperation, partnership, relationship between students and among colleagues the pedagogical practices of the teachers have profound effects. It makes the classroom life safer, more productive and more fulfilling for the children's lives. Usually, students are working in groups of two or more, mutually searching for understanding, solutions, meanings, and co-creating a product.

On the basis of pretest scores, the students of both the groups were found to be of same standard. The role of cooperative learning approach was found significant in immediate learning achievement of experimental group of the students. The consistent peer interaction could have a powerful influence on academic motivation and achievement (Light & Littleton, 1999 cited in Kshetree, 2011). In the cooperative learning, it has applied rational choice theory for peer activities as stated by Adam Smith and early functional theory for their self-esteem in peer groups which positively influenced to have immediate learning. In this regard, Doise (1990) argued that the main thesis of this approach is that "...it is above all through interacting with others, coordinating his/her approaches to reality with those of others, that an individual masters new approaches" (p. 46). It showed that the high achievement of the students was as expected and consistent due to the mastery of the individuals in it while working in groups. In this case, the study also found that the treatment applied to the experimental group under the cooperative learning approach

worked well to raise the scores of the students significantly than the students of control group.

The findings from the retention tests implied that the treatment effect produced a longer memory in the experimental group than in the control group. This finding is supported by Palincsar and Brown (1984) with basic reasons as talking turn by turn, listening more, reason, respect and being responsible, use of T/L materials, discussions to relate the problems to empirical methods, use of creativity, find the mathematics patterns and learning from concrete to abstract concepts of mathematics. Similarly, calling in action and do reflection, shifting from talking and describing to listening and addressing students' problems showed the tangible results of cooperative learning approach.

Moreover, in peers, students feel comfortable to exchange their every idea, each one is clear for his/her role of action. The students in groups take their own responsibility and be activated for their identity. They learn the mathematical concepts on their own pace and methodology, they verbalize their ideas to the group that help them to develop more clear concepts. Thus, the thought process becomes fully embedded in the students' memory for a longer time. Vygotsky supports this concept by claiming that verbalization plays significant role for long term memory (Vygotsky, 1978). As an effect of treatment, the net gain in learning was found to be significant in the students of experimental group in comparison to the control group. According to Vygotsky (1978), it happens due to availability of opportunities like - more interacting, arguing, conceptualizing the problem, rich problem solving, discussing for alternative solutions so that the students extend their zone of proximal development (ZDP).

Regarding the T/L challenges, the findings of qualitative study asserted that there was the stigma of dull students, no idea for peer education, teacher's unwillingness to take up additional responsibilities, noisy classes, ignorance, teacher dominance, and conventional assessment system. There was no support of other teachers and school staffs. It was difficult to identify socio-learning culture in the schools and classrooms. The teachers were not able to set the ground rules for peer groups, assessment of existing knowledge and attitude of the students, preparation and use of T/L aids with lesson plans. There was lack of supervision and its tools, indicators to monitor the progress, tools to interpret the experiences and narratives/anecdotal records. There was lack of leadership practice for making turn by turn group leaders, identifying inter and intra group relations/working modalities, etc. It means, the teachers and schools need to address these kinds of problems to see the full-fledged positive impacts of cooperative learning approach. However, as a result of the collective efforts, these activities were found supportive to face the challenging tasks or questions and helped moving towards applications which organized pertinent facts and ideas. Instead of being distant observers of questions and answers or problems and solutions, the students became immediate practitioners. It encouraged students to practice and develop higher order reasoning and problem-solving skills.

VIII. CONCLUSION

The students of control group were found to be in search of working rules and formulae to solve the problems rather than developing mathematical concepts. Teachers were supposed to be all in all, so the students could not expose their ideas and hence they could not go beyond the instructions of the teachers as a result they compelled to follow the fixed rules. But the students of experimental group were going beyond the fixed rules. So, they were making themselves involved in learning mathematics with more enthusiasm.

Though the students of conventional method had their own pace and strategies for learning the new concepts, but it was more revealed in the students of cooperative learning group. The learning pace, action and strategies were based upon the contemporary situation as the system of values, beliefs, norms, artifacts and symbols that had been developed by the circumstances created around it. In fact, every activity of a person was based on cause and circumstances. Therefore, the performance of experimental group could be better depending upon the environment that was created. The learning could meaningfully be taken place through their direct involvement in the cooperation of colleagues rather than the teachers' instructions. Students felt comfortable to be corrected in the group rather than in plenary with the supervision of teachers. The T/L system required a liberating experience in which the student explored, created, used his/her initiatives and judgment and freely developed his/her talents to the full potential. Further, it promoted the self-participation, cooperation, coexistence and harmonization among the peer groups.

The study showed that the students of cooperative learning were found to be more forward, sharing, valuing to colleagues, interactive, trying for hard problems, discussing, and happy to contribute in the group. Moreover, they seemed to come out of any kinds of shyness, nervousness and mathematics phobia. The students of cooperative group were found to be in search of some kinds of drawing or tools to handle their mathematical problems. The passive students started to be actively involved in learning process with own interest when they were learning with demonstrations with scissors, papers, cubes, blocks, open ended questions, etc.

It was found that mathematical understanding was supported by classroom friendly behavior, communication, connections and decision-making in team. The simple trial and error method as Thorndike's learning theory was also found to be popular in the working groups. Also, teachers and students worked together and created conducive environment in their cooperative classroom. The discussion part of this study showed that the students of experimental group were significantly handling the situation and demonstrating the problem-solving skills.

The teacher was found to be more aware towards students' abilities when they worked in small groups. In the similar manner NCTM (2000) declared that while closely working with the students, it gives the teacher insight into problem-solving abilities. The teacher solicits students' ideas about how the problems might be solved and then gives the students time to solve the problems. As the teacher reflects on the strengths and ideas offered by the students, his/her expectations generally change. The classroom where thoughts were accepted, ideas were investigated, and meaningful problems were solved. The teacher used to think that students lack the necessary skills to work in-group activities, but the cooperative learning approach disproved it. As Ong and Yeam (2000, as cited in Kshetree, 2012) argued teacher taught the

missing skills and reinforced the skills that students needed in cooperative learning approach.

In sum, if the problems created by age-old T/L methods, conventional mind set of teachers, physical infrastructures, training of teachers, classroom settings and lack of T/L materials are taken seriously and solved them, the CLA can bring a paradigm shift in T/L mathematics so that teachers and students can work together to bring the most positive changes in T/L mathematics with better achievements of the students.

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