EFFECTIVENESS OF COLLABORATIVE METHOD IN LEARNING MATHEMATICS AT SECONDARY LEVEL

A

THESIS

BY

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IN THE PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER IN MATHEMATICS EDUCATION

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Letter of Certificate

This is to certify that Mr. Aanand Prashad Joshi, a student of the academic year 2076/077 with campus Roll No. 122, Exam Roll No.7628193 thesis number 1865 and T.U Regd. No. 9-3-28-309-2019 has completed his thesis under the supervision of Assoc. Prof. Ram Chandra Ghimire during the period prescribed by the rules and regulations of Tribhuvan University, Kathmandu Nepal. This thesis entitled "Effectiveness of Collaborative Method in Learning Mathematics at Secondary Level" embodies the result of his investigation. I hereby Recommend and forward that this thesis be submitted for the partial requirements to award the Degree of Master of Mathematics Education.

…….

Dr. Abatar Subedi

(Head of Department)

Date: 29 Aug 2025

Letter of Approval

This thesis entitled **“Effectiveness of Collaborative Method in Learning Mathematics at Secondary Level."** submitted by **Mr. Aanand Prashad Joshi** in partial fulfillment of the requirement for the Master's Degree in Education has been approved.

Viva Voice Committee

1. Dr. Abatar Subedi …….
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3. Assoc. Prof.Ram Chandra Ghimire…….……
   (Supervisor)

Date: 29 Aug 2025

Recommendation for Acceptance

This is to certify that **Mr. Aanand Prashad Joshi** **as** completed his Master in Mathematics Education thesis entitled **"Effectiveness of Collaborative Method in Learning Mathematics at Secondary Level."** under my supervision during the period prescribed the rules and regulations of Tribhuvan University, Kirtipur, Kathmandu Nepal. I recommend and forward this thesis for final evaluation.

…….

Assoc. Prof. Ram Chandra Ghimire

(Supervisor)

Date: 29 Aug 2025

Defense Date: ……

Dedication

To my family who developed a Great Span of their life under very much difficult circumstances to make me what I am now.

Declaration

This dissertation contains no material which has been accepted for the award of another degree in any institution. To the best of my knowledge and belief, this dissertation contains no material previously published by authors except acknowledgment has been made.

……

Date: 25, June, 2025 (Aanand Prashad Joshi)

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……..

Aanand Prashad Joshi

Abstract

This thesis entitle **“**Effectiveness of Collaborative Method in Learning Mathematics at Secondary Level” aims to examine the effectiveness of the collaborative learning method in improving students' mathematical achievement at the secondary level. The research was conducted at Helambu Bodhisattva Model School and Ichok Secondary School, located in Helambu Rural Municipality-6, Ghopteghang, Sindhupalchok, Nepal by adopting experimental research design. 20 students of grade IX from each school were selected randomly and assigned into experimental group and control group by tossing a coin. The experimental group was taught mathematicsusing the collaborative method and the control group and taught using traditional lecture-based method. The intervention lasted for 20 school days and both groups were evaluated through a pre-test and post-test focused on algebraic expressions, linear equations, Meanwhile, qualitative data were gathered through semi-structured interviews with four students from experimental group.

This study investigated the effectiveness of a collaborative learning method on students' mathematical achievement. Pre-test scores confirmed both the experimental and control groups were statistically equivalent. However, post-test results revealed a significant improvement in the experimental group's performance, with an average gain of 11.55 points compared to the control group's 5.5 points. A t-value of 11.136 confirmed this difference was statistically significant. Qualitative data from interviews further supported these findings, showing that the collaborative method enhanced student engagement, critical thinking, and conceptual understanding. The study concludes that collaborative learning significantly improves mathematical achievement and recommends integrating it into secondary-level curricula, especially

in public and rural schools where traditional teaching is prevalent, to foster deeper learning.

Table of Contents

Chapter I

Introduction

The introduction section serves as the gateway to the study, providing an overview of the research topic, background of the study, statement of the problem, objectives of the study, research questions of the study and its significance.

Background of the Study

Mathematics is a fundamental subject in secondary education playing a crucial role in developing students' logical reasoning and problem-solving skills. However, in many secondary level classrooms in Nepal, traditional teacher centered instructional methods remain prevalent. These approaches often emphasize rote memorization and passive learning, limiting students' ability to engage deeply with mathematical concepts. As a result, many students struggle with mathematics, leading to low achievement levels and a lack of interest in the subject. To address these challenges, alternative teaching strategies, such as cooperative learning, have gained global attention for their potential to enhance student engagement and improve learning outcomes.

In this regards, Sharma and Bhandari (2021) found that collaborative learning strategies in mathematics classrooms in Nepal led to improved student understanding and retention. Likewise, Basnet (2022) highlighted how peer-assisted learning in secondary schools fostered deeper conceptual understanding and reduced math anxiety. Internationally, Thomas and Nguyen (2023) observed that digital collaborative platforms, when integrated effectively, promoted equitable participation and fostered a more inclusive learning environment.

Despite its theoretical promise and empirical support, collaborative learning in mathematics education faces several practical challenges. These include group

tension, unequal participation, and the “free-rider effect” where some members contribute less (Themes & Perry, 1998). According to Damon and Phelps (1989), effective collaboration requires conditions such as mutual respect, interdependence, and equity among group members.

A particularly relevant theoretical framework is the Identity Salience Theory (Brewer, 1996), which examines how individual and group identities influence participation in collaborative settings. In recent years, scholars have used identity-based approaches to analyze how students' self-perceptions and group dynamics affect their engagement in collaborative learning (Karki & Adhikari, 2020; Li & Torres, 2022).

In the context of Nepal, although collaborative learning is being increasingly recognized in policy documents and teacher training programs, its practical application remains limited. Classroom observations reveal a significant gap between the theoretical framework and its execution in daily instructional practices. Factors such as large class sizes, lack of training, traditional teacher-centered approaches, and insufficient instructional resources have hindered the effective implementation of collaborative learning in mathematics education (Acharya, 2020; Rai, 2023).

Mathematics is often perceived as a difficult subject by students, a perception that is further exacerbated by ineffective pedagogical strategies. The collaborative method, though pedagogically sound, has not been fully adapted to suit the Nepalese educational context. This has led to a mismatch between the intended educational reforms and actual classroom practices. Therefore, this study aims to compare the mathematics achievement of students taught through collaborative learning methods and conventional method in teaching mathematics in Nepal. By examining the current practices, pedagogies, and perceptions, the study seeks to bridge the gap between

policy and practice, and contribute to the development of more effective and contextually relevant collaborative strategies for mathematics education in Nepal.

Statement of the Problem

In Nepal, secondary-level mathematics education is still largely dominated by Traditional, teacher-centered approaches such as lectures, note dictation, and rote Memorization. These methods often fail to engage students meaningfully or address their diverse learning needs, resulting in widespread math anxiety, low participation, and poor academic performance. Despite global research supporting collaborative learning as an effective strategy for improving student engagement, critical thinking, and conceptual understanding, its adoption in Nepalese classrooms remains limited. While educational policies advocate for student-centered learning, a significant gap persists between policy and practice. Teachers frequently face multiple barriers to implementing collaborative strategies, including large class sizes, limited resources, lack of professional development, time constraints, examination pressures, and cultural expectations that prioritize individual effort and passive learning.

As a mathematics teacher, I had an eye-opening experience while experimenting with a group-based activity during a lesson on solving word problems. I noticed that even students who were usually disengaged showed interest, discussed actively, and attempted to solve problems collaboratively. One student, who typically avoided participation, confidently explained a solution to her peers. This unexpected outcome made me reflect deeply on the potential of collaborative learning in mathematics classrooms. However, I also encountered practical difficulties: managing time, maintaining group discipline, and ensuring meaningful participation from all students. These mixed results raised important questions in my mind Why is this

method not commonly used? What do other teachers and students think about it? What challenges are preventing its broader adoption in our schools?

These experiences sparked my curiosity and motivated me to explore collaborative learning more systematically. Despite its potential, there is a lack of in-depth, context-specific research on how teachers and students perceive collaborative learning in Nepalese mathematics classrooms and what factors hinder its effective implementation. Therefore, this study aims to investigate the perceptions of secondary-level mathematics teachers and students regarding collaborative learning, and to identify the key challenges they face in applying it. The findings will offer practical insights to improve classroom practices, inform teacher training, and support policy implementation toward more interactive and inclusive mathematics instruction in Nepal.

Objectives of the Study

The research objectives of this research were given

1. To compare the mathematics achievement of students when taught by using collaborative learning method and conventional method.
2. To explore the perceptions of students towards the practices of collaborative methods in teaching mathematics.

Research Questions

The Research questions of this study were given

1. Does the achievement of students in mathematics differ significantly when taught by using the collaborative method and conventional method?
2. How do students perceive the use of the collaborative method in teaching mathematics?

Significance of the Study

This study is significant as it provides empirical evidence on the effectiveness of collaborative learning methods in enhancing mathematics achievement among secondary-level students in Nepal. By comparing collaborative and traditional teaching approaches, the research offers valuable insights into how active student engagement, peer interaction, and shared responsibility can improve learning outcomes. The findings contribute to a better understanding of teaching practices that promote deeper conceptual understanding and problem-solving skills, which are essential for mathematics education at the secondary level.

Furthermore, the study highlights the perceptions of both teachers and students toward collaborative learning, revealing practical challenges and benefits within the Nepalese classroom context. This knowledge is important for educators, school administrators, and policymakers to develop targeted strategies that support teacher training, resource allocation, and classroom management for collaborative approaches. Ultimately, the research aims to encourage more inclusive, student-centered teaching methods that can transform mathematics learning in Nepal, particularly in rural and resource-limited settings.

Delimitation of the Study

This study was limited to two secondary-level schools in Sindhupalchok District, namely Helambu Bodhisattva Model School and Ichok Secondary School, both located in Helambu Rural Municipality-6, Ghopteghang. The scope of the research was confined to Grade IX students and focused mainly on comparing the mathematics achievement of the experimental group, taught through the collaborative method, with that of the control group, taught through the traditional lecture method. In addition to academic achievement, the study also examined changes in student behavior and perceptions toward collaborative learning, as outlined in the second objective. The research design was experimental in nature, applying a pre-test and

post-test equivalent group design to measure differences between the groups. The data collection was further delimited to specific tools, including achievement tests and semi-structured interviews with selected students from the experimental group. Within these boundaries, the study aimed to explore the effectiveness and challenges of collaborative learning in the given context.

Operational Definition of Key Terms

The major key term is given

Effectiveness. Effectiveness refers to the ability to achieve the intended goal or outcome. It means doing what is necessary to produce the expected results.

Collaborative Learning Method: Collaborative method of learningis a learning approach where two or more individuals work together to learn or solve problems. It emphasizes group efforts and shared responsibility in the learning process.

Traditional Method: Traditional method refers to the conventional method of teaching, where the teacher delivers information mainly through lectures, using tools like chalk and board. The focus is on passing knowledge from teacher to student.

Achievement Score: Achievement score refers to the marks or results obtained by students in the mathematics achievement test prepared by the researcher for secondary-level students.

Instruction: In this study, instruction refers to the teaching and learning activities, including the teaching methods applied in both the experimental and control groups.

Experimental Group: In this study, the experimental group refers to the group of students who were taught using the collaborative learning method.

Control Group: The control group in this study refers to the group of students who were taught using the traditional teaching method.

Chapter II

Review of Literature

This chapter focuses on the empirical literature, theoretical underpinnings, and conceptual framework relevant to the study. Literature review refers to the collection of works and findings from previous scholars and researchers. It is an essential component of any research as it aids in identifying variables pertinent to the study. This chapter summarizes various articles and the findings of earlier research in the field of mathematics education, particularly concerning the role of collaborative learning methods in teaching mathematics and the challenges faced in implementing these methods. The main goal of this literature review is to gain expertise in the research area, identify opportunities for new contributions, and inform the development of the research design by providing a general outline of the study.

The literature reviewed includes previous theses, books, academic journals, and online resources. It is classified into two types: empirical literature and theoretical literature.

Empirical review

The National Council of Teachers of Mathematics [NCTM] (2000) highlighted the principle of equity in mathematics education, asserting that excellence in mathematics requires high expectations and strong support for all students. The goal of achieving equity involves raising expectations for all learners, providing effective support, and ensuring that all students, irrespective of their personal characteristics, have access to mathematics education. Technology is identified as a tool to assist in achieving this goal by ensuring equitable access for all students (Vaugh & Schumm, 1995, as cited in Acdillister, 2002).

Bhudhathoki (2004) conducted experimental research on the "Effectiveness of Cooperative Learning Methods in Teaching Mathematics at the Secondary Level." His study aimed to investigate whether cooperative learning methods were more effective than traditional teaching methods in enhancing student engagement and performance in mathematics.

Karki (2013) conducted a study titled "Teaching Mathematics through a Collaborative Approach: An Auto ethnographic Inquiry," which provided a personal account of a mathematics learner transitioning into a novice teacher. This inquiry focused on pedagogical growth and the transformation witnessed through reflective teaching practices. Karki emphasized how collaborative learning and reflective teaching could lead to significant pedagogical changes in teaching mathematics.

Bhatta (2014) studied about "Pedagogical Processes of Mathematics Teachers in Ethnically Plural Classrooms at the Secondary Level," aimed to explore the management practices of secondary-level teachers in managing diverse classrooms. The research, conducted in Kanchanpur District, included 50 secondary students and 10 teachers. Data was collected through interviews, observations, and questionnaires. Bhatta concluded that secondary teachers primarily relied on traditional, teacher-centered approaches, which hindered the inclusion of all students, particularly in ethnically and culturally diverse classrooms.

Pandey (2016) researched on "Adversities in Teaching and Learning Mathematics in Culturally Diverse Classrooms" focused on the challenges faced by teachers in multicultural classrooms in Nepal. It emphasized the need for teachers to be aware of the cultural, linguistic, and gender backgrounds of their students to effectively address the diverse needs of learners. Pandey’s study concluded that

teachers should be trained to develop culturally responsive teaching strategies that incorporate students' diverse experiences and backgrounds.

Thapa (2020) studied entitle "Impact of Collaborative Learning on Student Performance in Mathematics," examined the effectiveness of collaborative learning on students' academic performance in mathematics at the secondary level in Nepal. The study found that students who participated in collaborative learning groups showed better problem-solving abilities and improved performance compared to those who were taught using traditional methods. Thapa emphasized that group work allowed students to share diverse ideas, leading to a deeper understanding of mathematical concepts.

Shrestha (2022) researched on "Challenges in Implementing Collaborative Learning in Rural Secondary Schools" explored the difficulties teachers face in implementing collaborative learning strategies in rural Nepalese schools. The study found that while teachers recognized the benefits of collaborative learning, they struggled with limited resources, large class sizes, and a lack of training. The research highlighted the importance of teacher professional development and adequate resources to successfully integrate collaborative learning.

Ghimire (2023) studied entitled "Teachers' Perceptions of Collaborative Learning in Mathematics Education," examined how secondary mathematics teachers perceive and implement collaborative learning. The study found that while teachers were generally supportive of collaborative methods, they faced challenges such as time constraints, student resistance, and a lack of structured curricula that support group-based learning. Ghimire suggested that curriculum reforms and ongoing teacher training programs are essential to overcoming these challenges.

Acharya (2023) study on “Overview of Cooperative Learning Strategies in Mathematics Teaching and Learning” Cooperative learning is a pedagogical approach that fosters collaboration among students, allowing them to develop a deeper understanding of mathematical concepts. In his article, he explores various cooperative learning strategies, their benefits, and challenges, emphasizing their importance in enhancing mathematics education. Traditional mathematics instruction often relies on teacher-centered methodologies, which may limit students' engagement and conceptual understanding. Cooperative learning, in contrast, encourages peer interaction, active participation, and shared knowledge construction. Grounded in Vygotsky’s social constructivist theory, this approach posits that learning is a social process facilitated by collaboration and discourse.

The reviewed literature clearly highlights the importance and benefits of collaborative learning in mathematics education, especially in addressing equity and enhancing student engagement. However, challenges such as teacher preparedness, resource constraints, and the diversity of student backgrounds persist in the implementation of these methods. This chapter provides a comprehensive understanding of the theoretical and empirical landscape surrounding collaborative learning in mathematics education, offering insights into both the achievements and the ongoing challenges in the field.

Theoretical Review

The collaborative learning method has garnered significant attention in recent years due to its potential in enhancing the learning process. It emphasizes the importance of peer interaction, shared responsibility, and accountability, fostering an environment where both individual and group learning experiences are maximized. Students’ involvement in the learning process is greatly enhanced by their

participation in collaborative activities, which are aimed at improving both their academic performance and social skills. Feedback and reflection play a critical role in the collaborative learning process, making it a dynamic method of learning that benefits all participants (Taylor, 1997).

Vygotsky's Theory of Social Constructivism

Vygotsky's theory of social constructivism provides a strong foundation for understanding the importance of social interaction in the learning process. His work emphasized that knowledge construction is not a solitary endeavor but a collaborative process that takes place in a social context. Vygotsky (1978) argued that intellectual development occurs through interactions with others, particularly in a cultural context. This convergence of social and practical elements in learning is vital to understanding how learners construct meaning. Vygotsky introduced the concept of scaffolding, where more knowledgeable individuals, such as teachers or peers, provide support that allows learners to progress beyond their current abilities (Shrestha, 2010). According to Vygotsky, the integration of social interaction with individual cognitive processes promotes deeper learning and development.

Collaborative Learning Theory

Collaborative learning is defined as a process where students work together to achieve common academic goals. According to Dillenbourg (1996), collaborative learning involves joint problem-solving and shared responsibility for learning outcomes. This approach emphasizes mutual engagement and participation, which can lead to more meaningful learning experiences. Roschelle and Teasley (1996) further expanded on this by describing collaborative learning as the "mutual engagement of participants in a coordinated effort to solve a problem together." Collaborative learning methods, such as group investigations, learning together (LT), and academic

controversy, promote active student involvement, peer interaction, and shared decision-making, making it an effective strategy for improving academic outcomes (Dillenbourg et al., 1996).

However, despite the positive outcomes, challenges remain in implementing collaborative learning effectively. A study by Yadav (2024) highlighted the difficulties faced by teachers in managing diverse student groups and ensuring equal participation among all members. These challenges underscore the importance of teacher training and the need for appropriate resources to support collaborative learning.

Research Gap

Although collaborative learning has gained global recognition as an effective instructional approach, especially in subjects like mathematics that require active engagement and critical thinking, its practical application in the context of secondary education in Nepal remains underexplored. Most mathematics classrooms continue to rely on conventional teacher-centered methods, with limited evidence available to show how collaborative learning influences students' academic achievement. While international studies suggest its positive impact, there is a lack of empirical research comparing collaborative and conventional teaching methods within the specific social, cultural, and educational settings of Nepal.

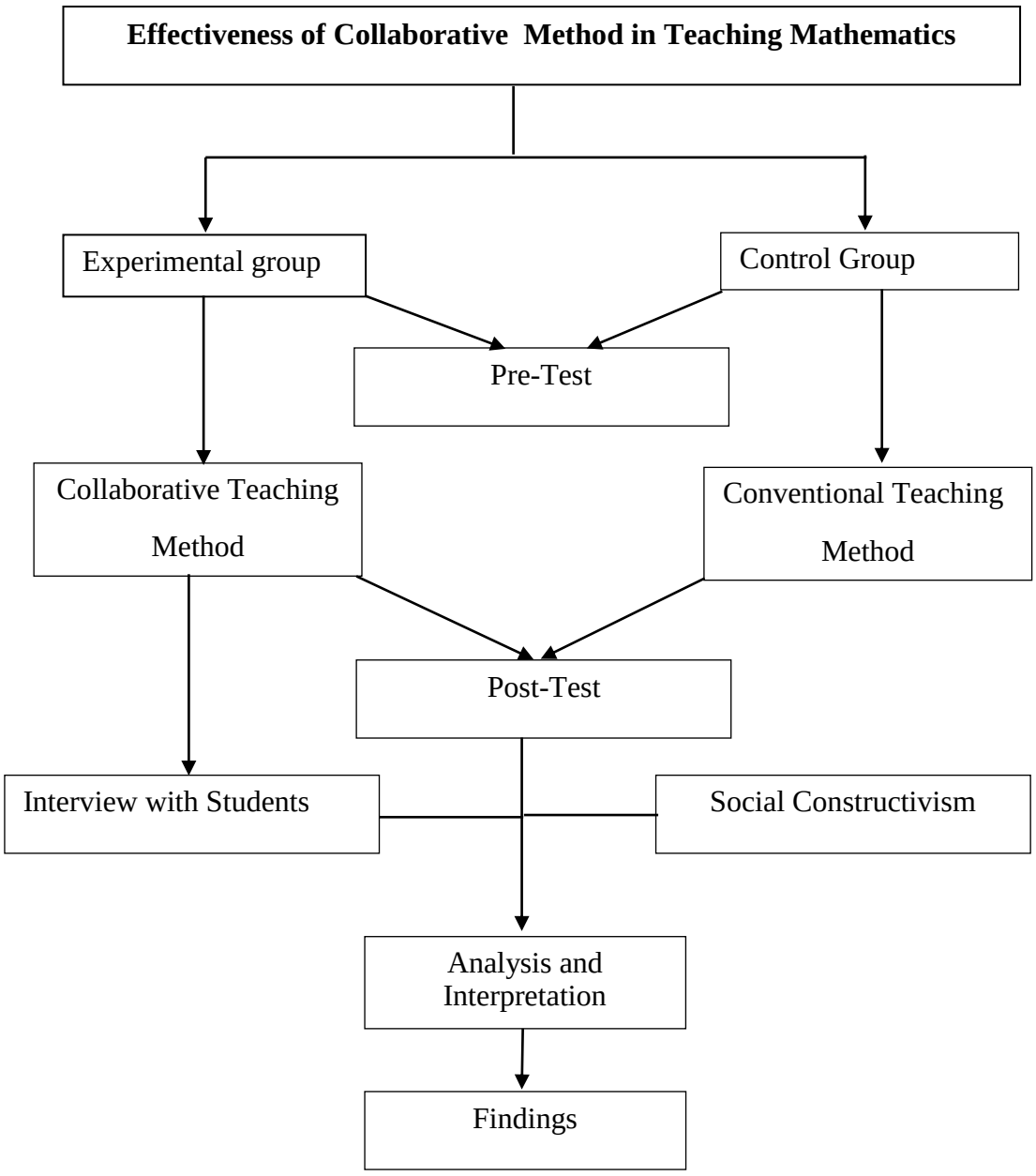
In addition, much of the existing literature in the Nepali context has focused on identifying the theoretical advantages or challenges of implementing collaborative learning, rather than understanding how it is actually perceived and experienced by teachers and students. These voices are essential to ensure that collaborative approaches are not only effective but also feasible and meaningful in everyday classroom practice. This study, therefore, seeks to address these gaps by examining

both the comparative effectiveness of collaborative and traditional teaching methods and exploring the perceptions of those directly involved in the learning process.

ConceptualFramework

Theconceptualframeworkto compete the research work fascinates the researcher to reach the destination.Theconceptual framework devised through theliteraturestudies facilitate of achieved the research objectives to get the answer of the research question and carryout the research work as a whole smoothly. Analyzing various literatures in relationtoadversities encounteredinteachinglearningactivities.Ihavedevelopeda framework to complete this research that is shown below.

Figure: Conceptual framework.



The conceptual framework of this study compares an experimental group using collaborative strategies (e.g., group formation, tasks, teacher facilitation) with a control group assessed via post-test for achievement, engagement, and participation. Data analysis involves quantitative pre-test/post-test comparisons and qualitative data from students. Findings and conclusions are derived from this analysis to evaluate the method's impact on mathematics learning.

Chapter III

Methods and Procedures

This chapter outlines the methodology adopted in this research study. It describes the overall design, study area, participants, sampling techniques, data collection tools and procedures, and the data analysis strategies employed to achieve the research objectives.

Research Design

The study followed quasiexperimental research design. This design was chosen to examine the effectiveness of collaborative learning in improving mathematics achievement and to gain deeper insights into the teaching-learning process through the perspectives of teachers and classroom practices.

The quantitative part used a pre-test and post-test equivalent group design. In this design, students of Grade IX from two different schools were assigned as experimental and control groups using a coin toss method. The experimental group was taught using the collaborative learning method, while the control group received traditional lecture-based instruction.

To support the quantitative findings, the qualitative part included semi-structured interviews with four students and my own feelings and experience during this period. These data provided a broader understanding of the teaching methods and student engagement and allowed triangulation of findings.

Population and Sample of the Study

The population of the study included all Grade IX students and mathematics teachers from secondary schools in the Helambu Rural Municipality. From this population, random sampling technique was used to select the students for

experimental group and control group, a purposive sampling was used to select four students from experimental group for interview.

Quantitative Sample

A total of 40 students of Grade IX were selected from Helambu Bodhisattva Model School and Ichok Secondary School. These schools were chosen because i was working in Helambu Bodhisattva Model School and another was located nearby, making access and coordination feasible. The sample consisted of 20 students from each school. In Ichok Secondary School, the total number of Grade IX students was 20, so all of them were included in the study. In Helambu Bodhisattva Model School, there were 38 students in Grade IX, but only 20 could participate because the classes were conducted after regular school hours. It was difficult for non-hostel living students as they had to travel long distances to return home. There were 20 students living in school's hostel so only 2o students were available for the extra class, which resulted in an equal number of participants in both schools. These students were then randomly assigned into two groups i.e. Experimental and Control group through a coin toss. This randomization ensured fairness and minimized selection bias in the study.

Qualitative Sample

Four students with two boys and two girls from experimental group were selected purposively for semi-structured interviews. Two boys and two girls were selected on the basis of highest scorer and lowest scorer in post- test.

Teaching Intervention Process

The teaching intervention in this experimental study was implemented under specific criteria and necessary conditions to ensure its effectiveness and reliability. Both the experimental and control groups were taught the same mathematical content,

covering algebraic expressions, linear equations, and word problems, within the same time frame of 20 school days. To maintain fairness, the same teacher (the researcher) instructed both groups, which controlled variation in teaching style and subject knowledge. Equal instructional periods, common textbooks, and identical pre-test and post-test instruments were used to ensure consistency. In the experimental group, collaborative learning strategies such as group work, peer discussion, and teacher facilitation were applied, while the control group followed the traditional lecture method. These conditions were necessary to isolate the impact of the collaborative method, minimize external influences, and provide a valid basis for comparing the academic achievement and behavioral changes of students in the two groups.

Control of Variables in the Experiment

To maintain the validity of the experimental design and reduce external influences, several variables were controlled:

Teacher Variable. The same teacher (the researcher) taught both the experimental and control groups. This helped control differences in teaching style, qualification, experience and subject knowledge.

Subject Matter. Both groups were taught the same topics from the Grade IX mathematics curriculum mainly focusing on algebraic expressions, linear equations and word problems using the same government-prescribed textbook.

Duration. Both groups received equal instructional time. The intervention lasted for 20 consecutive school days (3 weeks), with both groups taught for the same number of periods.

Assessment. The same pre-test and post-test were administered to both

groups. The tests were designed by the researcher and validated through expert consultation. The researcher also evaluated both sets of test papers using a standard marking scheme (see Appendix C).

Creating a Collaborative Learning Environment

For the experimental group, a supportive environment for collaborative learning was carefully established through several strategies. The class was divided into four groups with a balanced mix of boys and girls to ensure diversity and equal participation. Within these groups, students were given shared tasks such as solving mathematical problems, preparing group presentations, and engaging in peer discussions. The teacher's role was shifted from direct instruction to facilitation, providing guidance when necessary while encouraging students to take responsibility for their own learning. This arrangement allowed students to interact freely, raise questions, explain concepts to one another, and collaboratively explore solutions. Classroom activities particularly emphasized peer-to-peer dialogue, where the use of everyday language and reasoning helped strengthen conceptual understanding, improve problem-solving skills, and build students' confidence in learning mathematics.

Data Collection Instruments

The following instruments were used for data collection:

Pre-Test and Post-Test

A total of seven questions were prepared for both the pre-test and post-test, covering algebraic expressions and linear equations. While the number of questions was the same in both tests, the actual items differed to avoid practice effects. The questions included conceptual items to assess understanding and application-based problems to evaluate problem-solving skills. They were developed based on the Grade

IX curriculum and reviewed by mathematics experts for content validity. This design allowed the researcher to reliably compare students' performance before and after the collaborative learning intervention.(See Appendix A & B)

Interview Guidelines

Semi-structured interview guideline was constructed to conduct the interview with students to explore their experiences, perceptions and reflections on collaborative vs traditional methods.(See Appendix I)

Collaborative Learning Activity Sheets

For the intervention, a collaborative learning activity sheet was developed containing various tasks from the topics of algebraic expressions, linear equations, and related word problems. The activities were designed to promote discussion, problem-solving, and peer collaboration while aligning with the Grade IX mathematics curriculum. To maintain quality standards, the content of the sheets was reviewed by two mathematics experts (including supervisor) to ensure relevance, clarity, and appropriate difficulty level. The tasks were structured to progressively develop conceptual understanding and problem-solving skills, ensuring that students were actively engaged in meaningful learning during the intervention.(See Appendix D)

Data Collection Procedure

To gather the necessary data for this study, a structured and thoughtful approach was followed. The process began with a pre-test administered to both the experimental and control groups to understand their existing level of knowledge in mathematics. This helped establish a baseline for comparing learning outcomes later on. Following this, a 20-day teaching intervention was carried out. Students in the experimental group were taught using collaborative learning strategies, which

encouraged them to work together, share ideas and solve problems in groups. Meanwhile, the control group continued learning through conventional, teacher-centered instruction. At the end of the intervention period, the same evaluation framework was used to conduct a post-test for both groups, allowing the researcher to measure changes in academic performance. In addition to these tests, observation check list were conducted and interviews were held with four students of experimental group to gain deeper insights into the use and perception of collaborative methods in the classroom. Throughout the study, all data were handled with care, stored securely and analyzed anonymously to ensure privacy and uphold ethical research practices.

Data Analysis Procedure

To interpret the results of this study, both quantitative and qualitative data were analyzed using appropriate and complementary methods. The quantitative data, drawn from the pre-test and post-test scores of students in the experimental and control groups, were first analyzed using descriptive statistics such as mean and standard deviation. This helped in understanding the overall performance of each group. To determine whether there was a statistically significant difference in achievement between the two groups, an independent samples t-test was conducted. Alongside this, the qualitative data collected through interviews with students and observations check list were analyzed thematically. The researcher carefully reviewed the transcripts and field notes to identify recurring patterns and themes that shed light on how collaborative learning was implemented, the challenges encountered and the benefits observed in the rural school context. To ensure the reliability and depth of the findings, a triangulation approach was used and cross-validating insights from both quantitative and qualitative sources. This process allowed for a more comprehensive

and credible understanding of the effectiveness of collaborative learning in mathematics education.

Reliability and Validity Test

Reliability and validity are important concepts for ensuring the quality of research. Reliability refers to the consistency of the measurement, while validity indicates how accurately the tool measures what it is intended to measure. In this study, the pre-test and post-test items were reviewed by subject experts to confirm their alignment with the Grade IX mathematics curriculum. The same set of questions, uniform scoring criteria, and similar test conditions were used for both groups to maintain reliability.

For qualitative data, validity was supported through triangulation, where interview findings were cross-checked with classroom observations and students' test results. Reliability was ensured by using structured interview guidelines, applying consistent procedures, and carefully recording and analyzing student responses. These measures helped to make both quantitative and qualitative data trustworthy for the purpose of this study.

Ethical Consideration

Throughout this study, ethical responsibility was taken seriously to ensure that all participants were treated with respect, fairness, and care. Before beginning data collection, the purpose of the research and the procedures involved were clearly explained to participants, and their voluntary informed consent was obtained. They were also assured that they could withdraw from the study at any time without any negative consequences. To protect their privacy, all personal information was kept confidential by using pseudonyms and securely storing the data. The research followed the ethical guidelines of the institution and was approved by the relevant

review committee. No participant was pressured or misled in any way, and special attention was given when working with students, including obtaining permission from parents or school authorities. Open communication was encouraged throughout the process so participants could ask questions or express any concerns. These efforts helped build a foundation of trust and ensured the research was conducted with integrity and respect for everyone involved.

Chapter-IV

Data Analysis and Interpretation

This chapter presents the analysis and interpretation of both quantitative and qualitative data collected during the research. The primary focus of this study was to examine the effectiveness of the collaborative method compared to the traditional method in learning mathematics at the secondary level. The research was conducted in Helambu Bodhisattva Model Secondary School and Ichok Secondary School, located in Helambu Rural Municipality–6, Ghopteghang, Sindhupalchok, Nepal.

The quantitative data analysis is an important part of this research because it helps to clearly show how effective the collaborative method is compared to the traditional method of teaching mathematics at the secondary level. This analysis includes the results from both the pre-test and post-test given to the students in the experimental and control groups. The pre-test was conducted before the teaching started to check whether both groups had a similar level of understanding in mathematics. After the teaching intervention, a post-test was given to measure how much the students improved.

The experimental group was taught using the collaborative method, while the control group followed the traditional lecture method. To find out whether the difference in their performance was meaningful or just due to chance, a statistical tool called the independent samples t-test was used. The main aim of this analysis was to compare the students' knowledge before and after the teaching, to see how much they improved and to determine whether the collaborative method was more effective in helping students achieve better results in mathematics.

Research Participants and Grouping

The study included 40 Grade IX students from two schools in Helambu-6, Sindhupalchok: Helambu Bodhisattva Model School and Ichok Secondary School. These students were divided into two equal groups. The experimental group consisted of 20 students who were taught using a collaborative learning method. The control group also had 20 students, but they were taught using the traditional lecture-based method. To ensure an unbiased and random assignment, the groups were selected for the experimental and control conditions.

Description of the Pre-Test

Before starting the teaching intervention, a pre-test was given to both the experimental and control groups. This pre-test included basic questions from algebra and other introductory mathematics topics that the students had already learned. The main purpose of the pre-test was to check if both groups had a similar level of knowledge before the new teaching methods were applied. It also helped to create a starting point to compare how much each group improved after the teaching was completed. This way, any progress seen in the post-test could be measured more accurately. The result of pre-test was as given in the table 1.

Table 1: Pre-Test Scores

Group	Sample Size (n)	Mean Score	Standard Deviation (SD)	Variance	Calculated t-value	Tabulated t-value (df = 38, $\alpha = 0.05$)	Conclusion
Experimental	20	7.75	4.65	21.67	0.1468	1.960	No Significant Difference
Control	20	7.55	3.92	15.36			

The pre-test data compares the baseline mathematics performance of two groups, the experimental group (taught using the collaborative method) and the control group (taught using the conventional method) before any instructional intervention. The experimental group had a mean score of 7.75, slightly higher than the control group's mean of 7.55, indicating minimal initial differences in achievement. However, the independent samples t-test revealed a calculated t-value of 0.1468, which is significantly lower than the critical t-value of 1.960 at a 95% confidence level ($\alpha = 0.05$) . This means the difference between the two groups is not statistically significant, confirming that both groups started with comparable math proficiency.

The experimental group exhibited greater variability in scores (SD = 4.65, variance = 21.67) compared to the control group (SD = 3.92, variance = 15.36), suggesting more diverse initial performance levels among students exposed to collaborative learning. This finding is crucial for ensuring that any post-intervention differences can be attributed to the teaching method rather than pre-existing disparities. Since the pre-test establishes baseline equivalence, subsequent improvements in the experimental group's post-test scores would provide stronger evidence supporting the effectiveness of collaborative learning.

These results set the stage for further analysis, particularly in comparing post-test outcomes and exploring qualitative feedback from teachers and students regarding their perceptions of collaborative learning. The next phase of the study will determine whether the collaborative method leads to significant gains in mathematics achievement compared to conventional instruction.

Description of the Post-Test

At the end of the 20-days intervention period, a post-test was administered to both the experimental and control groups. This test was designed to be similar in structure and difficulty level to the pre-test, ensuring a fair comparison of student progress. The main purpose of the post-test was to evaluate how much the students had learned after being taught using either the collaborative method or the traditional method. It aimed to measure the effectiveness of the collaborative learning approach in improving students' mathematical performance. The test included a variety of questions, covering both conceptual understanding and the ability to apply mathematical knowledge in problem-solving situations. By including both types of questions, the post-test provided a more complete picture of the students' learning and helped assess whether the collaborative method led to a deeper understanding of mathematics compared to the traditional teaching approach.

Table 2: Post-Test Scores

Group	Sample Size (n)	Mean Score	Standard Deviation (SD)	Variance	Calculated t-value	Tabulated t-value (df = 38, α = 0.05)	Conclusion
Experimental	20	19.3	6.164	37.58	11.1368	1.960	Significant Difference
Control	20	13.05	4.34	18.89			

The post-test data reveals significant differences in mathematics performance between the experimental group (taught using the collaborative method) and the control group (taught using conventional methods) after the instructional intervention. The experimental group achieved a substantially higher mean score of 19.3, compared to the control group's mean of 13.05, demonstrating a clear advantage in learning outcomes. The independent samples t-test produced a calculated t-value of 11.1368, which far exceeds the critical t-value of 1.960 at a 95% confidence level ($\alpha = 0.05$). This large t-value indicates that the difference in post-test scores between the two groups is statistically significant, strongly suggesting that the collaborative learning method had a measurable positive impact on student achievement.

While both groups showed improved scores compared to the pre-test, the experimental group not only outperformed the control group but also exhibited greater variability in performance (SD = 6.164, variance = 37.58) compared to the control group (SD = 4.34, variance = 18.89). This wider spread in scores may reflect differing levels of engagement or adaptability among students within the collaborative learning environment. Nevertheless, the substantial mean difference and highly significant t-value provide compelling evidence that the collaborative method enhances mathematics learning more effectively than conventional instruction.

These findings align with the study's objective of comparing the effectiveness of teaching methods and support the potential benefits of collaborative learning in secondary mathematics education. Future research could explore the factors contributing to the higher variability in the experimental group, such as group dynamics or individual participation levels, to further optimize collaborative learning strategies. Additionally, qualitative insights from teachers and students regarding their

perceptions of the collaborative approach—could offer valuable context for these quantitative results.

Table 3: Summary of Quantitative Findings

Variable	Experimental Group	Control Group
Pre-Test Mean	7.75	7.55
Post-Test Mean	19.3	13.05
Score Gain	+11.55	+5.50
Standard Deviation (Post)	6.164	4.34
Variance (Post)	37.58	18.89
t-value (Post-Test)	11.1368	
Significance Level	0.05	
Result	Statistically Significant	

The comparative analysis of pre-test and post-test results between the experimental (collaborative method) and control (conventional method) groups reveals compelling evidence about the effectiveness of collaborative learning in mathematics education. Initially, both groups demonstrated comparable baseline performance, with the experimental group averaging 7.75 and the control group 7.55 in the pre-test ($t=0.1468$, $p>0.05$), confirming equivalent starting points for valid comparison.

Following the instructional intervention, the experimental group showed remarkable improvement, achieving a post-test mean score of 19.3 compared to the control group's 13.05. This represents a substantial learning gain of +11.55 points for the collaborative method group versus +5.50 for the conventional method group. The

independent samples t-test yielded a highly significant t-value of 11.1368 ($p<0.05$), far exceeding the critical threshold of 1.960, which conclusively demonstrates that the collaborative approach produced superior learning outcomes.

The post-test data shows greater variability in the experimental group (SD=6.164, Variance=37.58) compared to the control group (SD=4.34, Variance=18.89), suggesting that while collaborative learning was more effective overall, students responded to it with varying degrees of success. This variability may reflect differences in group dynamics, individual participation levels, or adaptation to the collaborative learning style.

These quantitative findings strongly support the research hypothesis that collaborative methods enhance mathematics learning more effectively than conventional approaches at the secondary level. The significant score differential, coupled with the robust statistical evidence ($t=11.1368$, $p<0.05$), indicates that the observed improvements are highly unlikely to have occurred by chance. The results not only demonstrate the efficacy of collaborative learning but also highlight its potential to substantially elevate student achievement in mathematics.

In addition, supportive qualitative data obtained from interview with students has analysis using thematic approach under some theme likes active learning beyond listening, Confidence Through Peer and Teacher Support, Responsibility and Fair Contribution, Motivation through Encouragement and Recognition and Shifting to a Student-Led Learning Approach. In this section B_1 and B_2 represent boy student participant first and second respectively. Similarly G_1 and G_2 represent girl student participant first and second respectively.

Active Learning Beyond Listening

Collaborative learning changes the classroom from a space where students only listen to the teacher into a place where they actively build their own understanding. In traditional lectures, students often take notes quietly and try to memorize facts, which may limit deep learning. In contrast, group discussions and peer activities encourage students to speak, think critically, and apply concepts during the lesson.

From my classroom observations, students in collaborative settings show higher engagement. They take responsibility for their own learning, solve problems together, and freely ask questions. This active involvement improves their understanding of mathematics and also strengthens their communication skills. In this regards it was found that

"Before, I used to stay quiet and just listen. But when we started doing group work, I began to speak more. Sometimes I explain my ideas, and sometimes I listen to others. I understand better now because we solve problems together and talk about different ways to answer them." (B1)

B1's words show how peer interaction helps students explain their thinking and see different problem-solving strategies. This illustrates that when students communicate with each other, they clarify their own ideas by putting them into words. It also allows them to hear various approaches from classmates, broadening their understanding beyond a single method. Such interactions encourage deeper cognitive processing, making problem-solving more flexible and creative.

"Working alone was okay, but I enjoyed learning more with friends. When we do projects or activities as a group, it's fun and also helpful. We ask questions, help each other and share what we know. It makes learning easier and more interesting for

me." (G2)

G2's experience reveals that working together transforms math from a solitary, sometimes stressful task into a shared and positive experience. The social aspect of collaboration provides motivation and emotional support, which can reduce anxiety and increase interest. This *enjoyment can lead to sustained engagement and a more positive attitude toward the subject.*

"Group work gives me a chance to speak and share my ideas. Sometimes I understand more from my friends than from the teacher. We all help each other, and it makes me feel like I'm not alone. It's also nice to hear different ways of solving a math problem." (G1)

This highlights how peer explanations can be easier to relate to than teacher explanations, adding value to student-to-student learning. When students explain concepts to each other, they often use language and examples that are more familiar and understandable to their peers. This reliability can bridge gaps in comprehension that sometimes occur in formal teaching. As a result, peer explanations complement teacher instruction by providing alternative perspectives that resonate more closely with students' current level of understanding.Leikin and Zaslavsky (1999) emphasize that real cooperative learning requires small group interaction, shared responsibility, and equal participation, which lead to deeper understanding.

Confidence Through Peer and Teacher Support

Confidence strongly affects how willing students are to participate in mathematics lessons. In collaborative classrooms, encouragement comes not only from the teacher but also from classmates. Small group activities reduce the fear of making mistakes and make it easier for students to share their ideas.

I have seen quiet students gradually become active contributors during group work. Trust within the group allows them to take risks and express their thinking without fear of judgment.

"When we work in a group, we become a team. I used to feel nervous to answer in front of the whole class, but in small groups, I feel more comfortable. We learn from each other, and it helps me feel confident and happy to come to school." (G2)

This shows how collaborative learning creates a safe space for participation, especially for shy students. Student also shared as

"*I used to be shy, but now I talk more in group work. My friends listen to me and we solve problems together. It makes learning fun."* (G1)

G1's experience demonstrates that being part of a supportive group helps reduce fear of making mistakes or being judged. Encouragement from peers creates a safer environment for participation, which helps shy or reluctant students become more confident. This shift from hesitation to involvement is crucial for developing communication skills and deeper learning.

"*Sometimes I understand better when a friend explains. We all support each other. If one of us is confused, we don't move on until everyone gets it."* (B2)

B2's experience highlights how mutual support ensures no one is left behind. Johnson and Johnson (2009) explain this as positive interdependence — the idea that the group's success depends on the success of each member, building cooperation and shared responsibility.

Responsibility and Fair Contribution

One of the strengths of collaborative learning is that it teaches students to be responsible for their role in the group. When every member's work is important, students are motivated to complete tasks on time and maintain quality.From my

observations, accountability is strongest when students are given clear roles in a project. They take pride in completing their part, knowing it affects the group's success. This finding is also supported by reflection of B1 as

"When we work in groups, it is important that everyone does their part. If one person does not do their work, it makes things unfair and harder for others. Everyone's effort matters for the group to do well, so I always try to do my share."

B1's statement indicates that the student recognizes the importance of each member's contribution for the group to succeed. This awareness of fairness motivates students to fulfill their duties, knowing that uneven effort can negatively affect the entire team. It demonstrates a developing sense of accountability and respect for shared goals within collaborative learning. Which is also supported by

"*If I don't do my part in the group, it will let my team down. Because of that, I always try my best and take my responsibilities seriously. We are all connected, and every member's work matters for success."* (G2)

G2's comment reveals that trust among group members encourages individual commitment. Feeling responsible not only to oneself but also to the team strengthens motivation to contribute fully. This trust creates a positive cycle where students are inspired to do their best because they know their efforts impact others and the collective success.

"In group work, we all help and check on each other to make sure everyone is doing their share. If someone is falling behind, we support them so the whole group can keep moving forward and finish the work well." (G1)

The statement highlights that while each student is accountable for their tasks, collaboration involves mutual assistance. When team members notice someone struggling, they offer help to ensure everyone keeps up. This balance between

individual responsibility and cooperative support fosters a productive and inclusive learning environment.

Motivation through Encouragement and Recognition

Encouragement is an important factor that keeps students motivated to learn mathematics. In collaborative classrooms, both teacher and peer encouragement help students stay engaged. Praise, recognition, and even small rewards can inspire students to keep trying, even when problems are difficult.

In my experience, even a small word of praise during group activities can make students more willing to participate. Peer motivation also plays a role, as students push each other to succeed. One of the student participant B1 explore as

"When teachers encourage us by praising our work, I feel happy and want to try even harder. Talking with friends in groups also helps me understand better."

B1's experience demonstrates that receiving positive feedback encourages students to believe in their abilities. Recognition not only validates their hard work but also motivates them to put more effort into learning tasks. This boost in confidence often leads to increased participation and persistence when facing challenges. In this regard,

"Sometimes I find some parts difficult, but when the teacher encourages me and my friends help me, I feel motivated to keep learning." (B2)

B2's statement shows how teacher and peer encouragement work together. Students also experience as

"Group discussions are good because we can share problems and help each other. When the teacher rewards us for good work, it makes me feel proud and want to learn more." (G1)

This statement emphasizes that motivation grows stronger when students both collaborate with peers and receive encouragement from teachers or group members.

Teamwork creates a supportive environment, while recognition reinforces students' sense of achievement, together promoting sustained engagement and a positive attitude toward learning. This finding is also matched with following saying of student:

"I like when the teacher praises my work and gives small rewards. It makes me feel that my efforts are noticed and pushes me to do better next time." (G2)

G2's words illustrate that when students feel their efforts are noticed and appreciated, they are more likely to continue working hard. This ongoing cycle of encouragement and effort helps maintain enthusiasm for learning and fosters continual improvement in both skills and confidence. Acharya (2013) affirms that motivation and encouragement improve not just academic results but also students' willingness to stay engaged in learning.

Shifting to a Student-Led Learning Approach

Student-led learning makes students active participants instead of passive listeners. In collaborative classrooms, they explore ideas, discuss solutions, and solve problems while the teacher acts as a guide.From my observation, this method encourages curiosity and independence. Students try out different solutions, learn from mistakes, and use mathematical ideas in practical situations. It is accepted by the argument of student as

"I like when teachers let us work and think by ourselves. It helps me understand better when I get to talk with friends and try things on my own." (B1)

B1's statement highlights that combining independent thinking with group collaboration leads to a deeper grasp of concepts.

"*Student-centered teaching lets us ask questions and share ideas. It makes learning fun and helps me remember things."* (G1)

G1 illustrates that being actively engaged in learning helps students retain information more effectively. Which is also supported by

"I feel more confident when the teacher helps me and my classmates work together. We learn more when we explain to each other." (G2)

G2's experience demonstrates that working with others enhances not only students' understanding of the subject but also their ability to communicate effectively. Vygotsky's (1978) Zone of Proximal Development explains that students can achieve more when guided by peers and teachers than when working alone. Collaborative learning provides the right setting for this growth.

The comparative analysis of pre-test and post-test results provides compelling quantitative evidence for the effectiveness of the collaborative method. Initially, both the experimental group and the control group demonstrated comparable baseline performance, with pre-test mean scores of 7.75 and 7.55, respectively. This minimal difference was found to be statistically insignificant, confirming that both groups started with an equivalent level of mathematics proficiency. Following the intervention, the experimental group achieved a significantly higher post-test mean score of 19.3, compared to the control group's mean of 13.05. This represented a substantial learning gain of +11.55 points for the collaborative group versus a +5.50 point gain for the control group. The independent samples t-test yielded a highly significant t-value of 11.1368, which conclusively demonstrates that the collaborative approach produced superior learning outcomes and that the observed improvements were highly unlikely to have occurred by chance.

Complementing the quantitative data, the qualitative findings, including teacher observations and student interviews, provide valuable insights into the learning experience within a collaborative environment. The statements from teachers

and students highlight key themes such as fostering active learning, enhancing confidence, and cultivating positive interdependence. Students reported that group work helped them speak more, share ideas, and understand concepts better from their peers, which they found to be more engaging and enjoyable than passive listening. The collaborative setting also created a safe space where students, particularly those who were initially shy, felt more comfortable and confident to participate. Furthermore, students and teachers noted that collaborative tasks instilled a sense of individual accountability and mutual support, as students felt a responsibility to their group members, which motivated them to work harder and ensure no one was left behind.

In conclusion, the research strongly supports the hypothesis that the collaborative method is more effective than the conventional method in learning mathematics at the secondary level. The quantitative results provide robust statistical evidence of a significant difference in achievement between the two groups, with the collaborative group showing a much greater improvement in post-test scores. This statistical efficacy is further contextualized and reinforced by the qualitative data, which demonstrates that collaborative learning not only improves academic performance but also fosters a positive, engaging, and supportive learning environment. The synthesis of these findings reveals that by promoting active participation, building confidence, and encouraging peer support, the collaborative method creates a more holistic and effective educational experience that is difficult to achieve through traditional lecture-based instruction.

Chapter-V

Findings, Conclusions and Implication

This chapter shares the main findings of the study on collaborative learning in secondary mathematics. It highlights how this approach affected students' performance and classroom experiences. Based on these results, conclusions are drawn about the value of collaborative methods. Finally, practical suggestions are offered for teachers and schools to improve math learning through teamwork and active participation.

Findings

Based on the analysis of the collected data, a number of key findings emerged from the study regarding the effectiveness of the collaborative method in learning mathematics at the secondary level. The research, which utilized both quantitative and qualitative data, offered a comprehensive view of how collaborative learning impacts both academic performance and the overall classroom environment, revealing several important conclusions about its efficacy are given below:

- The collaborative learning method resulted in significantly higher student achievement in mathematics compared to the conventional lecture-based method.
- The experimental group, taught using the collaborative method, showed a substantial learning gain of +11.55 points, more than double the gain of the control group (+5.50 points).
- An independent samples t-test confirmed that the difference in post-test scores between the two groups was statistically significant ($t=11.1368$, $p<0.05$), indicating the collaborative method's clear effectiveness.

- The pre-test established that both groups had a similar starting level of knowledge, with no statistically significant difference in their mean scores ($t=0.1468$, $p>0.05$).
- Qualitative findings revealed that collaborative learning fosters active engagement, moving students from passive listeners to active participants in their learning.
- The method significantly boosts student confidence, particularly for those who are shy, by creating a safe and supportive environment for sharing ideas and asking questions.
- Students and teachers found that peer interaction and explanation often lead to a deeper understanding of concepts than teacher-led instruction alone.
- Collaborative learning promotes individual accountability and a sense of positive interdependence, as students feel a responsibility for their own contributions and for the success of their group.
- The method enhances student motivation and makes learning more enjoyable, with students reporting feeling happy, proud, and more willing to try harder due to encouragement from peers and teachers.

Conclusion

This study set out to compare the mathematics achievement of students taught using the collaborative method versus the conventional lecture-based method. The quantitative data analysis revealed a significant difference in post-test scores, with the experimental group demonstrating a substantially higher mean score than the control group. The initial pre-test confirmed that both groups began the intervention with comparable levels of knowledge, indicating that the superior performance of the

experimental group can be attributed directly to the collaborative teaching approach. The statistical results provide robust evidence that the collaborative method is more effective in enhancing student learning outcomes in secondary-level mathematics.

Furthermore, this research explored the perceptions and experiences of teachers and students regarding the practices of collaborative learning. The qualitative data provides rich context for the quantitative findings, highlighting several key benefits. Students reported feeling more engaged and motivated, finding that peer-to-peer discussions and group activities made learning more enjoyable and understandable. Teachers observed a positive shift in classroom dynamics, noting that the collaborative method fostered student confidence, particularly among those who were initially shy, and promoted a supportive environment where students felt comfortable asking questions and sharing ideas.

By integrating both quantitative and qualitative data, this study employed data triangulation to draw a comprehensive conclusion. The numerical evidence of increased achievement is powerfully explained by the qualitative insights into student and teacher experiences. The significant improvement in test scores is not an isolated finding but a direct outcome of the active engagement, positive interdependence, and enhanced student confidence documented in the interviews. This synthesis of data provides a compelling case for the effectiveness of the collaborative method, demonstrating its capacity to improve both academic performance and the overall quality of the learning experience.

In conclusion, the findings of this research provide strong support for the adoption of collaborative teaching methods in mathematics education at the secondary level. The study's results suggest that shifting from a teacher-centered to a student-centered pedagogy can lead to superior learning outcomes while simultaneously

fostering essential social skills and a more positive attitude towards learning. It is recommended that educators consider incorporating collaborative strategies into their teaching practices. Future research could further explore the long-term impacts of this method and its effectiveness across different educational settings and subject areas.

Educational Implications

This research offers several important implications for the field of education, particularly in mathematics teaching. It highlights the contribution of collaborative learning methods in improving students' mathematics learning outcomes and provides practical guidance for teachers on implementing these strategies effectively. The study emphasizes the importance of fostering positive interdependence, accountability, and motivation within classroom activities while also identifying potential challenges in collaborative classrooms and suggesting proactive solutions. Furthermore, it serves as a valuable resource for teachers, students, researchers, academic institutions and policymakers seeking to enhance mathematics education, supporting the development of collaborative practices that promote equity and inclusion. In addition, the research has contributed to the professional growth of the researcher by deepening their understanding of effective mathematics instruction.

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Appendix A

Pre-Test Questions

Class: 9 **Full Marks:** 30

Subject: Mathematics**Time:** 1 Hour

Instructions: Answer all questions. Show all necessary workings.

1. Simplify: $(3x+5) - (x-7)$ (2 Marks)

2. Multiply and simplify: $(x+4)(x-3)$(3 Marks)

3. Factorize:$x^2+7x+10$(2 Marks)

4. If $p=3$ and $q=-2$find the value of: $pq + p^2 - q^2$(3 Marks)

5. Solve the pair of equation by graphical method and check it.

$3x-2y=4, 5x-y=23$ (4 Marks)

6. The sum of two numbers is 45 and their difference is 9. Find the numbers.
(4 Marks)

7.a) A fruit seller sells apples for Rs. 50 each and oranges for Rs. 30 each. If he sold 15 fruits in total for Rs. 600, Express this statement into algebraic expression and find the number of apples and orangessold. (4 Marks)

b) Factorize: $x^2-10x+24+6y-9y^2$ (4 marks)

c) A number is five more than twice another number. If their sum is 29, Express this statement into algebraic expression and find the numbers. (4 Marks)

Appendix B

Post-Test Questions

Class: 9 **Full Marks:** 30

Subject: Mathematics**Time:** 1 Hour

Instructions: Answer all questions. Show all necessary workings.

1. Simplify: $(4x^2-3x+7) - (2x^2+5x-9)$ (2 Marks)

2. Multiply and simplify: $(3x-2)(2x+5)$(3 Marks)

3. Factorize:$2x^2+7x+3$(3 Marks)

4. If $m=-2$and $n=4$, find the value of: $2m^2n-3mn^2+n^3$ (2 Marks)

5. Solve the pair of equation by Substitution method and check it.

$x+y=7$, $3x+y=15$(4 Marks)

6. The sum of three consecutive even numbers is 48. Find the numbers by forming a linear equation. (4 Marks)

7.a) A shopkeeper sold 3 shirts and 2 trousers for Rs. 2,300. On another day, he sold 2 shirts and 4 trousers for Rs. 2,800. Express this statement into algebraic expression and Find the cost of a shirt and a trouser.(4 Marks)

b) Solve the pair of equation by elimination method and check the solution.

$7x+9y=41$, $3x+3y13$ (4 Marks)

c) The sum of the ages of a father and son is 50 years. After 10 years, the father will be twice as old as the son. Express this statement into algebraic expression and Find their present ages son. (4 Marks)

Appendix D

Sample Collaborative Learning Activity Sheet

Subject: Mathematics **Grade Level:** 9

Topic: Linear Equations in Two Variables **Time:** 40 minutes

Group Size: 5 students

Instructions for Students:

1. Work together in your group to solve each task.
2. Discuss different methods and agree on one final solution.
3. Write all steps clearly and show who contributed what in the process.
4. You may use graph paper, calculators, and your textbook if needed.

Part A: Warm-Up Discussion (5 min)

Without solving, discuss:

- What is a *linear equation in two variables*?
- Give one real-life example where two variables are related linearly.

Write your group's definition and example here:

Definition: …….

Example: ……..

Part B: Group Problem Solving (25 min)

Task 1

The sum of two numbers is 30 and their difference is 10. Find the numbers using the method of linear equations.

Task 2

A school charges Rs. 500 per student for a field trip, plus a fixed transport fee of Rs.

2000 for the bus. Write a linear equation showing the total cost yy in terms of the number of students xx.

- Find the cost for 25 students.
- How many students can go if the budget is Rs. 15,000?

Task 3 (Graphical Method)

Plot the equations:

$x + y = 6$ $x−y=2$

Find their point of intersection and interpret its meaning.

Part C — Reflection (10 min)

- How did your group share the work?
- Did you face disagreements? How did you resolve them?
- What did you learn from other group members today?

Answer: _____

Appendix E

Pre-Test Raw Scores

Student ID	Experimental Group	Control Group
1	7	4
2	6	7
3	11	8
4	13	7
5	5	12
6	2	5
7	3	4
8	16	6
9	9	5
10	4	16
11	9	12
12	3	11
13	3	4
14	4	6
15	7	11
16	18	9
17	13	3
18	9	5
19	10	14
20	3	2
Mean	**7.75**	**7.55**

Appendix F

Post-Test Raw Scores

Student ID	Experimental Group	Control Group
1	24	12
2	16	15
3	23	16
4	26	8
5	20	17
6	6	11
7	11	9
8	27	17
9	20	7
10	12	21
11	23	18
12	20	19
13	10	11
14	18	10
15	21	9
16	29	13
17	24	13
18	19	11
19	23	18
20	14	6
Mean	**19.3**	**13.05**

Appendix I

Interview Guidelines for Students

- How do you feel when your teacher asks you to work in a group during class?
- What do you enjoy the most about participating in class activities or discussions?
- Can you describe a time when you felt supported by your teacher or classmates in learning?
- What kinds of classroom activities help you understand lessons better?
- What problems do you face when learning in a group or working on activities?
- What suggestions do you have to make classroom learning more interesting and student-friendly?
- How does your teacher encourage you to ask questions or share your ideas in class?
- Do you feel you’re learning needs are understood and respected in class? Please explain.

Lesson Plan (Day-1)

Topic: Introduction to Algebraic Expressions

Class: 9 **Subject:** Mathematics

Duration: 45 minutes **Teaching Method:** Collaborative Learning

1. Learning Objectives:

a. Students will understand the meaning of algebraic expressions.

b. Students will be able to identify terms, coefficients, and variables.

c. Students will simplify expressions by combining like terms collaboratively.

2. Teaching Materials:

- Whiteboard and markers, Chart papers, Activity worksheets.

3. Teaching–Learning Methodology:

Collaborative Learning Techniques Used:

Think–Pair–Share, Group Discussion, Peer Teaching

4. Lesson Procedures:

A. **Introduction (10 minutes)**

- Teacher asks where students have seen letters used in math or daily life.
- Presents an example expression: 3x+53x + 5 and discusses parts (terms, coefficients, variables).
- Defines "algebraic expression."

B. **Collaborative Activity (15 minutes)**

- Students work in groups of 4–5.
- Each group receives a worksheet with mixed expressions.
- Members identify the parts of each expression and simplify where possible.

C. **Presentation & Discussion (15 minutes)**

- Each group presents one expression analysis on chart paper.
- Other groups give feedback or ask questions.
- Teacher summarizes correct identification and simplification methods.

5. Assignment/Homework (5 minutes)

Simplify:

1. 2x+3x−52x + 3x - 5
2. 4a−3a+74a - 3a + 7
3. 5y+2−y+45y + 2 - y + 4
4. 7m−3+2m+67m - 3 + 2m + 6

Lesson Plan (Day-2)

Class: 9 **Subject:** Mathematics

Topic: Forming Linear Equations in One Variable

Duration: 45 minutes **Teaching Method:** Collaborative Learning

1. Learning Objectives:

a. Students will translate verbal statements into linear equations.

b. Students will identify the standard form ax+b=0.

c. Students will create and solve simple linear equations collaboratively.

2. Teaching Materials:

- Whiteboard, Chart papers, Worksheet with real-life problems.

3. Teaching–Learning Methodology:

Collaborative Learning Techniques Used:Think–Pair–Share, Jigsaw, Peer Questioning

4. Lesson Procedures:

A. **Introduction (10 minutes)**

- Teacher tells a puzzle: "I am thinking of a number, twice it plus 3 equals 11. What's my number?"
- Students guess and then form the equation together.
- Teacher defines linear equation in one variable.

B. **Collaborative Activity (15 minutes)**

- Groups receive 4 real-life situations to convert into equations.
- Each member works on one and teaches the method to groupmates.

C. **Presentation & Discussion (15 minutes)**

- One member presents the equation for one problem.
- Other groups comment or suggest improvements.
- Teacher reinforces the correct formation process.

5. Assignment/Homework (5 minutes)

Form equations for:

1. The sum of a number and 7 is 15.
2. Five less than twice a number is 9.
3. Three times a number equals 27.
4. Four more than a number is 20.

Lesson Plan (Day-3)

Class: 9 **Subject:** Mathematics

Topic: Solving Linear Equations in One Variable

Duration: 45 minutes **Teaching Method:** Collaborative Learning

1. Learning Objectives:

a. Students will solve linear equations using the balancing method.

b. Students will verify solutions.

c. Students will work collaboratively to explain each solving step.

2. Teaching Materials:

- Whiteboard, Chart papers, Worksheet with equations.

3. Teaching–Learning Methodology:

Collaborative Learning Techniques Used:Group Problem Solving, Peer Checking, Problem Relay

4. Lesson Procedures:

A. **Introduction (10 minutes)**

- Warm-up: Solve $2x-5=9$2x - 5 = 9 mentally.
- Students share different solving methods.
- Teacher explains balancing method briefly.

B. **Collaborative Activity (15 minutes)**

- Each group receives 6 problems.
- One student solves, another verifies, others explain reasoning.
- Rotate roles for each problem.

C. **Presentation & Discussion (15 minutes)**

- Groups solve one equation on chart paper and present the steps.
- Other groups ask questions or correct errors.
- Teacher summarizes best practices.

5. Assignment/Homework (5 minutes)

Solve:

1. $3x+4=13$ and 3x + 4 = 13
2. $7x-9=12$ and 7x - 9 = 12
3. $5x/2=15$ and 5x/2 = 15
4. $2(x-3)=10$ and 2(x - 3) = 10

Lesson Plan (Day-4)

Class: 9 **Subject:** Mathematics

Topic: Introduction to Linear Equations in Two Variables

Duration: 45 minutes **Teaching Method:** Collaborative Learning

1. Learning Objectives:

a. Students will identify two-variable linear equations.

b. Students will complete a table of values.

c. Students will plot the equation on a graph collaboratively.

2. Teaching Materials:

- Whiteboard, Graph paper, Chart paper, Rulers, Worksheets.

3. Teaching–Learning Methodology:

Collaborative Learning Techniques Used:Think–Pair–Share, Group Graphing, Gallery Walk

4. Lesson Procedures:

A. **Introduction (10 minutes)**

- Teacher presents: "Taxi fare = 50 + 10 per km."
- Groups write it as y=10x+50y = 10x + 50.
- Teacher defines two-variable linear equation.

B. **Collaborative Activity (15 minutes)**

- Groups get 3 equations.
- Each member calculates two ordered pairs; group combines results into a table.

C. **Presentation & Discussion (15 minutes)**

- Groups plot graphs on chart paper.
- Students walk around to see other groups' work and discuss differences.
- Teacher summarizes graph interpretation.

5. Assignment/Homework (5 minutes)

Complete table and draw graph for:

1. y=2x+1y = 2x + 1
2. y=−x+4y = -x + 4

Lesson Plan (Day-5)

Class: 9 **Subject:** Mathematics

Topic: Word Problems with Two Variables

Duration: 45 minutes **Teaching Method:** Collaborative Learning

1. Learning Objectives:

a. Students will form two-variable equations from word problems.

b. Students will solve using substitution or elimination.

c. Students will work collaboratively to check solutions.

2. Teaching Materials:

- Whiteboard, Chart paper, Worksheets with word problems.

3. Teaching–Learning Methodology:

Collaborative Learning Techniques Used:

Jigsaw, Group Problem Solving, Problem Swap

4. Lesson Procedures:

A. **Introduction (10 minutes)**

- Teacher narrates: "Adult ticket Rs. 150, child Rs. 100. 10 tickets cost Rs. 1200. How many of each?"
- Groups try to guess before forming equations.

B. **Collaborative Activity (15 minutes)**

- Teacher demonstrates one substitution example.
- Groups solve 3 problems, each member takes a different one, then share solutions.

C. **Presentation & Discussion (15 minutes)**

- Groups present one solution; others ask clarifying questions.
- Teacher discusses strengths and errors in strategies.

5. Assignment/Homework (5 minutes)

Solve:

1. The sum of two numbers is 20. One is twice the other.
2. The perimeter of a rectangle is 50 cm. The length is 5 cm more than the width.