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Impact of Cooperative Learning Approach on Students' Achievement in Mathematics

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Abstract

Cooperative Learning Approach (CLA), focusing on the collaborative, active engagement and group working to each other in mathematics learning, makes significant impact on the students' achievement in their academic career. The objective of this study is to investigate the impact of CLA on academic achievement in mathematics at grade nine students of Rukum (West), District, Nepal.

A quantitative method and a quasi-experimental research design were employed in this study to examine how CLA made an impact on students in two community-based schools. The two schools were purposely selected from two strata such as one experimental stratum (N=15) and another control stratum (N=15) assigned by result of pre-test result through random selection. Mathematical Achievement Test (MAT) and participants' observation dairy notes were used as tools for data collection. The research process based on Input, Process, and Output (IPO) model whereas experimental group was taught by using CLA and control group was taught by Conventional Teaching Approach (CTA) with twenty-six days on the topic of mensuration of compulsory mathematics. At the end of intervention, post-test was administered on both groups, while the daily reflective notes prepared during intervention period among two groups related with students' learning behavior and activities regularly.

The result is analyzed by using t-test to compare mean score of posttest for both groups. The result indicated significant association between mean achievements of experimental group and control group, $p<0.05$ that implies cooperative learning group performed better in mathematics achievement. Findings is that CLA was significantly motivated, engaged, shared, cooperative, and accountable approach than conventional approach in terms of learning concepts and skills in mathematics. The cooperative learning approach is more beneficial in mathematics teaching to enhance students' academic achievement, and therefore mathematics teachers would incorporate this approach in their teaching learning process.

Key words*:* Cooperative learning, quasi-experimental study, constructivist, achievement

Introduction

Teaching approach plays the significant role in learning mathematics. Different teaching approaches are used in teaching mathematics. Cooperative learning (CL) approach is one of them that are defined as a student centered teaching approach. This approach is based on group working and collaboration learning approach in educational field. Initially, the concept of CL approach was introduced by Johnson and Johnson (1987) and R. E. Slavin (1995). It is worldwide applicable and recognized teaching learning strategy. It gives an emphasis on social interaction and group sharing learning among students from school to higher education across various areas (Gillies, 2014). Likewise, it is also applicable in social and educational psychology (Johnson et al., 2008), social sciences and mathematics (Lenkauskaitė et al., 2020).

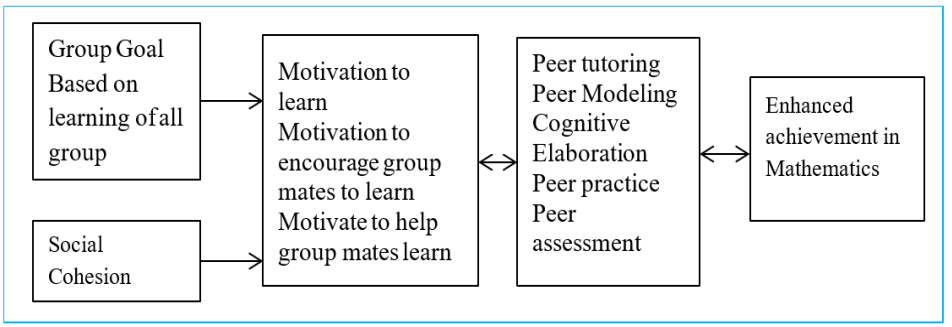
CL approach refers to situations where the class is divided into different groups, working together towards a common goal by sharing knowledge and skills (Entonado & García, 2003) and promotes learning and socialization (Gillies, 2014). It involves instructional strategies where students collaborate in small groups to support each other in learning academic content (Robert E Slavin, 2014) and enhanced learning efficiency (Saekhow, 2015). Thus CL methods allow all students in the classroom to collaborate and reach a shared solution through collective teamwork (Shafiuddin, 2010). In this learning approach, positive independence, individual accountability,

promote interaction, the appropriate use of social skills, and group processing are main essential elements of CL (Johnson et al., 2008).

CL approach is student-centered method based on constructivist learning theory (Tran, 2013). It is based on social constructivism in which students learn through social interaction and peer collaboration to each other's (Lenkauskaitė et al., 2020). There are two-way communications in teaching and learning process in cooperative learning. In this context, students as active learners and it promotes students'' engagement for meaning learning (Kalina & Powell, 2009). Therefore, in social constructivism advocated collaborative learning (Vygotsky, 1962) and cooperative learning and interaction (Lenkauskaitė et al., 2020). According to social constructivists, meaningful learning happens when individuals participate in interaction and collaboration in classroom teaching and learning process (Amineh & Asl, 2015; Kim, 2001). So, cooperative learning is key element of constructive learning theory and considered effective in mathematics learning (Berta & Hoffmann, 2020). In mathematics learning, a model of cooperative learning can be illustrated (Figure 1).

Figure 1

A Model of Cooperative Learning Effective Mathematics Learning (R. E. Slavin, 1995; Robert E Slavin, 2014)



This dynamic and student centered teaching learning strategy provides students' active participation and engagement in mathematics learning than traditional setting in teaching learning process (Gokkurt et al., 2012). Likewise, CL approach is one of prominent approaches (Robert E Slavin, 2010). The CL approach is a student centered teaching learning approach which enhances students' mathematics achievement and positive attitudes of students towards mathematics (Ndebil & Ali, 2024; Zakaria et al., 2010). By using CL approach in mathematics teaching revealed that students became more interested and motivated with mathematics and they perform better than traditional method (Ahmadi, 2000) and enhanced mathematical problem solving ability (Tarim, 2009). That is a cooperative learning approach is highly accepted as a student-centered teaching and learning approach to enhance effective engagement and learning achievement in mathematics of secondary schools' students.

In the context of Nepal, secondary level mathematics has recommended that mathematics teaching learning should be student-centered such as project learning, problem solving learning, and collaborative learning etc.(Curriculum Development Center (CDC), 2022). However, mathematics teachers have been practicing conventional teaching approach (Roka, 2022), banking model system (Roka, 2023). Moreover, mathematics achievement remains lower than other subjects. In the context of Karnali province, mathematics achievement is lower of other provinces as well as national average (ERO, 2022). In this regard, the relationship between cooperative learning and mathematics achievement at secondary level students need to be investigated.

Globally, various studies have reported that CL approach has promoted student' engagement and their academic achievement in mathematics learning. For example, Malaysia

(Zakaria et al., 2010), Denmark(Herrmann, 2013), Indonesia (Zakaria et al., 2013), Ethiopia (Geletu, 2022), and Kazakhstan (Kaymak et al., 2021). However, there are limited studies conducted in the context of Nepal such as that effectiveness of cooperative learning(Shah, 2023), cooperative practices of gender in health education (Acharya et al., 2020), using cooperative learning in geometry (Shrestha, 2022), and exploring prospects and challenging of cooperative learning approach in mathematics education (Kshetree, 2019). Issues concerning related cooperative learning intervention on mathematics in terms of mathematics achievement also considered research issues of this study.

Purpose of Study

The study investigates the impact of cooperative learning on mathematics achievement at community-based secondary schools in the Rukum West District. To achieve the purpose of study this study has answered the following research questions.

1. Does cooperative learning significantly impact on mathematics achievement of grade nine students?
2. How do students learning behaviors and activities demonstrate in cooperative learning in mathematics regarding the differences with conventional way?

Research Hypothesis

The research hypothesis was stated under the research question:

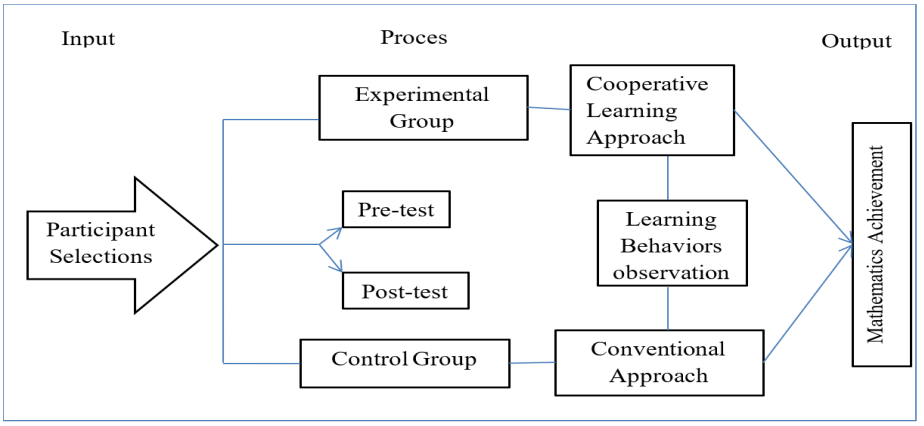
H_0: There is no significant difference in the achievement scores between the experimental and control groups in mathematics.

Conceptual Framework of the Study

This study focused on impact of cooperative learning (CL) approach in mathematics achievement. Cooperative learning approach is intervention variable (independent variable) and learning achievement of students in mathematics is dependent variable. The conceptual framework has designed by using Input, Process and Output (IPO) model (Jandoquile & Cruz, 2023). Thus, the conceptual framework of the study presented in (Figure):

Figure 2

Conceptual Framework of the Study



Materials and Methods

Research Design

The study used quantitative method, quasi-experimental research design (Ndebil & Ali, 2024) to examine the impact of cooperative learning on mathematics achievement at secondary level students. Study further explored students' learning behavior and engagement in mathematics learning in both cooperative learning group and traditional learning group. So, mixed interventional research design (Fetters & Molina-Azorin, 2020) was employed in this research.

Study Area

The study carried out in two secondary level community schools within Musikot Municipality of Rukum West. For the intervention study, two community- based schools, namely Tribhuvan Janata Secondary school and Yamuna Nanda Secondary School, were purposively selected.

Instruments/ Tools

A mathematics achievement test, designed with multiple-choice questions (MCQ) (Ndebil & Ali, 2024), was used as a pretest and posttest covering the same topics and following the same weight distribution. Both the pretest and posttest were conducted under identical conditions for both the control and experimental groups. The Mathematics Achievement Test (MAT) was validated by experts based on face and content. Also, we found that 0.827 correlation coefficient implies the instrument is reliable. Similarly, the daily classroom notes dairy has prepared based on elements of cooperative learning such as positive independence, individual accountability, promote interaction, the appropriate use of social skills, and group processing (Johnson et al., 2008) in students under both groups.

Research Procedure

This study mainly employed pretest-posttest quasi-experimental research. The research was conducted by using the Input, Process, and Output(IPO) model (Jandoquile & Cruz, 2023). The research process based on IPO model is presented as follows;

Pre-experimental Stage (Input)

First of all, two community schools Tribhuvan Janata and Yamuna Nanda Secondary schools were taken as sampled schools purposely from Rukum District and took permission from headmasters of required selected schools and then researcher meet with mathematics teachers for cooperation and research plan of study. Then author conducted pretest with the ninth-class students in both schools and based of pretest results, 15 students were selected from each school such that eight boys and seven girls from each school. The experimental group and control group were determined by using tossing a coin. Consequently, Yamuna Nanda School was as the experimental group while Tribhuvan Janata School was as control group. We already prepared instructional strategies based on the components of Student Team Achievement Division (STAD) developed by (Robert E Slavin, 1982; Robert E Slavin & Madden, 2021) in which same contents of mensuration topic taught in both class in the duration 26 days. The permission was first period in experimental group and third period in control group for intervention study.

Experimental Stage (Process)

It is interventional stage of research process. The experimental group was intervention through cooperative learning approach and control group through conventional approach in mathematics teaching based on contents mensuration of class nine students. Similarly, researcher notes down students' activities and learning behaviors in participants observation notes daily of both groups. The innervation class has conducted for 26 days with equal time.

Post-experimental Stage (Output)

At the end of the experiment, a post-test was conducted for both the experimental and control groups. The researcher reviewed and graded the students' test papers from each group. The scores were then collected and used to calculate the mean, standard deviation (S.D.), and variances of the achievement scores for both groups. The data were tabulated and analyzed to find the research results. Additionally, the information gathered from the classroom observation notes was categorized into different themes, and the triangulation method was applied to analyze this qualitative data.

Data Analysis Procedure

In the end of intervention mathematics achievement test was administered in both groups. The collected data was analyzed by using mean. S.D, and t-test (Boneau, 1960). However, Furthermore, a thematic analysis was carried out to explore cooperative learning elements, focusing on students' learning behaviors and activities, based on observations recorded in classroom diaries.

Results

In this section, the results of the analysis presented by using descriptive statistics and inferential statistical tests applied to analyzed quantitative data. The qualitative information obtained by reflective dairy notes analyzed through thematic analysis. The triangulation method is adopted for thematic the result. The mean, Standard deviation and T-test value of students learning achievement in mathematics on post-test presented in (Table 1).

Table 1

Summary of analysis t-test Result on post-test between the Groups

Group	Sample	Mean	SD	Tabulated value	Calculated Value	Remarks
Experimental	15	29.78	31.93	1.70	2.04	Significant
Control	15	25.46	36.87			

*TV< CV (significant at 0.05)

Table 1 shows that the experimental group (Mean = 29.78, S.D. = 31.93) and the control group (Mean = 25.47, S.D. = 36.87) were compared. The mean achievement of experimental group is higher than the control group and the standard deviation of experimental group is lower than the control. Similarly, the calculated t-value of 2.04 is greater than the tabulated t-value of 1.70 at the 0.05 level of significance. This indicates that the null hypothesis is rejected, revealing a significant difference between the experimental and control groups.

Students Learning Behaviors and Activities

In this section, researchers presented the students learning behaviors and activities in separate section.

Changes in Student Learning Behavior in the Learning Process

After starting the teaching-learning activities, researcher observed students' activities in the classroom with the help of regularity diary notes. The student's behavior was explained as the following theme:

Motivation and Regularity

When researcher went into the classroom of experimental group, students were found active, more interested to learn and excited. Similarly, researcher found them ready to learn anything in the nick of time. They wore more attentive to learn. It means they paid their full attention towards the study. On the other hand, researcher could not find students paying attention towards the study in the control group. They were not active, excited and interested to learn. Similarly, they had borne felling towards the subject in the control group. From this, we can undoubtedly say that the students, who were taught by the cooperative learning, were found highly motivated than the students who were taught by the conventional method.

Interaction and Engagement

In the experimental group, researcher found students working in the group where they had face to face interaction to each other. Similarly, the teacher and students had engaged their time to interact each other by which they could learn in the better way. Students were found more active and interested to take part in the interaction. In this way, teaching-learning process becomes effective. Unlike experimental group, students were not found busy in face-to-face interaction in the control group. They were only passive listener and did not get chance to interact with their teacher because of their fairness and shyness. Thus, face to face interaction was there in teaching by using the cooperative learning and there was effective teaching-learning than using traditional method.

Positive Independence

Students in experimental group had positive independence. That is to say, students were found more cooperative to each other during the classroom period so that they had the felling to togetherness rather than the felling of peer competition. In this group, researcher found students doing for the betterment of the group. On the contrary, students did not have the feeling of togetherness and cooperation in the control group. They were found doing for the betterment

of oneself rather than doing for the group. Similarly, they had the feeling of peer competition in the control group. So that, they were found that there is weaker in positive independence in mathematics learning. From this discussion what can be said that teaching through cooperative learning seemed better regarding positive independence than teaching through traditional way of teaching.

Individual and Group Accountability

In the experimental group, students were found responsible for the group work. That means every student was responsible doing for group activities. Students got ready for the examination and did not have the feeling of fairness and shyness towards the exam. They were also found sharing their ideas to the group's success. In order to make the group successful, they were found making correction in necessary. In this way, they seemed cooperative to learn and solve the problems emerged in the classroom. Similarly, they were found ready to answer the teacher. In the control group, on the other hand, students were found non-cooperative to learn and solve the problems. They were not found sharing their ideas to the group. Similarly, students were not found ready to answer the teacher. In this way, individual accountability and group-accountability seemed positive by teaching cooperative learning than traditional strategy.

Social Skills Development

Students were found more social, cooperative, helpful and constructive in the experimental group. They were busy working in the group so that they could develop their social skills. Similarly, researcher found them discussing in the group to solve the classroom problem and found asking questions to the teacher. They were found sharing their ideas to each other and encouraging friends to share ideas unhesitatingly. In this way, they were found more developing regarding social skill. On the contrary, students were found less social, non-cooperative and unhelpful in the control group. They were not found busy developing their social skill so that they could not build the capacity of being leadership. Similarly, they were not found sharing their ideas to each other in group. From the above discussion, we can undoubtedly say that the students who were taught through cooperative learning were found developed in social skills than the students who were taught through traditional method.

Discussion

The study focused on an impact of cooperative learning approach on mathematics achievement. The finding of this study has revealed that cooperative learning approach enhanced learning achievement of students in mathematics compared to conventional approach. The result indicates that there is statistically significant difference between experimental group and control group in mathematics learning. This result is similar to the study of Slavin (2015), Kagan and Kagan (2017), Zakaria et al. (2010) conducted in Malaysia, study of Kaymak et al.,(2021) in the context of Kazakhstan, Ethiopia (Geletu, 2022), Indonesia (Zakaria et al., 2013), and Turkey (Karali & Aydemir, 2018). This shows that the cooperative learning approach is effective in teaching and learning mathematics for increasing the student's learning achievement. This study found that the Cooperative learning approach improve the student's motivation, active participation, peer interaction, social skill development, and group accountability in learning mathematics. In addition, cooperative learning enhances students' self-confidence (Zakaria et al., 2013), positive attitudes towards mathematics (Karali & Aydemir, 2018), and increases learning motivation It cultivates a strong group work culture (Mueller & Fleming, 2001), where students are interdependent, accountable for their tasks, promote each other's success, effectively use social skills, and regularly assess their collective performance (Fernandez-Rio et al., 2017; Gillies, 2016; Johnson et al., 2007; Webb & Farivar, 1994). Finding of this research contradiction with the finding of the study of Dillenbourg et al. (2016) they argue that all students not participate equally in group work. Similarly, Kirschner, Sweller, and Clark (2006) found that novice learners should do more effort for collaborative learning which leading to cognitive overload and decreased individual accountability. Kutnick, Blatchford, and Baines (2014) become less productive and negatively affecting learning outcomes based on structure of learning environment. Thus, the findings of study indicated that cooperative learning strategy promotes positive impact on students' learning behavior and their learning achievement in mathematics.

Conclusions

This study provides valuable knowledge concerning into impact of cooperative learning approach on mathematics learning at grade nine students. The mathematics achievement of students through cooperative learning approach enhanced than conventional approach. Furthermore; students in the cooperative learning group have highly positive, motivated, active participation, better personal and group accountability, and developed cooperative and social skills compared students in the control group. The findings of this study will help education leaders and teachers to create and promoting cooperative learning environment to improving collaboration and social interactions led to learning achievement. Further study based on this topic through qualitative nature, across various disciplines of education need to be investigated.

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