USING COOPERATIVE LEARNING MODEL TO IMPROVE MATHEMATICS LOGIC ABILITY FOR SENIOR HIGH SCHOOL STUDENTS

DONG JUNCAN

A thesis submitted in partial fulfillment of the requirements for
Master of Education in Curriculum and Instruction
Academic Year 2024

Thesis:	**Using Cooperative Learning Model to Improve Mathematics Logic Ability for Senior High School Students**
Author:	**Dong Juncan**
Program:	**Curriculum and Instruction**
Advisor Committee:	**Dr.Phenporn Thongkamsuk**
Advisor Committee:	**Assistant Professor Dr.Supaporn Srihamee**

Bansomdejchaopraya Rajabhat University approved this thesis paper in partial fulfillment of the requirements for the Master of Education Program in Curriculum and Instruction

..... Dean of Graduate School

(Assistant Professor Dr.Nukul Sarawong)

Committees:

..... Chairman

(Associate Professor Dr.Jittirat Saengloetuthai)

..... Committee

(Dr.Phenporn Thongkamsuk)

..... Committee

(Assistant Professor Dr.Supaporn Srihamee)

..... Committee

(Associate Professor Dr.Jittawisut Wimuttipanya)

..... Committee and Secretary

(Assistant Professor Dr.Tanaput Chancharoen)

Thesis	**Using cooperative learning model to improve mathematics logic ability for senior high school Students**
Author	**Dong Juncan**
Program	**Curriculum and Instruction**
Major Advisor	**Dr.Phenporn Thongkamsuk**
Co-advisor	**Assistant Professor Dr.Supaporn Srihamee**
Academic Year	**2024**

ABSTRACT

The purpose of this research was to 1) To use cooperative learning model to improve mathematics logic ability for senior high school students. 2) To compare senior high school students' mathematics logic ability before and after the implementation based on cooperative learning model.

The sample group consisted of 50 senior high school students, No. 2 Senior High School of Panzhou City, Guizhou Province, China, who were selected through the cluster random sampling. The research instruments were 1) lesson plans using cooperative learning model, and 2) mathematics logic ability by data analyzed by frequency, percentage, interpretation, mean, and standard deviation for confirmation. The results revealed the followings:

1. Development of a model consisted of 5 components i.e., principle & rationale, objectives, contents, methods of teaching & materials, and evaluation. The research included three units, totaling 12 hours.

2. After implementing cooperative learning model, it was found that 50 students who enroll in the math course was at good level and cooperative learning model was successful in enhancing students' mathematics logic ability.

Keywords: Cooperative Learning Model, Mathematics Logic Ability, Senior High School Students

Acknowledgements

The swift passage of four years in postgraduate studies was notable, yet my initial visit to Bangsundzhampaya University remained vivid in my memory. My four-year academic journey has intensified my passion for teaching math and further solidified my resolve to follow a path in math education.

First of all, I would like to thank major professor Dr.Phenporn Thongkamsuk. She has profoundly influenced me. She guided me in the process of the defense and offered me patient advice, greatly inspired my topic selection and bolstered my confidence to overcome the challenges encountered in writing. I also want to thank the students from the same class, especially Jia Liang, and Wang Lei. We spent unforgettable times in Thailand. We discussed problems together, which made me deeply feel the strength of the team. I would like to thank my colleagues in No. 2 Senior High School, who has solid professional knowledge and noble character qualities.

Furthermore, my gratitude extends to my parents, whose educational journey has fueled my resolve to pursue continuous learning throughout my life. My gratitude also extends to my wife, whose comprehension and forbearance has filled me with happiness and inspiration throughout my academic journey.

The pursuit of knowledge is perpetual, and my dedication to advancing education and crafting a splendid life will persist. I wish all teachers, students and friends health and happiness in this blossoming day of spring! Learning is never-ending, and I will also continue to strive in the future and write a beautiful life!

Dong Juncan

Contents

Contents (Continued)

List of Figures

List of Tables

Chapter 1
Introduction

Rationale

The background of cooperative learning model to improve the ability of mathematical logical ability could be attributed to the promotion of educational reform and the demand of modern society for talent training. Under the background of quality education and intelligent education, mathematics discipline did not simply require students to get high scores, but hoped to cultivate students' comprehensive literacy. Cooperative learning could enable students to form a perfect ability of analysis, summary and problem-solving in the process of cooperative exploration. Cooperative consciousness was the requirement of social development for people, and then fed back to other disciplines to improve students' overall accomplishment (Ren, 2023)

The Ministry of Education issued the "Curriculum Standards for Full Time Compulsory Education (Experimental Draft)" in July 2001 (hereinafter referred as the "Curriculum Standards"). One of the key points of this curriculum reform was to change students' learning methods. The "Curriculum Standards" pointed out that hands-on practice, independent exploration, and cooperative communication were important ways for students to learn. In the basic concept of curriculum standards and the suggestions for curriculum implementation, group cooperative learning had become an important concept (The Ministry of Education, 2001)

Firstly, with the deepening of education reform, the traditional teaching model has gradually exposed some problems, such as students' lack of initiative, cooperation and communication. In order to change this situation, educators began to explore new teaching modes, among which cooperative learning model has attracted wide attention because of its emphasis on interaction and cooperation. Cooperative learning model not only helped to improve students' learning interest and enthusiasm, but also cultivated students' teamwork and communication ability, so it is widely used in the teaching of various subjects, including mathematics education.

Secondly, the modern society's demand for talent training also promoted the emergence of cooperative learning model. In the era of knowledge economy, innovation and teamwork ability have become important criteria to measure talents. As an important way to cultivate students' logical ability and innovative ability, mathematics education needed to pay more attention to students' initiative and participation. Through the interaction and cooperation among students, the cooperative learning model provided students with more logic thinking and communication opportunities, which was helpful to cultivate students' logic and innovation ability, and met the needs of talents in modern society.

In addition, the characteristics of mathematics also provided conditions for the emergence of cooperative learning model. Mathematics was a subject that required logical thinking and reasoning ability. Through cooperative learning model, students could discuss mathematics problems together, exchange problem-solving ideas, and inspire each other, so as to deepen their understanding of mathematics concepts and methods. At the same time, the cooperative learning model could also provide more practical opportunities for students, so that students could exercise their logical thinking ability in the process of solving practical problems (Luo, 2023)

There is also a lot of domestic research in this field. Tian (2018) pointed out with the deepening of the new curriculum reform, cooperative learning model had been widely concerned by the majority of educators, and most junior middle school mathematics teachers had begun to use cooperative learning model to carry out daily teaching activities, and had achieved good teaching results. Cooperative learning was a way of learning with complementary advantages, which helped to cultivate students' own cooperation ability, deepened their understanding of mathematics knowledge, and exercised students' cooperation and inquiry ability. Sun (2018) stated that in the middle school math class, teachers should actively guide students to adopt the learning mode of group cooperation and guide students to actively participate in the class. Teachers could also grasp the basic knowledge of students in time so as to better reform and optimize the classroom teaching plan. This way could create an active classroom atmosphere, students and teachers will be encouraged accordingly, and it was more conducive to the improvement of students' learning efficiency in junior middle school math class. Chen (2023) stated that during the process of mathematics teaching in junior middle school, the application of cooperative learning model could make teachers have a deep understanding of students' main body status so as to adopt effective methods to promote cooperation and competition among students, and then exert students' initiative to make students

learn better. Zheng (2023) proposed that cooperative learning could be used as a favorable carrier to improve students' mathematics literacy, while dynamic grouping was an effective catalyst to realize the formation of students' core literacy. Group cooperative learning based on dynamic grouping was effective in the overcoming of learning difficulties, the cultivation of core forces, which could improve the comprehensive mathematics literacy level of students. This showed that it was reasonable and necessary to change the traditional static grouping mechanism and apply the group cooperative learning model under the dynamic grouping mechanism. Xie (2020) pointed out that the new curriculum reform advocated the teaching method of group cooperation, which could not only enhance students' initiative, but also provide students with a good learning environment. In senior high school mathematics class, teachers should optimize the teaching process to the maximum extent by stimulating students' cooperative ability so as to achieve better teaching results.

To sum up, the background of cooperative learning model to improve mathematics logic ability mainly includes the promotion of educational reform, the demand for talent training in modern society and the characteristics of mathematics itself. These factors together promote the emergence of cooperative learning model, and make it become an important way to improve students' mathematical logical thinking ability.

Objectives(s)

1. To use cooperative learning model to improve mathematics logic ability for senior high school students.

2. To compare senior high school students’ mathematics logic ability before and after the implementation based on cooperative learning model.

Research Hypothesis

After implementing cooperative learning model, the students’ mathematics logic ability was improved obviously.

Scope of the Research

Population

There are 200 students enrolled in math course at No.2 Senior High School, distributed four classes with a class size of 50 students each.

The Sample Group

Through a cluster sampling random method, a survey was conducted among 50 students from Class One Grade One. Each class consisted of a mix of high, middle and low lever.

The Variable

Independent variable: cooperative learning model

Dependent variable: mathematics logic ability

Contents

Apply cooperative learning model to enhance students' mathematics logic ability. The course was divided into three units, totaling 12 hours:

1. Concept of set (4 hours)
2. Basic relationships between sets (4 hours)
3. Basic operations of sets (4 hours)

Time Frame

The study period is from March to June 2023 and will be divided into the following stages:

1. In March 2023, three chapters will be submitted and defended.
2. In April 2023, modify and complete the teaching plan, relevant tools and experiments based on cooperative learning model.
3. The formal research phase will be scheduled for May 2023.
4. In January 2024, the research findings will be summarized, the research thesis will be completed, and the paper will be published.

Advantages

1. For the students, first of all, cooperative learning can fully mobilize the enthusiasm of students to learn mathematics. Through group discussions and research, students are able to stimulate the desire to communicate and can't help but participate in it. This interactive way of learning allows students to unknowingly learn about other students' problem-solving ideas, and may internalize these ideas into their own problem-solving methods. Secondly, cooperative learning helps to cultivate students' language communication ability. In mathematics learning, although the main focus is on numbers and formulas, good language communication skills are still very important for understanding and explaining mathematical concepts and problem-solving ideas.

2. For the teachers, firstly, cooperative learning model provides teachers with more effective feedback. In cooperative learning, teachers can observe students' performance in group discussions and research so as to understand their learning and problems. This provides teachers with a more effective feedback mechanism, and allows them to more accurately assess students' progress. Secondly, cooperative learning model helps to build a harmonious classroom atmosphere. Cooperative learning mode encourages mutual help and cooperation among students, which helps to build a harmonious classroom atmosphere. In this atmosphere, students are more willing to participate in classroom activities, and have positive interaction and communication with teachers and classmates, so as to improve their mathematical logic ability.

3. For the school, cooperative learning model is an innovative teaching method which helps to promote the innovation of educational concepts and methods in schools. This kind of innovation can drive the improvement of the overall education level of the school, so that the school can maintain a leading position in the field of education.

Definition of Terms

Cooperative Learning Model asserted that it was an educational teaching method, which emphasized that students completed learning tasks together through cooperation and communication in a group, and promoted students' all-round development, especially logic ability. This model focused on students' active participation and interaction, emphasized team spirit and responsibility, and enabled students to learn from each other and inspired each other in cooperative learning, so as to achieve better learning results (Zhong, 2023).

Step 1: Role Assignment

According to the characteristics of students, interests and learning level, the students were divided into reasonable groups. When grouping, the heterogeneity among the members of each group should be ensured in order to promote each other in cooperative learning. At the same time, each group was assigned different roles, such as group leader, recorder, spokesman, etc., in order to cultivate students' teamwork ability and sense of responsibility.

Step 2: Task Setup

Teachers designed challenging and interesting cooperative tasks according to the teaching objectives and the actual situation of students. Assignments stimulated students' interest in learning and encouraged active participation in discussion and inquiry. At the same time, the difficulty of the task should be moderate to ensure that students can achieve certain teaching results in cooperation.

Step 3: Group Discussion

In the group, members discussed and explored the task of cooperation. Teachers should encourage students to express their own opinions boldly, listen to the opinions of others, and learn to respect and understand others. In the process of discussion, teachers should give timely guidance to ensure the direction and depth of discussion.

Step 4: Result Report

After group discussion and exploration, each group would display and exchange their results. The presentation form was diversified, such as oral presentation, exhibition board, PPT, etc. In the process of presentation, the groups could ask and evaluate each other to promote the sharing and deepening of knowledge.

Step 5: Teaching Comment

At the end of the presentation and communication, the teacher commented and summarized the students' performance. The comments should focus on the student's performance in the cooperative learning process, affirm the student's strengths, and point out areas for improvement. At the same time, teachers should also reflect and summarize the whole teaching process in order to better optimize teaching strategies and methods (Zhou, 2023).

Mathematics Logic Ability referred to the ability of an individual to solve problems and make decisions on the basis of understanding and mastering mathematical concepts through using logic reasoning and analysis, proof and refutation skills. Mathematical logic ability was expressed in three aspects: 1) conceptual understanding, 2) logical deduction, 3) critical thinking (Zhang, 2020).

Research Framework

This study about "Using cooperative learning model to improve mathematics logic ability for senior high school students", the researcher studied the concepts and principles of cooperative learning model, analyzed the method of cooperative learning model and introduced the research framework 5 steps: 1) Role assignment, 2) Task setup, 3) Group discussion, 4) Result report, 5) Teaching comment in Figure 1.1:

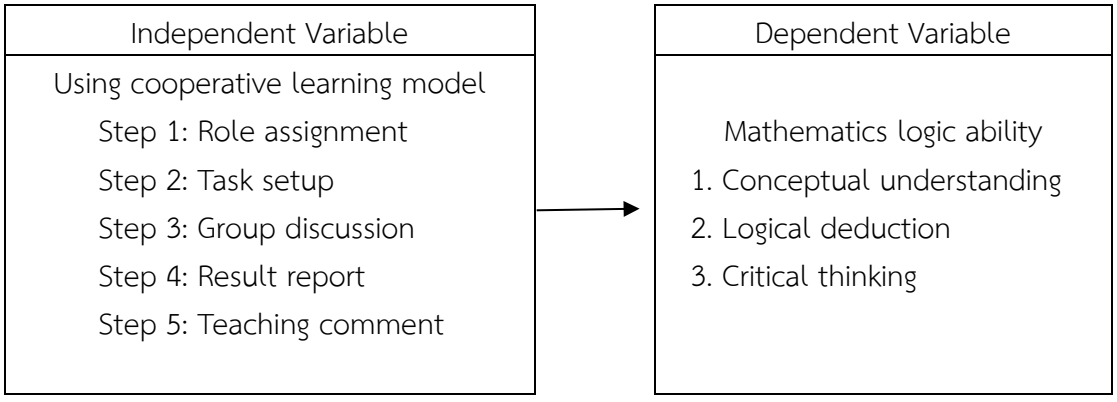


Figure 1.1 Research Framework

Chapter 2
Literature Review

In the research title "Using Cooperative Learning Model to Improve Mathematics Logic Ability for Senior High School Students", the researcher reviewed relevant documents concerning the following in order to construct the theoretical framework for this research.

1. Cooperative Learning Model
2. Mathematics Logic Ability
3. Related Research

Cooperative Learning Model

1. Meaning of Cooperative Learning Model

Cooperative learning could be traced back to thousands of years ago, the Jews recorded: when learning the Talmud, there was a study partner around to study together, so that the grasp of knowledge was better and more impressive. And the real sense of group cooperative learning started to be used in classrooms in the United States around 1970, around 1980. Since 1990, the research has become more systematic, and the application theory has become more abundant and more widely used. After entering the 21st century, scholars have paid more attention to the application of this model in the classroom. After long-term research, they have gained a lot in theory and practice, and group cooperative learning has entered a relatively mature stage.

Li (2023) mainly stated cooperative learning should first divide students into several groups, and each group could be composed of students with different abilities, gender, personality and cultural background. In the form of group cooperation, under the guidance of teachers, students in the group could jointly complete the learning task through exploration and mutual assistance activities, and at the same time had a positive impact on students' cognition, emotion, self-confidence and peer relationship. According to the learning theory of constructivism, students constructed new knowledge on the basis of their existing knowledge, experience and cultural background. Group cooperative learning could complement each other's advantages through interaction and communication among students, thus promote knowledge construction. Through cooperative learning, students' cooperative consciousness and ability (including cooperative knowledge, skills and

emotional attitude, etc.) were cultivated, and students could reduce pressure, enhance self-confidence and increase hands-on practice opportunities in the learning process, so they could cultivate innovative spirit and practical ability. At the same time, it promoted the personality development of all students (including the development of academic performance, emotion and other personality qualities). The cooperative learning model was based on interpersonal communication, including student-student communication, teacher-student communication and student-student communication. First, the students in the class were divided into groups, then the cooperative teaching links were designed according to different class types, and finally, reasonable evaluation criteria was designed to evaluate the group. The teaching mode of group cooperative learning could strengthen the communication between people, improve the learning atmosphere of the class, encourage the enthusiasm of learning and cultivate the ability of cooperation.

Guan (2023) emphasized that "cooperation" was a kind of good teaching mode with emotion as the bond, equality as the basis, mutual respect and exchange of views as the characteristics, which could fully reflect students' independent learning, and the play of these advantages depended on the reform of teachers' teaching ideas. In the face of the requirements of education in the new century, the role of teachers in classroom teaching should be the faithful implementer of textbooks, but the organizer who creatively used textbooks. Teachers were no longer the crafters who only taught, but the guides who had accurate educational views and were good at making students discover and explore. In the teaching process, teachers should accurately grasp their role, reduce the occupation of time and space for students, provide students with opportunities to fully engage in teaching activities for positive thinking, active exploration, so that they could have an effective partnership effect in the process of independent exploration and cooperation. The effect of this partner could create a psychological environment and emotional atmosphere that was convenient for exploration. Therefore, "cooperation" strengthened the form of group learning, and students interacted with each other more frequently, so the research atmosphere was stronger.

Ren (2023) mainly discussed that cooperative learning was open to all students and was conducive to promoting the development of each student. The traditional teaching mode was that the teacher spoke and the students listened. Cooperative learning helped every student have the opportunity to participate, and every student can show themselves. Cooperative learning could fully mobilize the enthusiasm of students. In cooperative learning, students were the main body of

learning, fully experienced the pleasure of learning, so as to have a strong interest in learning, which also produced the motivation of learning. Change the old "want me to learn" classroom mode to the current "I want to learn" or "I want to learn" mode. Cooperative learning helped to improve students' communication ability. Interpersonal communication was the ability to survive all one's life, which was the precious wealth of students. Therefore, school education must pay attention to the cultivation of students' communication skills, learn in cooperation, cooperate in learning, and strengthen the contact and cooperation through the exchange of ideas with others, so as to improve interpersonal skills. Cooperative learning could improve learning efficiency. In cooperative learning, since each member of the group actively participated in the learning activities and the learning task was shared by everyone, the problem became easier to solve. Moreover, in mutual learning, student could learn the advantages of other students and reflect on their shortcomings, which helped to develop strengths and give full play to their potential.

Zhu (2023) stated that cooperative learning could motivate students to perform at their highest level. In traditional learning, the success of one student tended to put pressure on other students, thus led to their lack of confidence. In contrast, in cooperative learning, if students worked together towards a common goal, it helped the whole team to succeed, so that each member could experience the joy and honor of success. Cooperative learning could build a more relaxing and free learning platform for students. First of all, students could transform the teacher's words into their own "student language", and make it easier for those who have difficulty understanding the teacher's explanation. Secondly, in cooperative learning, students learned by explaining to each other, and the students responsible for explaining must find ways to organize their thoughts, so that they could also improve their own understanding level. Thirdly, because students got along one-on-one, it was easier for them to understand each other's needs of help, and it was easier to eliminate the sense of constraint to the teacher. They were relaxed and free in mind, and they were more likely to get help from classmates rather than ridicule.

Overall, cooperative learning helps students improve each other. Each student has some unique and valuable intellectual highlights and sparks of wisdom. Cooperative learning can give full play to their main role, so that problems from students, through mutual exchange, promote the simultaneous development of intellectual quality and non-intellectual quality.

2. The Significance of Cooperative Learning Model

The importance of cooperative learning model is that it can effectively cultivate students' teamwork ability and collective sense of honor, promote exchanges, communication, cooperation and coordination among students, improve their problem-solving ability and independent thinking ability, and enhance their learning motivation and participation. This learning mode not only conforms to the trend of cooperation in modern society, but also meets the needs of educational reform, which is of great significance to the all-round development of students.

The significance of cooperative learning model includes the following aspects:

Firstly, enhance the sense of competition and stimulate the students' enterprising spirit. The all-round competition between individuals and groups makes students always in a competitive environment in school life. A contest or a match caught up with the classmates in front and won glory for the group. The concept of striving to surpass oneself and enter the next level was gradually internalized into the students' consciousness and action, and the sense of competition was significantly improved and the initiative was greatly enhanced. This competitive atmosphere greatly contributed to the overall improvement of academic performance.

Secondly, strengthen the sense of cooperation and enhance the cohesion of the class. In order to win the group, the members of the study group must work together, everyone gave play to their own strengths and helped other students in the group, thus formed a cooperative atmosphere in the group. Under the correct guidance of teachers, this sense of cooperation could be naturally transferred to each student's attitude towards the class, so that the cohesion and appeal of the class were greatly enhanced, and the solidarity and mutual assistance between students were enhanced.

In sum, cooperative learning model is an important teaching method, which emphasizes cooperation and communication among students and promotes mutual learning and growth among students.

Zheng (2023) pointed out that cooperative learning model emphasized the cultivation of teamwork ability. In the process of cooperative learning, students needed to cooperate with each other and completed tasks together, which could not only cultivate their teamwork ability, but also enhanced their sense of collective honor. Through teamwork, students could learn how to work together and coordinate communication so as to better adapt to the future working environment. Cooperative

learning mode indeed emphasized the cultivation of teamwork ability. The cooperation and collaboration among students were core elements that made this learning approach distinctive.

1. Team dynamics and collaboration skills. In cooperative learning, students learned to work effectively in teams. They understood the dynamics of teamwork, including the roles and responsibilities of each member. This helped them develop skills such as team leadership, decision-making, and conflict resolution.

2. Sharing teaching goals. Cooperative learning model fostered a sense of collective responsibility among students. They understood that achieving the group's goals was everyone's responsibility. This purpose created a strong bond among team members, and encouraged them to work together towards a common objective.

3. Communication skills. Effective communication was crucial for successful teamwork. In cooperative learning, students learned to communicate their ideas, concerns, and suggestions effectively. They also learned to listen actively to other students, and understood their perspectives and contributions.

Wang (2023) observed that in cooperative learning, students could share various resources, such as learning materials and experiences. This not only improved learning efficiency, but also enabled students to learn how to use resources rationally.

1. Through resource sharing, students could learn from each other and make progress together so as to better adapt to future social development. This kind of resource sharing not only improved learning efficiency and helped students to master knowledge faster, but also cultivated their cooperative spirit and teamwork ability.

2. At the same time, through resource sharing, students could also learn how to use and manage resources more effectively, which was an indispensable ability for their future life and work.

3. In this process, each student could get new inspiration from other students, find their own shortcomings, and constantly improve themselves. This learning mode enabled students to better adapt to the development of the future society, and laid a solid foundation for personal growth.

Qu (2024) stated that cooperative learning model could stimulate students' innovative thinking.

1. In cooperative learning, students needed to discuss problems and find solutions together, which could not only cultivate their innovative consciousness, but also stimulate their creativity. By constantly challenging themselves and trying new approaches, students could learn how to think differently and be better prepared for

future challenges. Cooperative learning model could really stimulate students' innovative thinking.

2. In cooperative learning, students needed to explore problems and seek solutions together, which not only fostered their sense of innovation, but also stimulated their creativity. By constantly challenging themselves and trying new approaches, students could learn how to think creatively and be prepared for the challenges ahead.

3. In addition, cooperative learning provided an environment that encouraged diverse perspectives and thinking, which helped students develop open, inclusive and critical thinking habits, further enhanced their innovative ability and comprehensive quality. Therefore, cooperative learning model played an important role in promoting students' all-round development, especially the improvement of innovative thinking ability.

Jing (2024) stated that cooperative learning model was helpful to promote students' all-round development.

1. In cooperative learning, students could not only learn knowledge, but also improve their teamwork ability, communication ability, innovative thinking and other abilities. These abilities were essential for the all-round development of students and could help them better adapt to the future social competition.

2. In a cooperative learning, students not only gained knowledge, but also improved their abilities in several key areas. First of all, through cooperative learning, students' teamwork ability was significantly enhanced. They needed to collaborate with each other to complete tasks together, which not only exercised their collaboration skills, but also developed their sense of community and responsibility. Secondly, cooperative learning model challenged students' communication ability. In a team, students needed to express their views effectively, listened to the opinions of other students, and consulted and discussed with others. Such communication exercises helped them to interact with people more confidently in the future. In addition, cooperative learning model encouraged students to develop innovative thinking. In the process of problem-solving, students needed to constantly explore new methods and ideas, which helped to cultivate their innovative ability and problem-solving ability.

To sum up, cooperative learning model is of great significance in promoting team cooperation, cultivating communication ability, stimulating innovative thinking, improving learning motivation, deepening knowledge understanding, sharing learning resource, enhancing problem-solving ability and promoting all-round development.

Therefore, in the teaching process, teachers should make full use of the advantages of cooperative learning model to provide students with more rich and diverse learning experience.

3. The Elements of Cooperative Learning Model

In modern education, cooperative learning model has become a widely used teaching method. Through group cooperative learning, students can cooperate and help each other in a team to solve problems and complete tasks together. However, in order to carry out effective group cooperative learning and obtain good learning results, some specific strategies and skills are needed.

Dong (2022) stated that cooperative learning model were integrated to form an efficient and comprehensive learning system.

Step 1: Role assignment. It ensured that each student could find a suitable position in the team and fully display their individual talents and strengths.

Step 2: Task setup. The objective set the tone for the whole team to work together and energized the learning process for the students.

Step 3: Group discussion. The discussion provided a platform for students to explore various issues in depth, exchanged each other's views.

Step 4: Result report. With the deepening of the discussion, students needed to organize a research report, which not only exercised their summarizing ability, but also improved their oral expression skills.

Step 5: Teaching comment. The feedback conducted an in-depth reflection and assessment of the entire cooperative learning process, thus helped students to recognize their own strengths and areas for improvement in the learning process. These five links were closely linked and progressive, which together constituted the solid foundation of cooperative learning model and provided strong support for the all-round development of students.

Zheng (2023) stated that cooperative learning model promoted to form a complete learning process.

Step 1: Role allocation. It was carried out to ensure that each student played a suitable role in the team.

Step 2: Task setup. Through providing appropriate learning opportunities, students discussed issues together, exchanged ideas, and promoted the collision of ideas and inspiration.

Step 3: Group discussion. It provided the peaceful atmosphere.

Step 4: Outcome report. The students needed to summarize outcome report, which not only exercised their summarizing ability, but also improved their oral expression ability.

Step 5: Teaching comment. The section reflected and evaluated the whole cooperative learning process, helped students realize their own shortcomings and progress, and provided useful guidance for the next step of learning. These five steps were interrelated and progressive, which together constituted the basic framework of cooperative learning model.

Liu (2023) pointed out that cooperative learning model were interwoven to build a comprehensive and efficient learning process.

Step 1: Role assignment. It was the first step in this process, which ensured that each student found his or her place in the team.

Step 2: Task setup. It provided direction for team cooperation and motivation for students' learning.

Step 3: Group discussion. The group discussion became a platform for students to exchange and clash ideas, where they discussed issues together, shared opinions, and inspired new ideas and inspirations.

Step 4: Result report. After the discussion, students needed to summarize finding report, which was not only the exercise of their summary ability, but also the improvement of their oral expression ability.

Step 5: Lesson commentary. In the end, the lesson commentary was an in-depth reflection and evaluation of the whole cooperative learning process These five steps were interlinked, which together formed a solid foundation for cooperative learning model.

Zhou (2023) emphasized that the five key elements of the cooperative learning model were interwoven to create an efficient and integrated learning experience.

Step 1: Role assignment. Starting with roles, this step ensured that each student found his or her place in the team and brought out unique strengths.

Step 2: Pre-task configuration. It provided a clear guide for the cooperation of the whole team, while providing a strong drive for the learning of the individual students.

Step 3: Brainstorming session. It became a stimulating place where students engaged in in-depth discussion around issues and shared their own insights, thus stimulated Creativity and imagination.

Step 4: Result report. After discussion, the students needed to report the conclusion, which not only exercised their summarizing ability, but also improved their oral expression skills.

Step 5: Teaching evaluation. The evaluation conducted an in-depth review and assessment of the entire cooperative learning process, helped students to recognize their own bright spots in the learning process, and provided valuable feedback and suggestions for future learning. These five links were closely linked and progressive, which together constituted the solid foundation of cooperative learning model.

Peng (2023) pointed out that cooperative learning model were integrated to build a comprehensive and efficient learning journey.

Step 1: Role assignment. It was the starting point for collaboration, ensured that each student could find his or her place in the team and make full use of unique talents and strengths.

Step 2: Task preparation. It provided clear direction for teamwork while providing strong motivation for students to learn.

Step 3: Collaborative discussion. It explored the problems in depth, exchanged views, and stimulated new thinking and creativity.

Step 4: Outcome summary. With the deepening of the discussion, students needed to organize and present the outcome summary, which not only improved their summarizing ability, but also exercised their oral expression skills.

Step 5: Teaching comment. It reflected and assesses the entire learning process, helped students to recognize their own strengths and weaknesses in the learning process, provided valuable advice and direction for future learning. These five links are closely linked and in-depth, which together formed a solid foundation for cooperative learning model.

Table 2.1 The synthesis of cooperative learning method

Author	Dong (2022)	Zheng (2023)	Liu (2023)	Zhou (2023)	Peng (2023)	My Research Detail
Step 1	Role assignment	Role allocation	Role assignment	Role assignment	Role assignment	Role assignment
Step 2	Task setup	Task setup	Task setup	Pre-task configuration	Task preparation	Task setup
Step 3	Group discussion	Group discussion	Group discussion	Brainstorming session	Collaborative discussion	Group discussion
Step 4	Result report	Outcome report	Result report	Result report	Outcome summary	Result report
Step 5	Teaching comment	Teaching comment	Lesson commentary	Teaching evaluation	Teaching comment	Teaching comment

All the above literature studies discuss the application of cooperative learning model in different disciplines. Among them, the subjects involved include English writing, geography, physics, history, and English teaching. These studies show that cooperative learning model is an effective teaching method, which can promote students 'active learning and independent thinking, and improve students' learning interest and learning effect. These studies also explore how to apply the cooperative learning model in a specific teaching process, including guiding students to participate in discussion and interaction, providing opportunities for practice and reflection. Overall, these studies suggest that cooperative learning model is important for promoting students' learning and development.

Cooperative learning mode plays an important role in the field of education, especially in cultivating students' teamwork, communication and autonomous learning ability. The steps of cooperative learning model are as follows:

Step 1: Role Assignment.

Role assignment is a key part of cooperative learning. It helps students realize the importance of each team member and pushes them to assume their respective responsibilities. By assigning different roles, students can learn how to play to their strengths in a team, and at the same time, students learn about the roles and responsibilities of other team members, thus increase mutual understanding and respect.

Step 2: Task Setup.

In cooperative learning, task setup is the key to stimulating student interest and motivation. By working together on tasks, students learn how to break down problems, assign work, and use resources efficiently. In addition, the setting of tasks should also be challenging to stimulate students' creativity and imagination.

Step 3: Group discussion.

Group discussion is the core of the cooperative learning model. In this session, students have the opportunity to share their own views and ideas while listening to the opinions and suggestions of other students. Through group discussions, students can learn how to listen to others, how to express their opinions, and how to communicate effectively with others. These skills are essential for developing students' social skills and critical thinking.

Step 4: Result Report.

Result report is an important part of showing the results of group cooperative learning. By organizing and reporting on the group's learning, students learn how to summarize information, how to prepare presentations, and how to

communicate their ideas effectively. In addition, the results report can enhance the cohesion and centripetal force of the group, and bring the team members closer together.

Step 5: Teaching Comment.

Teaching comment is the last link of cooperative learning model, and it is also an important link to improve students' self-cognition and learning motivation. Through the teacher's comments and guidance, students can learn about their own performance in cooperative learning. At the same time, teachers' comments can also provide students with further learning directions and suggestions to help them better develop their learning ability.

To sum up, cooperative learning model plays an important role in education. It can not only help students improve their teamwork and communication skills, but also cultivate their independent learning ability and critical thinking. Through the practice of five steps, such as role assignment, task setting, group discussion, result report and teaching comment, students can comprehensively improve their comprehensive quality and learning effect.

Mathematics Logic Ability

1. The Meaning of Mathematics Logic Ability

The ability of mathematics logic ability refers to the ability of individuals to deeply understand and apply mathematical concepts, principles and theorems through a series of complex thinking activities and skills in the field of mathematics. This ability goes far beyond simple mathematical calculations or the application of formulas. Mathematics logic ability involves a range of deep cognitive processes and skills, and it is an essential part of mathematical literacy.

Firstly, mathematics logic ability covers the ability of logical reasoning. In mathematics, every theorem, formula or concept needs to be rigorously verified by logic. People with good mathematics logic ability can deduce new conclusions or solve complex problems by logical reasoning based on known mathematics principles.

Secondly, abstract thinking ability is also an important part of mathematics logic ability. Mathematics itself is a highly abstract discipline, which requires people to be able to separate the non-essential properties of concrete things and focus on their mathematical structure and properties. Therefore, a person with strong mathematics logic ability is often better able to understand and apply mathematics concepts and principles.

To sum up, mathematics logic ability is the ability of an individual to deeply understand and apply mathematical concepts, principles and theorems through a series of complex thinking activities and skills in the field of mathematics. This ability not only requires individuals to have strong logical reasoning, abstract thinking and problem-solving abilities, but also requires them to understand and master various mathematical proof methods, so as to master and apply mathematical knowledge more comprehensively. In the process of mathematics education and learning, teachers should pay attention to cultivating and improving individuals' mathematics logic ability, and help students better understand and master mathematical knowledge, lay a solid foundation for their future academic and professional careers.

Table 2.2 The definition of mathematics logic ability

Scholars	Definition of Mathematics Logic Ability
Chen (2023)	Mathematical logic ability was the ability of individuals to analyze and solve problems by using mathematics concepts and principles through logical reasoning. This ability involved thinking methods such as observation, comparison, induction and deduction, as well as in-depth understanding and application of mathematical concepts and principles.
Wang (2023)	Mathematical logic ability was a kind of strict rational thinking ability, which required individuals to think correctly and reasonably, use correct reasoning methods and formats, accurately and logically express thinking process in the field of mathematics. This ability was especially important when solving complex mathematics problems or performing mathematics proofs.
Liu (2023)	Mathematical logic ability was the ability of individuals to use mathematical thinking to abstract and summarize. It required individuals to be able to abstract general laws or principles from specific mathematical problems in order to solve similar problems. This ability was widely used in mathematical modeling, theorem proving and so on.

Table 2.2 (Continue)

Scholars	Definition of Mathematics Logic Ability
Ma (2023)	Mathematical logic ability was the synthesis of various abilities necessary for an individual to engage in mathematical activities, including observation, comparison, induction, deduction, analysis, synthesis and other thinking abilities, as well as correct reasoning methods and formats. This ability was the core of mathematical ability, which was of great significance for improving individual mathematical literacy and solving mathematics problems.
Luo (2023)	Mathematical logic ability referred to the ability of individuals to understand and solve mathematics problems through logical reasoning, proof and refutation, abstract thinking and other methods. It covered many aspects such as concept understanding, symbolic formula application, problem analysis and solution, algorithm design and optimization.
Jing (2024)	Mathematical logic ability was the ability of an individual to use mathematical thinking to solve problems. It required individuals to be able to identify the key points of the problem, adopt appropriate mathematical methods and skills, and carry out effective problem analysis and solution. This ability was equally important in daily life and work, especially when mathematical thinking was needed to solve practical problems.

In conclusion, mathematics logic ability is a comprehensive ability, and aims at using mathematical thinking to solve problems. This ability requires an individual to have a deep understanding of mathematics concepts and be able to accurately grasp connotation and denotation. At the same time, logic ability is also essential, through reasonable reasoning steps, individuals can deduce unknown conclusions from known conditions.

2. The Importance of Mathematics Logic Ability

Mathematics logic ability is the basis of modern scientific decision-making, which can solve problems accurately, drive innovative thinking, and act as a bridge between disciplines. It cultivates the spirit of positivism, improves the ability of logical reasoning and abstract thinking, and guarantees rigorous argument, which is an indispensable core ability for scientific and technological development and personal growth.

Wang (2023) emphasized that mathematics logic ability was the basis of scientific research. Whether it was physics, engineering, or economics, mathematics logic ability was needed to model, analyze, and predict. Only through rigorous logical reasoning, can teachers ensure the accuracy and reliability of the research results. Mathematics logic ability was the cornerstone of scientific research, from the discovery of physical laws to the construction of economic models, it was necessary to carry out accurate modeling and careful analysis. It was a fundamental ability to see into the nature of things, to make informed predictions, and to ensure that the results of research were rigorous and accurate.

Li (2023) pointed out mathematics logic ability was not only a tool for scientific research, but also the key to solving practical problems. Through logical analysis and mathematical reasoning, the best solution to the problem can be found. The application of mathematics logic ability can simplify complex problems and improve the efficiency and accuracy of problem solving.

Guan (2023) explored mathematics logic ability played a crucial role in one's career development. In modern society, people with mathematics logic ability were favored in daily life. From the risk management of financial markets, to the design of scientific and technological innovation, to the teaching research in the field of education and the data analysis in the medical industry, mathematics logic ability has become a core element to promote the development and innovation of the industry. Therefore, if an individual wants to stand out in his career, he must pay attention to cultivating and improving mathematical logic ability to adapt to the increasingly complex and changeable career needs.

Zhu (2023) emphasized mathematical logic ability was not only an important tool to solve problems, but also the key to shape the way of thinking. Through the training of mathematics logic ability, logical thinking and abstract thinking could be improved. This ability allowed to understand problems more deeply, find solutions more quickly, and be more comfortable in the face of the complex and changing real world. Therefore, the cultivation of mathematics logic ability was not only conducive to personal academic and professional development, but also an important way to enhance the overall thinking ability and innovative spirit.

To sum up, mathematics logic ability plays a vital role in scientific research, practical problem solving, personal career development and thinking ability training. Whether it is the pursuit of academic research, the efficiency of solving practical problems, the competitiveness of career, or the improvement of personal thinking ability, mathematics logic ability plays an indispensable role. Therefore, we should

actively pay attention to the cultivation and training of mathematics logic ability, and strive to improve mathematics logic level through continuous learning and practice to adapt to the increasingly complex and changeable real world.

3. The Principle of Mathematics Logic Ability

The principles of mathematics logic ability can be summarized as: to maintain clarity, consistency, formalization, deductive reasoning and substantiality. These principles together ensure the rigor, reliability and accuracy of mathematics logic thinking, so that mathematics logic ability can be used to solve problems more systematically and effectively.

3.1 Clarity principle: Mathematics logical thinking emphasizes the clarity and precision of concepts. When dealing with mathematics problems, teachers need to be clear about the meaning of individual concepts and terms and avoid ambiguous or ambiguous expressions. Only by ensuring the clarity of the concept, can students carry out accurate logic reasoning.

3.2 Consistency principle: Mathematical logical thinking requires that our reasoning and conclusions remain consistent. This means that in reasoning we must not contradict ourselves and that all premises and conclusions should support each other. The principle of consistency ensures the reliability and stability of mathematical logic.

3.3 Formalization principle: Mathematics logical thinking tends to formalize problems, that is, to use mathematics symbols and formulas to express problems and reasons. Formalization helps simplify problems and makes logical reasoning more explicit and verifiable. Formal principles make mathematical logic a rigorous and reliable tool.

3.4 Deductive reasoning principle: Mathematical logical thinking emphasizes the importance of deductive reasoning. Deductive reasoning is a process of inference from general to special, which starts from known premises and deduces conclusions through logical rules. This way of reasoning ensures the inevitability and accuracy of the conclusion.

3.5 Substantiality principle: Mathematics logical thinking focuses on verification. Before drawing a conclusion, it is needed to carry out sufficient empirical work to ensure the correctness of the conclusion. This includes the use of mathematics methods for proof, testing and correction, as well as practical applications to verify the feasibility and practicality of the conclusions.

In sum, students can use mathematics logic to think and solve problems more rigorously and systematically, and improve mathematics logic ability (Wang, 2023)

4. The Measurement and Evaluation of Mathematics Logic Ability

As the study focuses on using cooperative learning model to enhance mathematics logic ability for senior high school students, the measurement and evaluation of mathematics logic ability should integrate the five steps of cooperative learning ability, Step 1: Role assignment, Step 2: Task setup, Step 3: Group discussion, Step 4: Result report, Step 5: Teaching comment.

Table 2.3 Cooperative learning ability assessment and review form

Area	Items	Self-Evaluation	Inter-Group Evaluation
Concept understanding ability (12)	1. The concept of sets. (3)		
	2. The relationship between elements and sets (3)		
	3. The characteristics of the elements in the set concept (3)		
	4. Classification of set concepts (3)		
Logical deduction ability (6)	1. Master the symbols and representations of subsets and proper subsets (3)		
	2. Use a coincidence to represent subsets and proper subsets (3)		
Critical thinking ability (12)	1. The concept and nature of intersection and union (3)		
	2. Intersection and union of two sets (3)		
	3. The significance of the complete set of mathematics (3)		
	4. A complement of a set in a complete set (3)		

According to the Table 2.3, the researcher analyzed documents and theory deeply. The researcher used the criteria to consider the relevant characteristics.

Relevant Research

Zhang (2018) emphasized junior middle school mathematics teaching activities paid attention to the fundamentals, and cooperative learning could strengthen the teaching reform, provide basic courses for mathematics teaching, and promote the development of basic education in the past period of time. According to the current form of class teaching, cooperative teaching mode was not only the main form of current teaching management, but also the key to the subject understanding of classroom teaching. Nowadays, with the continuous development of teaching mode, students' classroom presentation had changed, and students' thirst for knowledge had gradually deepened. The development of active learning and passive creativity had become the key to change students' independent learning mode, and it was also one of the important ways to carry out cooperative learning model. The combination of cooperative teaching mode and mathematics teaching can reflect the consistency of current teaching, provide the possibility for the transformation of teaching constitution and the establishment of mathematical theoretical basis. It was a popular teaching mode at present.

He (2020) pointed out that mathematics teaching in junior middle school was faced with the current situation of tight time, heavy tasks and being tired to deal with, so it was unrealistic for students to rely on imitation and memory to achieve effective mathematics learning. Based on this situation, it was necessary to pay attention to independent exploration and cooperation, create a situational learning mode, use group conventions to restrict and motivate students' learning behaviors, and solve the problems of inefficient learning and two-level differentiation in exercise sessions. To help students better understand and master the basic knowledge and skills, ideas and methods of mathematics in the process of mathematics teaching, cooperative learning model was necessary.

Chen (2021) emphasized that with the gradual advancement of the new round of curriculum reform, the teaching concepts of "independent inquiry, cooperation and exchange" were continuing to be deeply applied in the teaching of various subjects in junior middle schools. Group cooperative learning had become one of the most commonly used teaching methods in modern classroom teaching, which could significantly improve students' creative thinking ability, highlight students' main position in the learning process, and cultivate students' awareness of cooperation and communication. At the same time, problem-solving idea had gradually become an important part of mathematics teaching, and it was particularly important to improve students' problem-solving ability in mathematics teaching.

Cooperative learning teaching design and micro-strategies could improve the cooperative behavior of group members in practice, make intra-group cooperation more standardized and efficient, and effectively enhance students' mutual cooperation ability and problem-solving level.

Feng (2021) mainly stated that cooperative learning model in the smart classroom had rich organizational forms, and the desks could be adjusted at any time according to the needs of teachers to stimulate students' interest in learning. The division of cooperation was clear, and each student played a very important role in the group, which improved students' organizational ability. The cooperation requirements were clear, and each student's speech order was exquisite, so as to cultivate students' cooperation and communication ability. The cooperative task was exploratory and challenging, which fully stimulated students' learning drive and cultivated students' higher-order thinking. The teaching philosophy was student-oriented, provided students with enough time and space for independent thinking, group discussion and class sharing, and improved students' comprehensive ability in the exchange of ideas, so that students could truly become the master of the class. The integration of information technology and classroom teaching made students' thinking visible and promoted the diversity of teachers.

Dong (2022) believed that to cultivate students' mathematical problem-solving ability was indeed one of the core objectives of mathematics education. In order to achieve this goal, educators needed to adopt a series of strategies and methods to guide students to effectively participate in math learning. Firstly, create real and meaningful problem situations. Teachers designed problems that related to students' daily lives, interests, or future careers, so that students were interested and motivated to solve problems. Secondly, cultivate students' mathematical thinking. Mathematics thinking included logical reasoning, summary, transformation and so on. Teachers could cultivate students' mathematical thinking ability by analyzing examples and designing exercises, so that students could flexibly apply what they had learned when solving problems. Thirdly, organize cooperative learning activities. Students could solve problems together in mutual communication and cooperation through group discussions, team projects, etc. This not only cultivated students' teamwork skills, but also allowed students to broaden their thinking and improve their problem-solving skills in different perspectives and approaches. Fourthly, provide timely feedback and effective evaluation. Teachers provided timely feedback and evaluation of students' problem-solving processes and results, pointed out their strengths and weaknesses, and provided suggestions for improvement.

Luo (2022) stated that building cooperative learning mode of junior middle school mathematics teaching group could not only benefit both teachers and students, but also improve students' learning ability, thinking level, teamwork awareness and mathematical literacy while easing teachers' teaching burden, which was considered to be the only choice for junior middle school mathematics teaching reform. With the continuous advancement of the new curriculum reform process, more and more new teaching models had been applied to the classroom, which had injected vitality into the classroom teaching, and also made the majority of mathematics teachers paid more attention to the application of the group cooperative learning model. However, at the current stage, there were still obvious deficiencies in group cooperative learning in junior middle school mathematics teaching. Teachers needed to face up to these deficiencies, deepen teaching research, analyze students' learning situation, and adjust the construction strategy of group cooperative learning mode according to the actual teaching situation, so as to ensure that the group cooperative learning mode was fully applied in junior middle school mathematics teaching, so as to benefit teachers and students.

Liu (2023) stated how to stimulate students' independent thinking, develop creative thinking and strengthen practical skills had become a key issue to be solved. "Problem" was the most original driving force for the development of mathematics. Traditional teaching often took "question and answer" as the main method for students to construct knowledge, but neglected the development of students' creative thinking and the cultivation of practical skills. Therefore, cooperative learning model based on a variety of theoretical ideas such as constructivism, discovery theory, social interdependence theory always took "problem" as the communication medium between teachers and students. On the one hand, it could promote the development of teachers' teaching skills and cultivate students' mathematics core quality so as to realize mutual learning. On the other hand, it also responded to the curriculum concept of "implementing teaching activities to promote students' development" proposed in the new curriculum standard of 2022 Edition, which had certain theoretical and practical significance.

Da (2023) pointed out with the continuous deepening and expansion of quality education, educators needed to make more efforts for the all-round growth of students. Combined with the current educational needs and technological tools, teachers should actively innovate teaching methods and tools, and strive to create an efficient mathematics classroom environment. The traditional teaching method mainly focused on teachers, while students passively accepted knowledge. The effect

of classroom teaching was very limited, which was not conducive to cultivating students' independent thinking and problem-solving ability. In order to meet the needs of modern society and stimulate students' learning enthusiasm, teachers must always follow the "people-oriented" teaching concept, always remember to put students in the core position of classroom teaching, and be reflected in the teaching mode. Independent cooperative inquiry was a new teaching method, which could effectively improve the efficiency of classroom teaching, enhance the interaction between teachers and students, make the classroom atmosphere more active, and help mobilize the desire and enthusiasm of students to actively explore mathematical knowledge. Therefore, in high school mathematics class, teachers should actively carry out the teaching practice of independent cooperative exploration. Based on this, teachers fully stimulated the enthusiasm of students to participate in mathematics class, promoted the healthy development of students' interpersonal relationship and cultivated their awareness of cooperation and communication through independent cooperative exploration, so as to promote the continuous progress of students in the core literacy and comprehensive ability of the subject.

Li (2023) stated that stratified teaching mode required teachers to scientifically group students according to their knowledge reserve, cognitive level, personal potential, interest and personality traits, so as to achieve the goals of different teaching levels. In the traditional teaching mode, classroom teaching paid too much attention to the control of classroom time, and often neglected the choice of classroom content and mode. The cooperative learning model based on hierarchical teaching could encourage all group members to cooperate and help each other to achieve the common learning goal. Through the evaluation of each student's learning attitude and learning situation, teachers could promote each student in the group to actively participate in learning activities. This way of learning greatly stimulated the participation and cooperation spirit of each group member, and ensured that they learned from each other and complemented each other in team cooperation, which not only brought more vitality to the classroom, but also cultivated the students' active thinking and exploration ability, thus improved the learning effect.

Zha (2023) emphasized that although the cooperative mode was a new teaching mode under the background of the new curriculum standard, it was not difficult to find that this teaching mode played a significant role in the teaching of junior middle school mathematics after long-term experiment and exploration. Cooperative learning could help each other in mathematics teaching, promote the

teaching purpose of learning, and also create a positive, relaxing and harmonious learning atmosphere for students. In the team, teachers could help students accumulate more learning experience and skills through the collective wisdom, so that students had a track to follow in math learning, so as to enhance students' sense of experience and self-confidence in the process of learning knowledge theories related to math subjects. Teachers helped students develop good habits of teamwork, solidarity and friendship in the process of learning, and improved their core quality of mathematics under the environment of mutual help.

Li (2023) pointed out that the cooperative learning model of high school mathematics was centered on cooperation and exchange, and promoted interaction and co-construction among students through group discussion, problem solving and project cooperation. It broke the traditional teacher-centered teaching mode, ignored the main role of students, and emphasized the subjective initiative of each person. This teaching mode not only helped to cultivate students' ability in teamwork and communication, but also stimulated their critical thinking and innovative spirit, further promoted their independent learning process. They ensured that collaborative learning achieved its best results by setting clear learning objectives, used flexible group strategies, encouraged discussion and developed students' independent problem-solving skills.

Zhong (2023) state that cooperative learning was a kind of advanced teaching method which conformed to the new curriculum concept. Cooperative learning could cultivate students' teamwork consciousness and cooperation ability, and improve classroom efficiency. In the middle school mathematics teaching process, the use of cooperative learning had a significant value, it not only helped to realize the mutual assistance and cooperation between students, but also improved the comprehensive quality of students. Therefore, educators needed to carefully plan the perfect combination of cooperative learning model and mathematics education. Therefore, in order to ensure the effective implementation of cooperative learning mode in junior middle school mathematics teaching, teachers could carry out practice from four main aspects: optimizing student grouping mechanism, guiding students to conduct cooperative inquiry activities, enhancing interaction and communication among students, and implementing diversified evaluation mechanism.

Chen (2023) emphasized that with the continuous advancement of the new curriculum reform, the innovation of teaching methods had become one of the key means to improve the comprehensive quality education level of students. Teachers should actively change the traditional teaching methods, adopt scientific and

effective methods to carry out mathematics teaching activities, and improve the efficiency of classroom teaching. Group cooperative learning model was an innovative teaching method with cooperation as the core concept, which had been gradually applied in senior high school mathematics education in recent years. It mainly referred to a teaching method in which several people formed a group to conduct research and exploration together. This teaching strategy used a group format, through in-depth exploration, group discussion and interactive communication, to help students better grasp the required knowledge and skills. Its purpose was to train students to actively participate in classroom activities, stimulate their thinking, so that they could better play the subjective initiative, so as to promote their overall development. By implementing a learning mode of group cooperation, teachers were able to enhance students' independent thinking and practical skills. At the same time, the group cooperative learning mode was also conducive to cultivating students' sense of teamwork, so that they could learn to cooperate and support each other, so as to better serve the society. In addition, in the learning mode of teamwork, teachers were able to quickly identify and guide students, so that they could be targeted to solve problems and further improve their abilities.

Ma (2023) stated that because of the high abstractness of mathematics language and the change of thinking to the rational direction, knowledge had a strong independence in senior high school mathematics education. This situation limited students' thinking ability when exploring problems alone, which was not conducive to their self-breakthrough. In order to effectively deal with these problems, teachers needed to implement the group cooperative learning model, encourage students to cooperate in exploration, and realize the integration of ideas, so that students could efficiently and high-quality deal with mathematics learning tasks, and improve their cooperative learning ability.

To sum up, cooperative learning model provides strong support for the cultivation of students' mathematical logic ability by enhancing students' understanding and mastery, cultivating critical thinking, promoting the development of logical thinking, improving problem-solving ability, and cultivating communication and cooperation skills. This teaching model not only helps to improve students' math performance, but also lays a solid foundation for future development

Chapter 3
Research Methodology

The method of this research was developed through cooperative learning model. This research was divided into 2 phases: 1) To use cooperative learning model to improve mathematics logic ability for senior high school students. 2) To compare senior high school students' mathematics logic ability before and after the implementation based on cooperative learning model.

The contents included the following procedures:

1. The Population/The Sample Group
2. Research Instruments
3. Data Collection
4. Data Analysis

The Population/ The Sample Group

Population

There are 200 senior high school students, No. 2 Senior High School of Panzhou City, Guizhou Province, China, distributed four classes with a class size of 50 students each.

The Sample Group

Through a cluster random sampling method, a survey was conducted among 50 students from Class One, Grade One. The class consisted of a mix of high, middle and low lever at No. 2 Senior High School of Panzhou City.

Research Instrument

Using cooperative learning model to improve mathematics logic ability for senior high school students. The research tools were as follows:

1. A Lesson Plan Based on Cooperative Learning Model

The researcher developed cooperative learning model course and factors affecting mathematics logic ability. Apply the teaching mode based on cooperative learning model to enhance students' mathematics logic ability at No. 2 Senior High School of Panzhou City. This study focused solely on cooperative learning skills training for Class One Grade One students. The course was divided into three units, totaling 12 hours:

1.1 Create new knowledge by exploring, reviewing and using students' existing knowledge. This approach emphasizes starting the course in a friendly atmosphere and uses dialogue, exploration, review and experience, as well as the teacher's own experience to enhance the student learning atmosphere. The purpose of this approach is to make students feel warm, safe and comfortable so that they can learn in pleasure, and introduce new course content by asking questions, creating situations or setting up activities that allow students to express themselves from their own experience.

1.2 Explore new mathematical problems and solutions from existing mathematical concepts and principles. Teachers can provide a series of math problems or challenges that students can try to solve in different ways.

1.3 Create an active discussion environment for students to share their ideas and methods for solving problems. By interacting with each other, students can learn different problem-solving strategies and spark new ideas.

1.4 Use open-ended questions to lead students to think. These problems can be about a deep application of a mathematical concept, or a practical problem that requires students to apply their mathematical knowledge to solve.

1.5 Use cooperative learning model to improve mathematics logic ability for senior high school students, and the teaching steps are as follows:

Step 1: Role Assignment

According to the characteristics of students, interests and learning level, the students were divided into reasonable groups. When grouping, the heterogeneity among the members of each group should be ensured in order to promote each other in cooperative learning. At the same time, each group was assigned different roles, such as group leader, recorder, spokesman, etc., in order to cultivate students' teamwork ability and sense of responsibility.

Step 2: Task Setup

Teachers designed challenging and interesting cooperative tasks according to the teaching objectives and the actual situation of students. Assignments stimulated students' interest in learning and encouraged active participation in discussion and inquiry. At the same time, the difficulty of the task should be moderate to ensure that students can achieve certain teaching results in cooperation.

Step 3: Group Discussion

In the group, members discussed and explored the task of cooperation. Teachers should encourage students to express their own opinions boldly, listen to the opinions of others, and learn to respect and understand others.

In the process of discussion, teachers should give timely guidance to ensure the direction and depth of discussion.

Step 4: Result Report

After group discussion and exploration, each group would display and exchange their results. The presentation form was diversified, such as oral presentation, exhibition board, PPT, etc. In the process of presentation, the groups could ask and evaluate each other to promote the sharing and deepening of knowledge.

Step 5: Teaching Comment

At the end of the presentation and communication, the teacher commented and summarized the students' performance. The comments should focus on the student's performance in the cooperative learning process, affirm the student's strengths, and point out areas for improvement. At the same time, teachers should also reflect and summarize the whole teaching process in order to better optimize teaching strategies and methods.

1.6 Design math problems or challenges. This can be a completely new mathematical problem, or it can be a reinterpretation or adaptation of an existing problem. Such tasks can stimulate students' creativity and offer them a deeper understanding of mathematics.

1.7 Use math games and contests to increase students' interest and engagement in math. These activities can help students consolidate their knowledge of mathematics while developing their sense of competition and teamwork skills.

1.8 Submit the revised curriculum activity plans to 3 experts for review to assess the correctness and completion of factors that can enhance mathematics logic ability for senior high school students.

+1 = Sure that the contents are related to the topics

0 = Not sure that the contents are related to the topics

-1 = The contents are not related to the topics

Table 3.1 Evaluation results of course

Using cooperative learning Model to improve sculpture creation ability for undergraduates	**Hours**	**IOC**	**Evaluation Results**
1) Concept of set	4	1.00	accept
2) Basic relationships between sets	4	1.00	accept
3) Basic operations of sets	4	1.00	accept

The acceptable items must have the IOC values not less than **0.5.** The IOC calculated from the validation measures 1.00 each unit.

2. Mathematics logic ability measurement form and criteria

2.1 Analyze the contents of mathematics logic ability consistent with the course arrangement.

2.2 Be familiar with theories and methods on mathematics logic ability assessment through the research.

2.3 According to the dimensions of mathematics logic ability, and referring to the mathematics logic ability evaluation of previous researchers, and mathematics logic ability evaluation standard is planned. The scoring criteria and scores had been set up for 30 points in all. Different scores represent degrees.

Rank 1: 27-30 represents strong;

Rank 2: 23-26 represents relatively strong;

Rank 3: 18-22 represents general;

Rank 4: 14-17 represents relatively weak;

Rank 5: 10-13 represents weak.

Table 3.2 Mathematics logic ability measurement form and criteria

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Conceptual understanding	1. The concept of sets	Accurately understand the relationship between the elements inside a set, such as whether they are mutually exclusive or ordered, which reflects a deep insight into the internal structure of the concept of a set.	Moderately understand the boundaries of a set, that is, the ability to judge which elements belong to the set and which do not.	Hardly understand the identification of the common features or attributes of the elements in a set, which is fundamental to understanding the concept of a set.
	2. The relationship between elements and sets	Accurately distinguish the relationship between elements and sets, judge whether elements belong to a certain set, and deeply analyze the status and role of elements in the set, as well as the correlation with other elements.	Moderately determine whether an element belongs to a set, and may not be clear about the specific role and relevance of the element in the set.	Hardly understand the relationship between elements and sets, difficult to judge whether elements belong to sets, and hard to analyze the role and relevance of elements in sets.

Table 3.2 (Continue)

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Conceptual understanding	3. The characteristics of the elements in the set concept	Accurately understand the common properties and properties of the elements in a set, articulately define and distinguish the set, and accurately identify and apply these features in complex situations.	Moderately understand certain characteristics of the elements in the set, and may not be able to or grasp these characteristics, or may have some difficulty in applying them.	Hardly understand the characteristics of the elements in the set, difficultly to describe or apply these characteristics, and may even be confused about the basic concept of the set.
	4. Classification of set concepts	Accurately classify sets, clearly understand the boundaries and relationships between various sets, and flexibly classify in complex situations.	Moderately understand the classification of sets, and may lack accuracy and depth of classification, or have some difficulty making appropriate classifications in the face of complex situations.	Hardly understand the classification of sets, have difficulty classifying them based on the characteristics of elements, or easily confuse the boundaries of different sets when classifying them.

Table 3.2 (Continue)

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Logical deduction	1. Master the symbols and representations of subsets and proper subsets	The relationship and transformation between subsets and proper subsets can be explained clearly, and complex set relations can be analyzed quickly and correct conclusions can be given. The concepts of subsets and proper subsets flexibly solve various mathematical problems.	Be able to understand and distinguish the basic concepts of subsets and proper subsets, and moderately apply these concepts in simple scenarios. For the wider application of subsets and proper subsets in advanced mathematics or in practical problems, it is not deep enough.	The definition of subsets and proper subsets cannot be accurately distinguished, and there is a lack of clear understanding of the relationship and differences between them. It is not possible to correctly determine whether a set is a subset or proper subset of another set.
	2. Use a coincidence to represent subsets and proper subsets	The use of symbols has reached a level of automation, even when dealing with very complex or abstract set problems.	Use symbols to define subsets and proper subsets and apply them correctly in moderate cases.	Even if the basic symbolic representation method is known, confusion or error often occurs in practice.

Table 3.2 (Continue)

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Critical thinking	1. The concept and nature of intersection and union	Use relevant symbols accurately and reflexively, whether simple or complex set problems, quickly and accurately apply " $\cap$ " to indicate the intersection and " $\cup$ " to indicate the union, without any hesitation or reference.	Be able to understand and apply basic symbols to represent intersection and union, but may encounter some challenges in practical application.	It is almost impossible to apply the relevant symbols correctly. Even in the face of simple set problems, it takes a lot of time to think and understand.
	2. Intersection and union of two sets	Analyze and answer a simple or complex question quickly and accurately.	Be able to understand and apply the basic concepts of intersection and union, apply them correctly in some situations.	Have an understanding of the basic concepts of intersection and union, but are often mistaken or confused in practical application.

Table 3.2 (Continue)

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Critical thinking	3. The significance of the complete set of mathematics	Be able to quickly identify which elements belong to the complete set and which do not, and be able to accurately apply the concept of the complete set to solve problems.	Have a certain understanding of the basic concepts and properties of the complete set, and can be moderately applied in some common situations.	Unfamiliar with the concept of the complete set of mathematics. It is not clear about the definition of the complete set, that is, a set that includes all the objects of study, and it is not well understood about the nature and application of the complete set.
	4. A complement of a set in a complete set	Quickly and accurately find the complement of a given set in another set (usually the complete set).	In common mathematical problems and situations, it is moderate to identify the complement of a given set in a global set and understand the relationship.	When dealing with problems related to complement sets, it is not possible to identify the complement of a given set in the total set.

According to the Table 2.3, the researcher analyzed documents and theory deeply. The researcher used the criteria to consider the relevant characteristics.

2.4 Submit the designed evaluation criteria to the thesis supervisor, check their accuracy, and make modifications.

2.5 Submit mathematics logic ability assessment evaluation criteria created to three experts for measurement and inspection. Experts check the content validity and calculate the Index of Item Objective Congruence (IOC). The consistency indicator of each evaluation content is greater than or equal to 0.50 and is considered suitable for research. The IOC (Index of Item Objective Congruence) value for each item in this evaluation standard is 1.00.

2.6 Update and enhance the evaluation standards, then try out with students who were not the sample to ensure the quality of the assessment.

2.7 Check the reliability of measurement standards using Cronbach's α Coefficients is 0.86, which can be used for research.

Data Collection

The data collection was as follows:

1. Data collection and verification for test tools:

1.1 Coordinate with 3 professional scholars experts dispense official document from Bansomdejchaopraya Rajabhat University professional scholar experts and give information about data collection process and research tools: instructional model and checklist form about quality of instructional model for consideration (Index of Objective Consistency: IOC).

1.2 Collect data from 3 professional scholar experts and analysis data for consideration (Index of Objective Consistency: IOC).

2. Data collection and validation for research work.

2.1 Relevant literature research: Collect literature related determination of the research time: the formal research will be carried out in July 2023, and the research data will be collected after the experimental research is completed.

2.2 Before and after teaching test: This research is experimental research.

Table 3.3 Experimental design

Group	Pretest	Experimental	Posttest
R	O_1	X	O_2

The meaning of the symbols used in the experimental design

R means Random Sampling

X means Experimental

O_1 means Pretest

O_2 means Pretest

Data Analysis

The data were analyzed as follows:

1. Analyze data to compile and summarize findings of cooperative learning model, mathematics logic ability and students' behavior.

2. Use cooperative learning model to evaluate mathematics logic ability for senior high school students before and after the experiment, and statistically analyze the data obtained from the experiment by means, standard deviation, and T-test for dependent sample.

Chapter 4
Results of Analysis

The research "Using Cooperative Learning Model to Improve Mathematics Logic Ability for Senior High School Students" aims to study the factors of influencing mathematics logic ability and compare students' mathematics logic ability before and after using the cooperative learning method. The data analysis results are as follows:

1. Symbol and Abbreviations
2. Results of Data Analysis

The details are as follows:

Symbol and Abbreviations

Represent data analysis results based on symbols and semantics. The details are as follows:

$\bar{X}$	means	average value
SD.	means	standard deviation
n	means	number of students
D	means	scores of differences between pre and post test
df	means	degree of freedom
t	means	statistical data for t-test value
**	means	statistical significance at level .01

Results of Data Analysis

The study used cooperative learning model to improve mathematics logic ability for senior high school students. The researchers conducted the research in the following order: The researchers conducted the research in the following order:

Part 1: To use cooperative learning model to enhance mathematics logic ability for senior high school students.

Firstly, cooperative learning model encourages communication and discussion among students. In group activities, students can share ideas and methods to solve problems, find their own shortcomings and learn the advantages of others through comparison and discussion. This kind of communication can promote the collision of ideas and stimulate the students' logical thinking and reasoning ability.

Secondly, cooperative learning model helps to cultivate students' teamwork spirit and cohesion. In group activities, each student is required to work towards the common goals of the group, which requires them to pay attention not only to their own learning progress, but also to the learning of the whole team. This kind of teamwork spirit can help students better understand math knowledge and improve learning results.

Thirdly, cooperative learning model can improve students' autonomous learning ability. In group activities, students need to choose their own learning content and style, which is helpful to cultivate their independent learning ability and self-management ability. At the same time, students also need to evaluate their own academic performance and progress, which helps them to better control their own learning situation and direction.

Fourthly, cooperative learning model is conducive to cultivating students' ability of system thinking. In solving mathematical problems, students need to start from the relationship between the whole and the part, decompose the complex problem into simple parts, then use logical and analytical methods to deal with each part separately, and finally integrate the results of each part to draw a global conclusion. This ability of system thinking is a very important ability in mathematics learning, and cooperative learning mode can help students develop this ability better.

To sum up, cooperative learning mode encourages communication, discussion and cooperation among students, cultivates students' teamwork spirit and cohesion, improves students' autonomous learning ability and systematic thinking ability, and thus contributes to improving the mathematical logic ability of students. Apply the teaching mode based on cooperative learning model to enhance students' mathematics logic ability in senior high school. The course is divided into three units, totaling 12 hours: 1) Concept of set (4 hours); 2) Basic relationships between sets (4 hours); 3) Basic operations of sets (4 hours). The units are as follows:

Step 1: Role Assignment

According to the characteristics of students, interests and learning level, the students were divided into reasonable groups. When grouping, the heterogeneity among the members of each group should be ensured in order to promote each other in cooperative learning. At the same time, each group was assigned different roles, such as group leader, recorder, spokesman, etc., in order to cultivate students' teamwork ability and sense of responsibility.

Step 2: Task Setup

Teachers designed challenging and interesting cooperative tasks according to the teaching objectives and the actual situation of students. Assignments stimulated students' interest in learning and encouraged active participation in discussion and inquiry. At the same time, the difficulty of the task should be moderate to ensure that students can achieve certain teaching results in cooperation.

Step 3: Group Discussion

In the group, members discussed and explored the task of cooperation. Teachers should encourage students to express their own opinions boldly, listen to the opinions of others, and learn to respect and understand others. In the process of discussion, teachers should provide timely guidance to ensure the direction and depth of discussion.

Step 4: Result Report

After group discussion and exploration, each group would display and exchange their results. The presentation form was diversified, such as oral presentation, exhibition board, PPT, etc. In the process of presentation, the groups could ask and evaluate each other to promote the sharing and deepening of knowledge.

Step 5: Teaching Comment

At the end of the presentation and communication, the teacher commented and summarized the students' performance. The comments should focus on the student's performance in the cooperative learning process, affirm the student's strengths, and point out areas for improvement. At the same time, teachers should also reflect and summarize the whole teaching process in order to better optimize teaching strategies and methods.

In sum, cooperative learning model can encourage communication, discussion and cooperation among students, promote thinking collision and teamwork, improve students' autonomous learning ability and systematic thinking ability, and thus help students to understand and master mathematics knowledge more deeply and improve learning effect. This teaching mode not only helps to cultivate students' cooperation spirit and teamwork ability, but also enhances students' self-confidence and learning interest.

Unit 1. Concept of set (4 hours)

Step 1: Role Assignment

Role assignment teaching is a teaching method based on role playing and assignment of tasks, which emphasizes student participation and interaction. In this teaching method, teachers can assign different roles and tasks to students according to their interests and characteristics, so that students can learn and master knowledge in the process of completing tasks.

1. The Role of the Teacher.

1.1 Determine the role of students: Teachers can assign different roles to students according to their personality, ability, interest and other factors. For example, some students may be good at presentation and communication and can act as leaders or debriefers in group discussions; Some students may be thoughtful and analytical, and can act as the main force of problem solving or research. Through reasonable role allocation, teachers can give full play to the advantages of each student and improve the overall learning effect.

1.2 Clarify student responsibilities: In the process of role arrangement, teachers should clarify the responsibilities and tasks of each student. For example, in the group discussion, each student should have their own speech and contribution. In a group study or project, each student should assume corresponding responsibilities and tasks. Clear responsibilities and tasks can help students better engage in learning and improve learning results.

1.3 Provide guidance and support: After the role is assigned, the teacher should provide the necessary guidance and support to the student. For example, for students who are leaders, teachers can give them some advice on organization and management. For the students who are the main force of problem solving or research, the teacher can provide some guidance on problem solving ideas or research methods. At the same time, teachers should also pay attention to students' learning process and difficulties, and give timely help and support.

1.4 Promote role conversion and cooperation: In the process of role arrangement, teachers should also focus on promoting students' role conversion and cooperation. For example, group leaders or problem solvers can be changed regularly, giving each student the opportunity to try out different roles and tasks; At the same time, it can also encourage cooperation and communication among students, promote knowledge sharing and thinking collision.

2. The Role of Students.

2.1 Understand roles and responsibilities: When teachers assign roles and tasks to students, students should listen carefully and understand their roles and responsibilities. This means that students need to be clear about what their tasks are, what work needs to be done, and how their role contributes to the overall learning process.

2.2 Accept challenges and take responsibility: Students should accept their role and take responsibility. This may mean that they need to take on some leadership responsibilities, or actively speak up in group discussions, or contribute their own thinking and solutions to group research. Students should understand that they can enhance their learning ability and overall quality. by accepting challenges and taking responsibility.

2.3 Participate and collaborate actively: Regardless of the student's role, they should actively participate and collaborate with other students. In group discussions, students should actively express their own opinions, listen to the opinions of others, and try to reach a consensus. In group research, students are expected to share their knowledge and experience, help others solve problems, and get inspired by the ideas of others.

In general, students should understand their roles and responsibilities, accept challenges and take responsibility, actively participate and collaborate. Through these actions, students can better participate in the learning process and improve their learning ability and comprehensive quality.

Step 2: Task Setup

In order to give students a preliminary understanding of the basic concepts of sets, teachers can design some basic tasks, such as asking students to list some examples of sets in their daily life, or asking them to describe some simple math problems in the language of sets.

1. The Role of the Teacher.

1.1 Design targeted exercises: To help students consolidate the basic concepts, representations, and rules of the set, teachers can design a series of targeted exercises. These exercises can cover different difficulty levels to meet the learning needs of different students.

1.2 Organize group discussion: In order to promote interaction and communication among students, teachers can organize group discussion activities. In the group discussion, students can share their understanding of the concept of set, problem-solving methods, and deepen their understanding of the concept of set through brainstorming.

1.3 Carry out practical activities: In order to help students understand and master the concept of set, teachers can design some practical activities, such as organizing students to play games of set operation and building models of set relations. These activities can help students combine theory with practice and deepen their understanding of the concept of sets.

1.4 Assign homework: In order to consolidate students' learning results, teachers can assign some homework and ask students to complete it independently or with their parents. These assignments can be a review of the set concept, an extension of the class content, etc.

2. The role of Students.

Before accepting the new set concept, students should preview and have a preliminary understanding of the basic concept, representation and operation rules of sets. This helps students to better follow the teacher's pace and participate more actively in discussions in class.

1.1 Active participation in class: In class, students should maintain a high degree of attention and actively participate in various activities organized by teachers, such as questions, discussions, group cooperation, etc. Through active participation, students can gain a deeper understanding of set concepts and exercise their thinking and expression skills.

1.2 Complete exercises and tasks: Students should carefully complete the exercises and tasks assigned by the teacher. These exercises can help students consolidate what they have learned and deepen their understanding of set concepts. In the process of completing the task. Students should pay attention to thinking and exploring, and try to use the knowledge to solve practical problems.

1.3 Reflection and summary: After completing the task, students should reflect and summarize in a timely manner. Reflection can help students realize their shortcomings and mistakes in the learning process so as to adjust their learning methods and strategies in time. Summary can help students to sort out and summarize the knowledge, and form a systematic knowledge framework.

In short, students should keep a positive attitude and active learning behavior when teaching the concept of high school set. Through the steps of preview, participation in class, completion of tasks, reflection and summary, students can better understand and master the set concept and improve their learning ability and comprehensive quality.

Step 3: Group Discussion

As an important branch of mathematics, set theory provides a rigorous logical foundation for mathematics and other disciplines. For beginners, understanding the concept of a set can be a challenge. As an effective teaching method, group discussion can encourage students to participate actively, think actively, and deepen their understanding of the set concept in the communication.

1. The Role of the Teacher.

1.1 Clarify the objectives of group work: Teachers first need to clarify the objectives of group work, and ensure that each student is clear about what tasks they need to accomplish in the group and how these tasks relate to the learning of set concepts.

1.2 Organize groups and assign roles: Teachers can divide students into different groups according to their abilities, interests and personality traits, and assign one or more roles to each group, such as group leader, recorder, spokesman, etc. This helps to ensure that each student can use their strengths in the group and actively participate in the discussion and learning.

1.3 Provide guidance and support: In the process of group cooperation, the teacher should provide necessary guidance and support. They can answer students' questions, lead them to think deeply about set concepts, and provide feedback and suggestions to help students improve their understanding and application.

1.4 Promote communication and collaboration: Teachers should encourage students to actively communicate and collaborate in groups to share their ideas and insights. They can organize group discussions and provide questions or challenges to stimulate students' thinking and facilitate interaction between them.

1.5 Monitor and evaluate group performance: Teachers should pay close attention to the performance of the group and evaluate their cooperation and learning outcomes. They can observe student participation, quality of discussion, task completion, etc., in order to make adjustments or provide additional support if necessary.

1.6 Summary and evaluation: At the end of the group work session, the teacher should summarize and evaluate the whole process. They can review group performance and outcomes, emphasize the importance of ensemble concepts, and encourage students to continue applying these concepts in their future studies.

In general, in the process of teaching the set concept of senior high school, teachers should play the role of organizer, instructor, facilitator, supporter and evaluator in group cooperation to ensure the effectiveness of group cooperation and students' learning outcomes.

2. The Role of Students.

Active participation in the discussion: Within the group, students should actively participate in the discussion and share their understanding and ideas about the set concept. They should not hesitate to express their own opinions, but also respect and listen to the opinions of other panelists.

2.1 Collaborative task completion: Students should collaborate with group members and work together to complete the task by depending on the group's goals and assigned tasks. They should give full play to their strengths and contribute to the group while accepting suggestions and help from others.

2.2 In-depth learning of set concepts: Students should study set concepts in depth through discussion and practice during the process of group work. They should take the initiative to ask questions, seek answers, and deepen their understanding and application of the set concept in practice.

2.3 The resolution of conflict and disagreement: In group discussions and cooperation, disagreements or conflicts may arise. Students should actively seek solutions to problems with an open and inclusive attitude and avoid escalating differences into conflicts.

2.4 Careful record and summary: Students should carefully record the process and results of group discussions and cooperation for future review and summary. They should summarize their performance and gains in group cooperation as well as areas for improvement to prepare for future learning.

In general, in the group work session, students should actively participate in discussions, collaborate on tasks, learn set concepts in depth, resolve conflicts and disagreements, and carefully record and summarize what to learn. Through these actions, students can enhance their learning ability and overall quality while contributing to the success of the group.

Step 4: Result Report

Results reporting is a method of teaching in which students demonstrate their learning by completing practical tasks or projects. This method can stimulate students' learning interest and motivation, and help them combine theoretical knowledge with practical application, and improve their understanding of concepts. In the teaching of set theory, students can deepen their understanding of set concept in practice through the teaching of results reporting,

1. The Role of the Teacher.

1.1 Preparation and planning: Before the results are reported, the teacher should fully prepare and plan. They need to be clear about the purpose, content, format and timetable of the report and ensure that all students have a clear understanding of the requirements and expectations of the report.

1.2 Guidance and support: Teachers should provide students with the necessary guidance and support to help them collate and analyze the learning outcomes of set concepts. They can organize group discussions and provide questions or challenges to stimulate students' thinking and facilitate interaction between them.

1.3 Offering opportunities to demonstrate: Teachers should provide opportunities for students to demonstrate their learning by presenting themselves in class or in public at school. This not only increases students' motivation to learn, but also helps them exercise their expression skills and self-confidence.

In general, in the process of teaching the set concept, teachers should play a guiding and supporting role in the process of reporting result to ensure the smooth progress of the report and the effective learning of students

2. The Role of Students.

2.1 Organize learning outcomes: Students need to review and organize their own results in the process of learning set concepts. This may include class notes, assignments, transcripts of group discussions, individual or group research projects, etc. Students need to ensure that these results demonstrate a clear and methodical understanding and application of set concepts.

2.2 Prepare the content of the presentation: Students are expected to prepare the content of the presentation, which may include a short introduction, main learning points, examples or case studies, and application or reflection on set concepts. Students should ensure that the content of the presentation is logical and coherent, and can hold the attention of the audience.

2.3 Practice presentation and presentation: Students need to practice their presentation skills to ensure they can communicate fluently and confidently during the presentation process. They can improve their presentation skills by giving simulated speeches and practicing with group members.

2.4 Engage in interaction and discussion: Students should actively participate in interaction and discussion during the presentation process. They should be prepared to answer questions from the audience as well as provide constructive feedback and suggestions on other students' reports.

2.5 Provide reflection and improvement: At the end of the presentation, students should reflect on their performance, assess their own presentation content and presentation skills, as well as their understanding and application of set concepts. They should identify their strengths and weaknesses and make plans to improve learning and presentation skills.

In general, students need to organize learning outcomes, prepare report content, practice presentation and presentation skills, engage in interaction and discussion, and reflect on and improve their performance. Through these actions, students can better demonstrate their understanding and application of set concepts while improving their learning and presentation skills.

Step 5: Teaching Comment

In the teaching process, teachers should pay attention to cultivating students' problem-solving ability. Through the design of challenging and practical problems, students are guided to analyze and solve problems, so as to cultivate their independent thinking and problem-solving ability.

1. The Role of the Teacher.

1.1 Collect and analyze feedback: Teachers gather feedback from students, colleagues, or others involved in teaching about the teaching effectiveness. This may include the assessment of the student's understanding of the set concept, the acceptance of teaching methods, the effect of classroom interaction, etc. Teachers will carefully analyze the feedback to understand the strengths and weaknesses of the teaching results and areas for improvement.

1.2 Assess teaching objectives: The teacher will assess whether the teaching objectives have been achieved, that is, whether the students have really mastered the set concept. This can be assessed by the student's homework completion, classroom performance, test results, etc. If the teaching goal is not fully achieved, teachers need to think about how to adjust the teaching strategy to better help students grasp the set concept.

1.3 Reflect on teaching methods and strategies: Teachers will reflect on whether the methods and strategies used in the teaching process are effective. For example, they may think about which teaching methods are more likely to stimulate students' interest in learning, which strategies are more effective in helping students understand set concepts, etc. Through reflection, teachers can continuously optimize the teaching methods and strategies and improve the teaching effect.

1.4 Prepare an improvement plan: Based on the results of the teaching review, the teacher will prepare an improvement plan. This may include adjusting teaching content, improving teaching methods, and providing more practical opportunities. The purpose of the improvement program is to better meet the learning needs of students and help them better grasp the set concept.

1.5 Share and exchange experiences: Teachers also share and exchange teaching experiences with other teachers. By sharing successful teaching cases and discussing problems and challenges in the process of teaching, teachers can learn from each other and make progress together so as to continuously improve their teaching level and ability.

In general, in the process of teaching review, the main tasks of teachers are to collect and analyze feedback, evaluate the achievement of teaching objectives, reflect on teaching methods and strategies, prepare improvement plans, and share and exchange experiences. These tasks are helpful for teachers to fully understand the teaching effect, optimize the teaching strategy and improve the teaching quality.

2. The Role of Students.

2.1 Provide feedback: Students can provide feedback to teachers about the teaching process. This includes feedback on their level of understanding of set concepts, clarity of class presentation, adaptability of teaching methods, and so on. Student feedback is crucial for teachers to improve teaching mode.

2.2 Participate in the discussion: Students can actively participate in the discussion during the teaching review session. They can put forward their own doubts or difficulties in understanding the concept of set, and communicate and discuss with teachers or other students. By participating in discussions, students can gain a deeper understanding of set concepts and exercise their thinking and presentation skills.

2.3 Assess your own learning: Students can take advantage of the opportunity for teaching reviews to assess their own learning outcomes. They can review their performance in the learning process of set concepts, think about their progress and shortcomings, and make a learning plan accordingly.

2.4 Make suggestions: Students can make suggestions to teachers based on their own learning experience. These suggestions can relate to teaching content, teaching methods, classroom management and so on. Students' suggestions help teachers to improve teaching and improve teaching effect.

2.5 Reflect learning strategies: During the teaching review process, students can reflect on their own learning strategies. They can think about which learning methods are more effective for learning set concepts and which methods need to be improved. By reflecting and adjusting learning strategies, students can learn set concepts more efficiently.

In general, in the teaching review process, students can actively participate in teaching review by providing feedback, participating in discussions, evaluating their own learning, making suggestions and reflecting on learning strategies, etc., to promote their own learning and teachers' teaching improvement.

Unit 2. Basic relationships between sets (4 hours)

Step 1: Role Assignment

1. The Role of the Teacher.

1.1 Provide clear teaching objectives: First, teachers need to clearly set teaching objectives to ensure that students have a deep understanding of the fundamental relationships between sets. This includes the concepts of inclusion relation, equality relation, subset, proper subset and so on.

1.2 Design role assignment scheme: According to the teaching content and the characteristics of students, teachers need to design a suitable role assignment scheme. This may include having students to impersonate different sets and demonstrate the relationships between sets through interaction.

1.3 Assign specific roles and tasks: Teachers will assign designed roles and tasks to students. This needs to take into account students' abilities, interests and engagement and ensure that each student has gains in their role.

1.4 Provide guidance and support: In the process of role assignment, teachers need to provide necessary guidance and support to students. This may include explaining concepts, answering questions, offering advice, etc. Teachers need to ensure that students can successfully complete the task and learn from it.

1.5 Monitor and evaluate the effect of role assignment: In the process of role assignment, teachers need to monitor the performance of students and evaluate the effect of role assignment. If problems or deficiencies are found, teachers need to adjust the role-assignment plan in time to ensure the teaching effect.

1.6 Offer summary and feedback: At the end of the role assignment, the teacher is required to provide summary and feedback. This includes a review of the student's performance in the role-assignment process, an assessment of the level of understanding of basic relationships between sets, and suggestions for further learning.

Through effective role assignment, teachers can help students better understand the basic relationships between sets, increase students' engagement and interest in learning, and also provide students with opportunities to demonstrate their abilities.

2. The Role of Students.

1.1 Clarify individual roles: Students need to have a clear understanding of their roles and tasks. This may include acting as a particular set, analyzing relationships between sets, or taking on a particular learning task.

1.2 Prepare relevant content: Depending on the role assigned, students are expected to actively prepare and research relevant content. For example, if playing a particular set, students need to understand the definition of that set, its properties, and its relationship to other sets.

1.3 Participate in interactions and discussions: Students need to be actively involved in classroom interactions and discussions. This may include working with other students to demonstrate relationships between sets, participate in class debates, or discuss applications of set theory.

1.4 Provide reflection and summary: After completing the role tasks, students need to reflect on their own learning process and outcomes. This includes assessing the understanding of relationships between sets, thinking about strategies and approaches to solving problem.

1.5 Accept feedback: Students need to accept feedback from teachers and fellow students. This helps us to know our strengths and weaknesses in understanding set concepts so as to adjust learning strategies and improve learning methods.

By actively participating in the role assignment process, students can gain a deeper understanding of the fundamental relationships between sets and improve their learning effectiveness and engagement. At the same time, it is also a good opportunity to show the ability of improving teamwork and communication skills.

Step 2: Task Setup

1. The role of the teacher.

1.1 Provide clear teaching objectives: First of all, teachers need to clearly set teaching objectives and determine which basic relationships between sets should be mastered by students, such as union, intersection, complement, subset, etc. This will provide clear guidance for setting up the task.

1.2 Design hierarchical tasks: Teachers will design a series of hierarchical tasks to suit different learning levels and understanding abilities of students. Tasks can range from simple to complex, from concrete to abstract, and gradually guide students to understand and grasp the relationships between sets.

1.3 Determine the specific content of the task: The teacher will clarify the specific content and requirements of each task, such as analyzing the relationship between a given set, constructing a specific set example, and solving problems related to the set. Make sure students are clear about the objectives and requirements of the assignment.

1.4 Offer the necessary resources and support: In order to help students complete the task, the teacher will provide the necessary resources and support. This may include textbooks, reference books, online resources, problem-solving tools, etc. Teachers will also provide necessary guidance and answer students' questions to ensure that students can successfully complete the task.

1.5 Set up the time and way to complete the task: The teacher will set up the time and way to complete the task such as individual completion or group work, class completion or after-class completion. This will help students to arrange their time reasonably and choose a suitable way of study.

1.6 Evaluate the effectiveness and feasibility of the task: After setting the task, the teacher needs to evaluate the effectiveness and feasibility of the task. This will help teachers to know whether the difficulty of the task is moderate and whether it can stimulate students' learning interest and motivation so as to adjust the task setting in time.

Through careful design and setting of tasks, teachers can guide students to gradually grasp the basic relationship between sets, and cultivate students' logical thinking ability and problem-solving ability. At the same time, task setting is also an important means to promote students' active learning and exploration.

2. The Role of Students.

2.1 Understand task requirements: Students need to listen carefully to the teacher's explanation and understand the specific requirements of the task. This includes the goal of the task, the knowledge required to master, the way to complete the task and the deadline.

2.2 Participate in task discussion: In the task setting stage, students usually have an interactive discussion with teachers to raise their understanding and questions about the task. Such discussions help to clarify the task requirements and ensure that students have an accurate understanding of the task.

2.3 Make a study plan: According to the requirements of the task and their actual situation, students need to make a reasonable study plan. This includes determining the time of study, selecting the appropriate learning resources and methods, and planning the steps of task completion.

2.4 Take the initiative to seek help: Students need to take the initiative to seek help if they encounter problems or confusion in the process of the completion of tasks. This can be done by asking teachers, or by asking classmates for help or discussion. Actively seeking help can help solve problems and improve learning efficiency.

2.5 Prepare to complete the task: After defining the task requirements and making a study plan, students need to start preparing to complete the task. This may include reviewing relevant knowledge points, gathering necessary information, and conducting exercises or experiments, etc.

By actively participating in the process of task setting and completion, students can better understand and grasp the basic relationships between sets, and improve learning and problem-solving skills. At the same time, it is also a good opportunity to cultivate independent learning, cooperative learning and critical thinking.

Step 3: Group Discussion

1. The Role of the Teacher.

1.1 Organize and guide the discussion: The teacher first needs to clearly define the topic and goal of the discussion, and ensure that students can discuss the basic relationships between the sets. In the process of discussion, teachers should always pay attention to the progress of the discussion to ensure that the direction of the discussion is correct and does not deviate from the topic.

1.2 Provide necessary support: If students encounter difficulties or questions during the discussion, teachers should provide necessary support and help in a timely manner. This may include answering students' questions, providing relevant mathematical knowledge and methods, and guiding students to in-depth thinking.

1.3 Encourage active participation: In order to make group discussion more effective, teachers should encourage students to actively participate in the discussion and express their own opinions. For active students, teachers should give timely recognition and praise, stimulate the enthusiasm of other students to participate.

1.4 Observe and record student performance: During the discussion, the teacher should carefully observe and record the student's performance. This helps to understand how well students have mastered the fundamental relationships between sets as well as how they think and express themselves in discussions.

In short, in the group discussion, teachers should play the role of organizer, guide, supporter and evaluator to ensure the effectiveness and depth of the discussion, and help students better understand and grasp the basic relationship between sets.

2. The Role of Students.

2.1 Active participation in discussion: Students should actively participate in group discussions and take the initiative to express views and opinions. They should be prepared with examples, questions, or reflections related to the fundamental relationships between the sets and share them with the group members.

2.2 Cooperation and mutual assistance: Group discussion is a process of cooperation and mutual assistance. Students should work with group members to solve problems and explore relationships between sets. They can ask each other questions, answer questions, and find answers together.

2.3 Recording and organizing the discussion: During the discussion, students can play the role of note-taker, recording the important ideas, examples and conclusions of the discussion. This helps them to review and summarize the discussion and deepen their understanding of the fundamental relationships between the sets.

2.4 Thinking and asking questions: Students should think positively during the discussion and ask questions about the relationships between sets. Through questions and answers, they can further clarify concepts and deepen their understanding of relationships between sets.

2.5 Listening to and respecting the views of others: Group discussion is a multi-interactive process, and students should learn to listen to and respect the views of others. They should listen carefully to the panelists, understand their points of view, and try to communicate and discuss with them.

2.6 Summarizing and sharing learning results: After the discussion, students can summarize the discussion content together with the group members and share their learning results. They can sort out the key points and difficulties in the discussion and share and communicate with other groups in the class.

By actively participating in group discussions, students can better understand and grasp the fundamental relationships between sets, while improving their ability to cooperate, communicate, and solve problems.

Step 4: Result Report

1. The Role of the Teacher.

1.1 Clear reporting requirements: Teachers first need to clarify the specific requirements of the results report, including the content, format, time limit, etc. This helps students understand the purpose and framework of the report so that they can prepare it in a targeted way.

1.2 Providing guidance and support: Teachers should provide necessary guidance and support to students in the process of preparing the report. This can include helping students organize their thoughts, answering questions, providing information or suggestions. At the same time, teachers should also encourage students to participate actively to improve their self-confidence and expression skills.

1.3 Organizing reporting activities: In the reporting of results, teachers need to organize students to report. This can include arranging the order of reports, the venue and equipment to provide reports, and ensure the smooth running of reports, etc. At the same time, teachers should also encourage interaction and communication among students to promote knowledge sharing and understanding.

1.4 Evaluation and feedback: After the student completes the report, the teacher needs to evaluate and give feedback on the report. The evaluation can include the evaluation of students' report content, expression ability, thinking logic and so on. Feedback points out the student's strengths and weaknesses, and provides suggestions for improvement. This helps students to understand their own learning situation and further improve the learning effect.

1.5 Summary and expansion: After the result report, teachers need to summarize and expand the whole activity. Summary can summarize the student's main ideas and findings, emphasize the importance and application of fundamental relationships between sets; Extension can guide students to further think and explore relevant problems, and cultivate their innovative thinking and problem-solving skills.

In conclusion, in the results reporting process, teachers need to play the role of mentor, organizer, evaluator and extender to ensure the smooth progress of the report and the effective presentation of students' learning results.

2. The Role of Students.

2.1 Preparing the content of the report: First of all, students need to carefully prepare the content of the report according to the guidance and requirements of the teacher. This includes reviewing and understanding the fundamental relationships between sets, organizing and analyzing the learning material, and conceiving the structure and logic of the report.

2.2 Organizing and presenting learning outcomes: Students need to organize and aggregate the knowledge and insights they gain in the process of learning the fundamental relationships between sets. This may include definitions, properties, examples, steps and ideas for solving the problem. In the report, students need to clearly demonstrate their learning results and use supporting materials such as charts, illustrations, examples to help explain and illustrate.

2.3 Oral presentation: Students are required to offer oral presentations in a predetermined order and schedule. During the presentation, students are expected to articulate their views and insights and use appropriate language and terminology to explain and illustrate the fundamental relationships between sets. At the same time, students also need to answer questions that teachers and classmates may have.

2.4 Receiving evaluation and feedback: At the end of the presentation, students need to receive evaluation from teachers and feedback from classmates. The assessment may include the answers to the teacher's questions, the ability to understand and apply the content of the report, and so on. Feedback may include students' opinions and suggestions on the content, presentation, logical structure, etc.

2.5 Summarizing and improving effect: Finally, students need to summarize the experience and lessons learned throughout the reporting process, and make improvements based on feedback. This may include improving the logic and structure of reports, improving presentation skills, deepening understanding of fundamental relationships between sets, and so on.

Through the result reporting process, students can better demonstrate their learning results and understanding depth, and also improve their expression skills, thinking logic and problem-solving skills.

Step 5: Teaching Comment

1. The Role of the Teacher.

1.1 Review of teaching objectives: Teachers should first review the teaching objectives of this lesson to evaluate whether the expected teaching effect has been achieved. This helps the teacher to understand the students' understanding and application of the basic relationships between sets.

1.2 Analysis of student performance: Teachers need to analyze students' performance in the result reporting process, including their report content, expression ability, thinking logic and other aspects. This helps teachers to understand students' learning situation and existing problems, and provides targeted guidance for subsequent teaching.

1.3 Summarizing teaching experience: Teachers need to summarize the experience and lessons in the teaching process, including teaching methods, teaching organization, teaching materials and so on. This will help teachers optimize teaching strategies and improve teaching results.

1.4 Providing feedback and suggestions: Teachers need to provide feedback and suggestions to students, point out their problems and shortcomings in the process of learning the basic relationships between sets, and provide suggestions for improvement. This helps students to understand their own learning situation and further improve the learning effect.

1.5 Planning subsequent teaching: Finally, teachers need to plan subsequent teaching content and teaching methods to ensure that students can fully grasp the basic relationships between sets and lay a solid foundation for subsequent learning.

Through the teaching review, teachers can reflect and summarize the whole teaching process, find the existing problems and shortcomings, and take corresponding measures to improve and optimize. This is helpful to improve the teaching level of teachers and promote the all-round development of students.

2. The Role of Students.

1.1 Review content: Students should review the basic relationships between sets learned in this lesson, including the concepts of subsets, proper subsets, equality of sets, and empty sets, as well as their application to practical problems. This helps to consolidate students' understanding and lays the foundation for subsequent learning.

1.2 Reflect on the learning process: Students need to reflect on their own learning process, including the difficulties and challenges encountered in understanding the fundamental relationships between sets, as well as the strategies and methods employed in the learning process. This helps students identify their shortcomings and look for the ways to improve.

1.3 Provide teaching feedback: Students can provide teaching feedback to teachers, including opinions and suggestions on teachers' teaching methods, teaching organizations, teaching materials, etc. Students can put forward their views and suggestions on teaching from their own point of view to help teachers improve teaching methods and improve teaching results.

1.4 Participate in teaching evaluation: Students can also participate in teaching evaluation to assess their own learning outcomes and performance. This helps students understand their own learning status, identify their own shortcomings, and set follow-up learning goals.

1.5 Plan learning contents: Finally, students need to plan the content and direction of subsequent learning to ensure that they can fully grasp the basic relationships between sets and prepare for subsequent learning.

Through the teaching review session, students can engage more deeply in the learning process, reflect on their own learning strategies and methods, provide teaching feedback, and participate in teaching evaluation. This helps students to improve their overall learning effectiveness and ability.

Unit 3. Basic operations of sets (4 hours)

Step 1: Role Assignment

1. The Role of the Teacher.

1.1 Clarify roles and tasks: First, teachers need to clarify their own responsibilities and tasks in the role arrangement, as well as the roles and responsibilities of students in the process. This helps to ensure the smooth running of the teaching process while developing students' ability to learn independently and cooperatively.

1.2 Analyze student characteristics: Teachers need to fully understand the characteristics of students' personalities, interests, learning styles, etc., in order to fully consider these factors in the role arrangement. For example, for students who like hands-on practice, they can be arranged to conduct experimental operations or demonstrations. For expressive students, oral presentations or explanations can be arranged.

1.3 Design suitable roles and tasks: According to the teaching content and the characteristics of students, teachers need to design suitable roles and tasks. These roles and tasks should be able to stimulate students' interest and motivation in learning while understanding and mastering the knowledge and skills of ensemble basic operations. For example, a group task can be designed in which students play different roles in the group and work together to complete an exercise or project of set arithmetic.

1.4 Provide guidance and support: Teachers are expected to provide necessary guidance and support to students during the course of the role arrangement. This includes explaining task requirements, providing learning resources, answering difficult questions, and more. At the same time, teachers also need to pay attention to the learning process and performance of students, and give timely feedback and suggestions to help them better complete the role tasks.

Through reasonable role arrangement, teachers can stimulate students' learning interest and enthusiasm, and improve their independent learning and cooperative learning ability so as to better achieve the teaching goal.

2. The Role of Students.

Students need to listen carefully to the teacher's explanation of roles and tasks, understand their role positioning in the class and the tasks they need to complete. This includes understanding the role in the group, the specific requirements of the task, and how to collaborate with other students.

2.1 Prepare relevant materials and tools: According to the task requirements, students should prepare relevant learning materials and tools. This may include textbooks, notebooks, calculators, or other instruments. Students will better complete the tasks by applying tools and materials.

2.2 Participate in learning and discussion: Students need to be actively involved in learning and discussion during the process of the role arrangement. This may include expressing one's own opinions in the group, proposing problems or solutions, and discussing with other students. Through active participation, students can better understand the knowledge and skills of set basic operations, and improve their learning and thinking skills.

2.3 Complete the task carefully: Students need to complete the task assigned by the teacher carefully. This may include completing exercises, writing reports, giving oral presentations, etc. In the process of completing the task, students need to follow the task requirements, seriously think and solve problems, and ensure the quality and accuracy of the task.

By actively participating in the process of role arrangement, students can better understand the knowledge and skills of ensemble basic arithmetic, improve their learning ability and thinking ability, and provide useful feedback and suggestions for teachers' teaching.

Step 2: Task Setup

1. The Role of the Teacher.

1.1 Build teaching objectives: First of all, teachers need to clearly determine the teaching objectives of this lesson, that is, the knowledge points and skills of the basic operation of the collection that students need to master. This helps teachers to develop targeted tasks to ensure that students can achieve the expected learning results during the completion of the tasks.

2.2 Analyze students' actual situation: Before setting tasks, teachers need to fully understand students' actual learning situation, including their knowledge reserve, learning style, interest points, etc. This helps teachers to design tasks that meet students' actual level and stimulate their interest in learning.

2.3 Design tasks with hierarchy: In order to meet the learning needs of different students, teachers need to design tasks with hierarchy. These tasks can range from simple to complex, from basic knowledge to practical application, and gradually guide students to deeply understand and master the basic operation of sets.

2.4 Ensure the tasks to be practical: In order for students to better understand and apply set basic operations, teachers need to ensure that the designed tasks have practical meaning. This can be done by introducing life examples, practical problems, or connections to other subject areas.

2.5 Provide necessary guidance and support: Teachers need to provide necessary guidance and support for students in the task setting process. This includes explaining task requirements, providing learning resources, answering difficult questions, and more. At the same time, teachers also need to pay attention to the learning process and performance of students, and give timely feedback and suggestions to help them better complete the task.

2.6 Assess and adjust tasks: Finally, teachers need to evaluate and adjust the tasks. This includes collecting student feedback, observing student performance and behavior, and analyzing task completion. Based on the assessment results, teachers can adjust and optimize the tasks to better meet students' learning needs and developmental goals.

Through setting up the reasonable task, teachers can stimulate students' learning interest and enthusiasm, improve their independent learning and cooperative learning ability, so as to better achieve the teaching goal. At the same time, setting task also helps to cultivate students' thinking ability, analysis ability and problem-solving ability.

2. The Role of Students.

2.1 Clear learning objectives: Students should clearly understand the learning objectives of this lesson, that is, the knowledge points and skills of basic arithmetic collection that they need to master. This helps them engage with tasks in a more targeted manner and ensures that their learning process meets the teacher's expectations.

2.2 Preview and preparation: Before the task is set, students can preview and understand the basic concepts and knowledge points of this lesson. They can consult textbooks, related materials, or online learning resources to prepare for the task.

2.3 Participating in task discussion: When the teacher proposes a task, students should actively participate in the discussion and understand the requirements and objectives of the task. They can raise their own questions and suggestions, communicate and discuss with teachers and classmates, and ensure a clear understanding of the task.

2.4 Making a personal learning plan: Students can make a personal learning plan according to their actual situation and learning goals. This can include setting study times, prioritizing tasks, making practice plans, etc., to ensure that students can effectively complete the task.

2.5 Independent thinking and problem solving: In the process of completing tasks, students need to think and solve problems independently. They can apply the basic computational knowledge and skills they have learned to analyze problems, find solutions, and try to solve problems themselves.

2.6 Seeking help and cooperation: If students encounter problems or difficulties that are difficult to solve, students should actively seek help, exchange and discuss with classmates or teachers. They can also cooperate with other students to complete tasks and improve their learning results.

By actively participating in the task, students can better understand the learning objectives and task requirements, and improve learning effect and independent learning ability. At the same time, proper tasks can also cultivate their thinking skills, analytical skills and problem-solving skills, lay a solid foundation for future learning and development.

Step 3: Group Discussion

1. The Role of the Teacher.

Group discussion is an important teaching activity in the process of teaching senior high school mathematics, especially the collection of basic operations. In the group discussion session, teachers should do the following:

1.1 Design discussion topics: Teachers should design targeted discussion topics according to students' learning progress and course requirements. These topics can be a concept of a collection of basic operations, the application of operational rules, or strategies for solving practical problems.

1.2 Set up group guidance: Teachers should make reasonable groups according to students' learning styles and characteristics. Ensure that there are different levels of students in each group to promote mutual learning and communication. At the same time, the teacher should appoint a leader for each group, who is responsible for organizing and coordinating the discussion within the group.

1.3 Provide discussion framework: In order to ensure the smooth progress of discussion, teachers can provide students with a discussion framework, including the goal of discussion, problems to be solved, possible solutions, etc. This helps

guide the students to have in-depth discussions around the topic and avoid going off topic.

1.4 Monitor the discussion process: During the discussion, teachers should pay close attention to the discussion of each group to ensure that the discussion is conducted in an orderly and efficient manner. If it is found that the group discussion deviates from the theme are difficulties, the teacher should give timely guidance and help.

1.5 Encourage active participation: In order to stimulate students' enthusiasm for participation, teachers should encourage each student to actively participate in discussions and express their views and ideas. For students who are timid or unwilling to speak, teachers can give more encouragement and support to help them overcome psychological barriers.

Through the effective organization and guidance of group discussion, teachers can stimulate students' learning interest and enthusiasm, and improve their independent learning and cooperative learning ability. At the same time, group discussions also help to develop students' communication skills, critical thinking and problem-solving skills.

2. The Role of Students.

2.1 Participate in discussion: Students should actively participate in group discussions and express their own views and opinions. They can discuss the basic concepts, operation rules, application examples and so on, and share their understanding and thinking.

2.2 Communicate with students: In the discussion, students need to listen to other students, respect their views, and communicate with them actively. By listening and communicating, students can learn about different ways of thinking and problem-solving strategies, and broaden their thinking.

2.3 Solve problem: Students can take advantage of group discussions to solve problems in the basic operations of sets together. They can work together, explore ways to solve problems, and improve the efficiency of problem solving through mutual help and support.

2.4 Organize and summarize results: After the discussion, students can organize and summarize the results of the group discussion together. They can summarize the key points and difficulties of the basic operation of the set, sum up the experience and skills of solving the problem, so as to better apply in the subsequent study.

2.5 Raise questions and confusion: During the discussion, if students encounter questions that they do not understand or are confused, they can raise the problems to the group members or teachers in time. By asking questions and puzzles, students can seek help and answers, and deepen their understanding of the basic operations of sets.

2.6 Learn from each other: Group discussion provides a platform for students to learn from each other. Students can observe the performance and thinking styles of other students and learn from their strengths and experiences to improve their own learning methods and strategies.

By actively participating in the group discussion, students can deepen their understanding and mastery of the basic operation of sets, improve their thinking ability and problem-solving ability. At the same time, group discussion also helps to cultivate students' teamwork spirit and communication skills, which lays a good foundation for future study and work.

Step 4: Result Report

1. The Role of the Teacher.

1.1 Prepare a reporting framework: Teachers should prepare a clear reporting framework for students and specify what they are expected to present. This can include, for example, topics discussed, key findings, approaches to solving problems, challenges encountered, and how to solve them.

1.2 Listen to students' report: In the reporting of results, teachers should patiently and carefully listen to each student's report. This not only helps teachers to understand the level of understanding of students, but also provides opportunities for students to give feedback.

1.3 Offer feedback: After the student completes the report, the teacher should give timely and specific feedback. The feedback should focus on students' understanding, expression ability and problem-solving strategies. At the same time, teachers should also give recognition and encouragement to students' efforts and progress.

1.4 Summarize the report: After listening to all the students' reports, the teacher should summarize and summarize the entire discussion and report session. This can help students review and consolidate what they have learned, and it can also provide a basis for teachers to improve their teaching methods.

1.5 Clarify the report: If there is confusion or ambiguity in the student's report, the teacher should ask questions and clarify in time. This not only helps students deepen their understanding, but also ensures that all students have a clear understanding of what is being discussed.

1.6 Lead further discussion: If students raise interesting or valuable questions in the presentation, the teacher can lead the class to further discussion. This can not only stimulate students' interest in learning, but also help them to understand more deeply the concepts and applications of the basic operation of sets.

In general, teachers play the role of facilitator, supporter and evaluator in the process of result reporting. They need to help students present content clearly, listen to and evaluate their debriefs, provide feedback and suggestions, and guide them to further discussion and learning.

2. The Role of Students.

2.1 Prepare report content: Before the results report, students need to carefully prepare the report content. They can review the topic and focus of the discussion, organize their own thoughts and findings in the group discussion, and prepare relevant examples and exercises. Make sure the report is clear, and highlights the key points and highlights.

2.2 Present Learning results: In the presentation session, students need to present learning results to the class. They can demonstrate their understanding and mastery through oral presentations, presentation of slides, and sharing of problem-solving processes. This can include the basic concept of the set, the operation rules of the set, the application examples and so on.

2.3 Share experiences and strategies: During the process of presentation, students can also share their own experiences and strategies in group discussions. They can tell stories about how they solved problems, overcame confusion, and worked with others. This can not only promote communication and learning within the class, but also help other students get inspiration and reference.

2.4 Answer questions and interact: At the end of the presentation, students are expected to answer questions and interact with their classmates. This can help students further clarify and understand their own learning outcomes while providing students with the opportunity to demonstrate the ability to change and express themselves.

2.5 Summarize performance: After the debriefing session, students also need to reflect and summarize their performance. They can review their reporting process and think about their performance in terms of presentation, understanding, problem solving, etc., and areas that need to be improved. This helps students to continuously improve their learning ability and comprehensive quality.

In general, in the results reporting session, students need to demonstrate their learning results and experiences, communicate and interact with classmates, and reflect and summarize their performance. By participating in the results reporting process, students can deepen their understanding and mastery of the basic operation of sets, improve their ability to express themselves and solve problems, and lay a good foundation for future study and work.

Step 5: Teaching Comment

1. The role of the teacher.

1.1 Collect students' feedback: Teachers can collect students' feedback on the teaching content, teaching method, learning difficulty and other aspects through questionnaire survey, oral inquiry or group discussion. This helps teachers to understand students' learning needs and difficulties, and provides a basis for subsequent teaching adjustment.

1.2 Evaluate students' learning results: Teachers can assess students' mastery of basic set operations through assignments, tests, or exams. This can include students' understanding of basic concepts, mastery of operation rules, and solution of application examples. At the same time, teachers also need to pay attention to the way of thinking and problem-solving strategies displayed by students in the learning process.

1.3 Reflect on teaching effectiveness: Teachers need to reflect on their teaching effectiveness based on student feedback and evaluation results. They can think about whether the teaching method is appropriate, whether the teaching content is clear enough, and whether the teaching progress is appropriate. At the same time, teachers also need to pay attention to whether they give full play to students' initiative and creativity in teaching, and whether they cultivate students' mathematical thinking ability and problem-solving ability.

1.4 Develop an improvement plan: On the basis of reflecting on the teaching effect, teachers need to develop an improvement plan. They can adjust the teaching content and methods according to students' learning needs and difficulties, and strengthen students' practical exercises and applied training. At the same time, teachers also need to pay attention to the personalized learning needs of students,

and provide different teaching tools or advanced content to meet the different needs of students.

1.5 Exchange and share with other teachers: Teachers can also exchange and share teaching experience with other teachers. This can promote cooperation and mutual learning among teachers and improve teaching effectiveness and quality.

In general, in the teaching review process, teachers need to comprehensively evaluate students' learning effect and their own teaching effect, collect students' feedback and suggestions, and reflect on and improve their own teaching methods and contents. At the same time, they also need to exchange experiences and share ideas with other teachers to jointly improve the effectiveness and quality of teaching.

2. The Role of Students.

2.1 Provide feedback: Students can provide their feedback to the teacher on the content, teaching methods, learning difficulty, etc. They can share their feelings and experiences in the learning process, as well as their opinions and suggestions on teaching content and methods, by filling out questionnaires and participating in oral discussions or group discussions.

2.2 Evaluate your learning performance: Students can self-evaluate their mastery of basic set operations. They can review their learning process to see if they understand the basic concepts, master the rules of operations, and apply this knowledge to solve practical problems. In addition, they can objectively assess their learning by completing self-tests and participating in classroom quizzes or exams.

2.3 Participate in discussion and sharing the opinions: In the teaching review section, students can actively participate in discussions and share their learning experiences and problem-solving strategies. They can communicate with their classmates about the difficulties and solutions encountered in the learning of set basic operations, and share their thinking process and experience in solving problems. Such discussions help to promote communication and cooperation within the class, and help students gain a deeper understanding and mastery of basic set operations.

2.4 Ask questions and ask for help: If students have questions or confusion in learning the basic operation of sets, they can ask the teacher for help in the teaching comment section. Teachers can give answers and guidance to students' specific problems, help students solve learning problems, and improve learning results.

In general, students can actively participate in the teaching review by providing feedback, evaluating their own learning effects, participating in discussions and sharing the opinions, and asking questions and seeking help from teachers. This not only helps promote communication and cooperation within the class, but also helps teachers better understand students' learning needs and difficulties, and provides a basis for subsequent teaching adjustment.

Part 2: To compare students' mathematics logic ability before and after the implementation based on cooperative learning model.

In this section, the researchers aim to evaluate the effectiveness of cooperative learning model during the process of teaching mathematics courses. This study focuses solely on mathematics logic training for Grade one in senior high school. The course is divided into three units, totaling 12 hours:

1. Concept of set (4 hours)
2. Basic relationships between sets (4 hours)
3. Basic operations of sets (4 hours)

The researchers compare 50 students' mathematics logic ability before and after the implementation of cooperative learning model. The teaching effectiveness of the instructional course was analyzed as follows. 1) study the factors to improve mathematics logic ability for senior high school students, and 2) examine the effects of implementing cooperative learning model. The sample group consists of 50 senior high school students, No.2 Senior High School of Panzhou City, who were selected through the cluster random sampling. In the research, 50 students were selected as experimental subjects in the study, including 27 male students (54%), and 23 female students (46%). The evaluation standard of mathematics ability consists of 10 evaluation items. Each evaluation item is worth 1-3 points, a total of 30 points. The results are summarized in Table 4.1 below.

Table 4.1 Scores on mathematics logic ability before and after the implementation of cooperative learning model

Number of students	Pretest total score (30)	Posttest total score (30)	Differences between scores (D)
1	14	22	8
2	20	25	5
3	23	29	6
4	20	26	6
5	18	25	7
6	22	28	6
7	21	27	6
8	18	28	10
9	24	26	2
10	16	24	8
11	20	27	7
12	23	29	6
13	18	28	10
14	23	27	4
15	24	28	4
16	19	26	7
17	22	26	4
18	24	29	5

Table 4.1 (Continue)

Number of students	Pretest total score (30)	Posttest total score (30)	Differences between scores (D)
19	16	24	8
20	27	30	3
21	16	22	6
22	23	27	4
23	27	29	2
24	26	30	4
25	22	26	4
26	25	26	1
27	26	29	3
28	19	27	8
29	17	25	8
30	19	27	8
31	18	24	6
32	20	26	6
33	15	24	9
34	17	25	8
35	22	26	4
36	16	28	12
37	20	28	8
38	25	30	5
39	17	28	11
40	20	30	10

Table 4.1 (Continue)

Number of students	Pretest total score (30)	Posttest total score (30)	Differences between scores (D)
41	23	28	5
42	20	22	2
43	22	25	3
44	23	29	6
45	19	25	6
46	24	26	2
47	20	27	7
48	22	28	6
49	12	20	8
50	18	29	11
Average score $\bar{X}$	20.50	26.60	6.10
SD.	3.47	2.30	2.60

As can be seen in Table 4.1, through the application of teaching theory based on cooperative learning model, average score of mathematics logic ability of senior high school students was 20.50 before experiment, 26.60 after the experiment, with a difference of 6.10 in the average scores, which indicated that the scores had been improved significantly before and after the experiment.

The researcher conducted data analysis using the mean, standard deviation, and dependent T-test based on the students' mathematics logic ability scores before and after the experiment. The results of the data analysis are presented in Table 4.2.

Table 4.2 Comparison of students' mathematics logic ability before and after the implementation of cooperative learning model

Mathematics logic ability	n	Full score	$\bar{X}$	SD.	df	t	p
Pretest	50	30	20.50	3.47	49	16.61	.000
Posttest	50	30	26.60	2.30			

Statistically significant at the level .01($p<.01$)

According to Table 4.2, through the implementation of cooperative learning model, students' mathematics logic ability significantly improved at the level .01.

Chapter 5
Conclusion Discussion and Recommendations

After analyzing and presenting data analysis results in chapter 4 as serving the present study "Using cooperative learning model to improve mathematics logic ability for senior high school students", certain approaches are recommended on the basis of the findings, and the conclusion and discussion can be summarized as follows.

Research Objectives

Part 1: To use cooperative learning model to improve mathematics logic ability for senior high school students.

Part 2: To compare senior high school students' mathematics logic ability before and after the implementation based on cooperative learning model.

Apply cooperative learning model to enhance students' mathematics logic ability. The course was divided into three units, totaling 12 hours:

1. Concept of set (4 hours)
2. Basic relationships between sets (4 hours)
3. Basic operations of sets (4 hours)

1. As an important part of mathematics education, set course not only requires students to master basic operator skills, but also emphasizes conceptual understanding ability, logical deduction ability, and critical thinking ability.

Cooperative learning model provides a new perspective and method for mathematics conceptual understanding ability. In group work, students need to work together to solve problems. Such a process not only exercises students' math skills, but also improves their communication and teamwork skills.

Cooperative learning model has unique value in mathematics education, which provides students with a learning environment different from traditional teaching. In this mode, students are no longer passive receivers of knowledge, but become active participants, discuss and solve problems with their peers. This interactive process helps to stimulate their thinking vitality and encourage them to think actively, thus cultivate mathematical logical deduction ability.

Cooperative learning model can also promote students' critical thinking development. In the group discussion, students need to distinguish different points of view and put forward their own opinions. This process helps develop students' critical

thinking, understand mathematical problems deeply and learn to think about problems from different perspectives.

Therefore, cooperative learning model provides a new perspective and method for the cultivation of mathematics logic ability. It allows students to learn in an interactive and collaborative environment that energizes thinking level. At the same time, this learning model also helps to cultivate students' teamwork skills and critical thinking, lay a solid foundation for their future study and life.

2. Develop tools for research. Cooperative learning model involves creating lesson plans and conducting research, which encompasses five key steps: 1) Role assignment; 2) Task setup; 3) Group discussion; 4) Result report; 5) Teaching comment**.**

3. The research instrument was submitted to three experts to confirm its validity, evaluate lesson plan standards, and assess mathematics logic ability, while its dependability was examined by sample tests as the basis for evaluation (IOC: Index Objective Congruence). Once the creation of research instruments is finalized and approved, specialists will undertake inquiries and implement lesson plans. During the initial half of the 2023 school year, a distinct examination was carried out for students in the senior high school, and gathered data through cooperative learning model.

4. Gather information for students, utilize experimental findings, and examine the means ($\overline{X}$), standard deviation (SD.) and the T- test for dependent sample.

Conclusion

Part 1: To use cooperative learning model to improve mathematics logic ability for senior high school students.

The course is divided into three units, totaling 12 hours. The researcher has examined various studies and literature on cooperative learning model from multiple scholars and has consolidated these findings into a five-step framework for crafting lesson plans tailored to cooperative learning model. Analysis of the data involved evaluating the lesson plan's quality through cooperative learning model by three specialists, and the research goals' appropriateness was the most fitting.

Part 2: To compare senior high school students' mathematics logic ability before and after the implementation based on cooperative learning model.

Table 4.1 illustrates that when applying teaching theory -based on cooperative learning model, students' mathematics logic ability scores averaged 20.50 pre-experiment, and 26.60 post-experiment, showing a 6.10 difference in average scores.

The researcher conducted the data analysis by using the mean, standard deviation, and dependent T-test, centering on the students' performance in mathematics logic ability during the process of pre-experiment and post-experiment. Utilizing cooperative learning model significantly improved the students' mathematics logic ability. The results support the research theory and demonstrate a statistically significant improvement at the .01 level.

Discussions

Part 1: To use cooperative learning model to improve mathematics logic ability for senior high school students.

1. Role Assignment

Role assignment is a crucial part in cooperative learning. In order to improve the mathematical logic ability of high school students, teachers can divide students into several groups and assign different roles to each group such as group leader, recorder, spokesman, etc. This role allocation helps to develop students' teamwork skills and responsibility, and also ensures that each student can bring out his or her strengths in group activities. (Qu, 2024)

2. Task Setup

In order to improve the mathematical logic ability of high school students, teachers should pay attention to the level and challenge of the task when setting cooperative learning tasks. For example, teachers can design some tasks involving logical deduction, comprehensive proof, problem-solving strategies, etc., so that students can constantly exercise and improve their mathematics logic ability in the process of completing the task. At the same time, the difficulty of the task should be moderate, which can not only stimulate students' interest, but also ensure that students can achieve certain results in the process of cooperative learning. (Ma, 2023)

3. Group Discussion

Group discussion is the core of cooperative learning. In group discussions, students can fully communicate and discuss tasks and jointly find ways and strategies to solve problems. In order to improve the mathematical logic ability, teachers should guide students to pay attention to the logical structure, reasoning process and problem-solving ideas of the problem in the group discussion, so as to help students establish a correct mathematical thinking mode. In addition, teachers can also encourage students to put forward their own opinions and insights in group discussions to develop students' critical thinking and innovation skills. (Luo, 2023)

4. Result Report

After completing the group discussion, each group is required to report their discussion results to the class. The process of result reporting can not only show students' cooperative learning results, but also help students exercise their oral expression ability and logical thinking ability. In the reporting process, teachers should ask students to clearly explain the problem-solving ideas, logical reasoning process and achievements, so that other students can understand and use for reference. At the same time, teachers should also give timely feedback and evaluation to students' reports so as to help students further improve their mathematics logic ability. (Chen, 2023)

5. Teaching Comment

Teaching commentary is an important link in the process of cooperative learning, which helps teachers to understand students' learning situation and adjust teaching strategies in time. In the process of comment, teachers should pay attention to the following aspects: Firstly, evaluate students' performance in cooperative learning, including participating enthusiasm, cooperation spirit and contribution degree. Secondly, analyze the effect of improving students' mathematical logic ability in order to provide reference for subsequent teaching. Finally, in view of the problems and difficulties encountered by students in cooperative learning, teaching comment puts forward specific suggestions and guidance measures for improvement. (Wang, 2023)

In short, it is a systematic and comprehensive process to improve the mathematics logic ability of senior high school students by using cooperative learning model. Through the organic combination of reasonable role assignment, task setup, group discussion, result report and teaching comment, cooperative learning model can effectively promote the development of students' mathematics logic ability, and cultivate students' teamwork spirit and comprehensive quality.

Part 2: To compare senior high school students' mathematics logic ability before and after the implementation based on cooperative learning model.

As can be seen in Table 4.1, through the application of cooperative learning model, average mathematics logic ability for senior high school students was 20.50 before experiment, 26.60 after the experiment, with a difference of 6.10 in the average scores, which indicated that the scores had been improved significantly after the experiment.

The researcher conducted data analysis by using the mean, standard deviation, and dependent T-test based on the students' mathematics logic ability scores before and after the experiment. The results of the data analysis are presented in Table 4.2.

According to Table 4.2, through the implementation of cooperative learning model, students' mathematics logic ability significantly improved. This result supports the research hypothesis and demonstrates a statistically significant improvement at the level .01.

In summary, after the implementation of cooperative learning model, students' mathematics logic ability will be improved.

Recommendation

1. Recommendations for the application of cooperative learning model

Cooperative learning model is a student-centered teaching method that promotes students' active participation and mutual learning through group discussion and team cooperation. When implementing cooperative learning model, teachers need to put forward application suggestions from the following five aspects.

Firstly, select cooperation content.

When choosing the content of cooperative learning, teachers should give full consideration to students' knowledge background, interests and subject characteristics. The content should be challenging and stimulate students' interest in learning, while also meeting the teaching objectives and helping to develop students' ability to cooperate and solve problems. In addition, teachers also need to pay attention to the difficulty of the cooperation content, ensure that students can gain something in the cooperation process, and avoid the effect of cooperation because the task is too simple or complicated.

Secondly, divide into reasonable groups.

In cooperative learning mode, grouping is a key link. Teachers should make reasonable groups according to the characteristics, abilities and interests of students to ensure that the members of each group are complementary and can promote each other. At the same time, teachers also need to assign clear tasks and roles to each group to ensure that each student can play their own advantages in the cooperation and avoid the phenomenon of "free riding". In addition, teachers also need to pay attention to the dynamic changes of the group and adjust the grouping strategy according to the actual situation to ensure the smooth progress of cooperative learning.

Thirdly, change teachers' role.

In the cooperative learning model, the role of teachers has changed from the traditional knowledge imparts to the guide and collaborator of students. Therefore, teachers need to adjust their mentality and teaching methods, give full play to their guiding role, and help students solve the problems encountered in the process of cooperation. At the same time, teachers also need to pay attention to students' needs and psychological changes, give timely care and support, establish a good relationship between teachers and students, and create a good atmosphere for cooperative learning.

Fourthly, develop cooperation skills.

Cooperative learning mode requires students to have certain cooperative skills, such as communication ability, coordination ability, leadership and so on. Therefore, when implementing cooperative learning mode, teachers need to pay attention to cultivating students' cooperative skills. Students' cooperation skills can be improved by organizing special training courses and carrying out role playing activities. At the same time, teachers also need to infiltrate the cultivation of cooperation skills in daily teaching, so that students can continue to learn and progress in practice.

Fifthly, provide multiple evaluation feedback.

Evaluation is an important link in cooperative learning model, which can not only test students' learning results, but also provide feedback and improvement direction for teachers' teaching. When implementing the cooperative learning model, teachers need to adopt multiple evaluation methods, such as self-evaluation, group evaluation, teacher evaluation, etc., in order to have a more comprehensive understanding of students' learning situation and cooperation ability. At the same time, teachers also need to feedback the evaluation results in time to help students

understand their own strengths and weaknesses, so as to adjust learning strategies and improve learning results. In addition, teachers need to reflect and improve the cooperative learning mode according to the evaluation results, and constantly improve the teaching strategies and methods.

In short, the application of cooperative learning mode needs to be comprehensively considered from many aspects, including selection of cooperative content, reasonable division of labor in groups, teacher role transformation, training of cooperative skills and multiple evaluation feedback. Only in the aspects, can teachers ensure the effectiveness and efficiency of cooperative learning mode and provide strong support for the all-round development of students.

2. Recommendations for the future research

As an efficient teaching method, cooperative learning model has been widely used in school education. Cooperative learning model can carry out teaching research from the following five teaching steps:

Firstly, role assignment.

Role assignment could explore more refined and personalized role allocation strategies. Teachers assign roles according to students' personalities, abilities and interests, allow students the freedom to switch roles during the collaborative process. This maximizes the potential of each student and promotes collaborative efficiency in the team.

Secondly, task setup.

To set learning tasks in cooperative learning model, it is necessary to consider teaching objectives, students' characteristics, task hierarchy, cooperation and interaction, problem solving and innovation ability, and evaluation criteria. Through carefully designed learning tasks, students' active participation and common development in cooperative learning can be effectively promoted.

Thirdly, group discussion.

Group discussion could focus on the dynamic process. For example, by observing and recording the process of group discussion, teachers can analyze the way in which students interact and cooperate in the discussion, and how these factors affect the learning effect. In addition, teachers can also study how to guide group discussions to be more in-depth and effective.

Fourthly, result report.

Result report could explore how to better present and evaluate the results of group collaboration. For example, how to design reports that demonstrate both group work and individual contributions, and how to establish fair and objective evaluation systems to ensure that each student gets the recognition they deserve.

Fifthly, teaching comment.

Teachers can strengthen the research and application of teaching comment. For example, how to conduct effective teaching reviews, including the content, mode, frequency and timing of the reviews, and how to adjust teaching strategies and methods according to the review results to improve the effectiveness and quality of cooperative learning model.

To sum up, future research on cooperative learning model can further explore the specific implementation strategies and methods of each step so as to optimize the teaching effect and application range.

References

Bao, S. F. (2019). **Cooperative learning model in mathematics in Senior One.** Master's Thesis, Central China Normal University.

Chen, J. (2023). The application of group cooperative learning model in high school mathematics teaching (Eds.) **Proceedings of the 9th Academic Conference on Innovative Education -- Educational Innovation** (pp.2-4).

Chen, J. W. (2021). **Instructional design and practice inquiry of junior middle school mathematics cooperative learning for problem solving.** Master's Thesis, Liaoning Normal University.

Chen, L. (2023). The application of group cooperative learning in high school mathematics teaching (Eds.) **Proceedings of the 4th Life Education Forum, 2023** (pp.27-29).

Chen, P. (2023). The application of cooperative learning in junior middle school mathematics teaching. **Mathematics Learning and Research** (21), 26-28.

Chen, Y. (2023). Construction of cooperative learning model in junior middle school mathematics teaching group. **Good Parents** (21), 52-54.

Da, L. J. (2023). Practical research on the teaching mode of independent cooperative inquiry in high school mathematics. **College Entrance Examination** (18), 60-62.

Deng, L. D. (2021). **Optimal strategies for cooperative learning in primary mathematics groups.** Master's Thesis, Southwest University.

Dong, Y. Y. (2022). **An empirical study on the Improvement of students' mathematical problem-solving ability by group cooperative learning.** Master's Thesis, Nanning Normal University.

Feng, L. (2021). **Strategic research on cooperative learning in primary school mathematics under the concept of smart classroom.** Master's Thesis, Southwest University.

Guan, L. P. (2023). Returning the classroom to the students: The application of cooperative learning model in the teaching of mathematical problem solving in junior middle school. **Mathematical World (Junior High School Edition)** (07), 27-28.

He, Y. T. (2020). **Strategic research of junior middle school math exercise teaching based on group cooperative learning model.** Master's Thesis, Southwest University.

Jing, S. (2024). On the application of cooperative learning in mathematics teaching. **Henan Education (Basic Education Edition***)* (01), 79-80.

Li, H. (2023). Thinking on the application of cooperative learning model in the stratification teaching of mathematics in junior middle school**. New Curriculum** (08), 100-102.

Li, J. X. (2023). An analysis of the implementation strategies of cooperative learning in high school mathematics teaching (Eds.). **2023 Proceedings of the Third Summit Forum on Innovative Education and Precise Management in Education Theory and Management (Topic 1)** (pp.314-317).

Li, S. H. (2019). **Action research in group cooperative learning in mathematics class in Senior One.** Master's Thesis, Yunnan University.

Li, X. B. (2021). **Cooperative learning model in junior high school mathematics group.** Master's Thesis, Changchun Normal University.

Liu, C. (2023). On the application of cooperative learning model in high school mathematics teaching. **Second Classroom** (D) (10), 52.

Liu, J. N. (2021). **Practical research on mathematics review course under the guidance of cooperative learning in Senior Three.** Master's Thesis, East China Normal University.

Liu, Z. P. (2023). **Problem-based teaching and research in mathematics cooperative learning for junior high school students.** Master's Thesis, Hubei Normal University.

Luo, Y. X. (2023). The application of cooperative learning model in high school mathematics teaching. **Science Lovers** (04), 65-67.

Luo, Z. G. (2022). Construction of cooperative learning model in junior middle school mathematics teaching group. **Journal of Science** (30), 70-72.

Ma, Z. M. (2023). Research on the application of group cooperative learning in high school mathematics teaching. **Questions and Research** (25), 150-152.

Peng, Z. Z. (2023). **Research on teaching strategies of junior middle school math exercises based on the concept of cooperative learning.** Master's Thesis, Shanghai Normal University.

Qiao, Z. X. (2020). **Teacher-directed research in group cooperative learning in middle school mathematics classroom.** Master Thesis, Shanxi Normal University.

Qu, X. Y. (2022). **Practical research on cooperative learning model to promote the metacognitive development of junior middle school students.** Master's Thesis, Shanxi Normal University.

Qu, Z. X. (2024). On the construction of group cooperative learning model in junior middle school mathematics teaching. **Enlightenment and Wisdom** (I) (03), 65-67.

Ren, Q. C. (2023). Exploration of the integration of cooperative learning model and junior high school mathematics teaching. **Intelligence** (12), 53-56.

Sun, T. (2018). **The application of cooperative learning in high school geometry teaching**. Master's Thesis, Ningxia Normal University.

Tang, W. Y. (2023). Group cooperative learning model improves the quality and effectiveness of mathematics classroom teaching. **Reading and Writing** (22), 95-97.

Tao, X. Y. (2023). The application strategy of group cooperative learning model in junior middle school mathematics teaching. **Science Lovers** (05), 77-79.

The Ministry of Education. (2001). Curriculum Standards for Full Time Compulsory Education (Experimental Draft). **The Ministry of Education Press.**

Wan, R. K. (2018). **Research on the practice of group cooperative learning in junior middle school mathematics teaching.** Master's Thesis, Hainan Normal University.

Wang, A. J. (2023). Research on the application of cooperative learning in junior middle school mathematics teaching. **Examination Weekly** (50), 81-84.

Wang, C. Y. (2023). The application of cooperative learning model in junior middle school mathematics teaching. **Examination Weekly** (25), 96-99.

Xie, B. M. (2023). The analysis of high school mathematics teaching strategies based on group cooperation model. **Research on Mathematical and Physicochemical Solutions** (18), 38-40.

Xie, C. L. (2020). **The application of STAD cooperative learning model in junior middle school mathematics teaching.** Master's Thesis, China West Normal University.

Xue, T. L. (2023). The application of cooperative learning model in junior middle school mathematics teaching (Eds.). **Proceeding of the Second National Teaching Seminar of Guangdong Teachers' Continuing Education Association** (VII) (pp.381-383).

Zha, Q. J. (2023). The application of cooperative learning model in junior high school mathematics (Eds.). **Network Forum on Teaching Quality Management Research -- Proceedings of the Sub-Forum on Informatization Theory and Education Development** (1) (pp.24-26).

Zhang, L. (2018). **Research on the application of group cooperative learning in junior middle school mathematics teaching.** Master's Thesis, Central China Normal University.

Zhang, N. Z. (2020). **Research on the implementation of group cooperative learning in junior middle school mathematics teaching.** Master's Thesis, Northwest Normal University.

Zhang, Y. (2021). **Cooperative learning strategies in junior middle school mathematics based on core literacy.** Master's Thesis, Jinan University.

Zheng, T. (2023). **An exploration of efficient cooperative learning model of junior high school mathematics based on dynamic grouping.** Master's Thesis, Qufu Normal University, China.

Zhong, D. W. (2023). Implementation strategy of cooperative learning model in junior middle school mathematics. **Asia Pacific Education** (12), 142-144.

Zhou, K. X. (2023). **Teaching strategies of cooperative learning in high school mathematics under the background of "Three New".** Master's Thesis, Southwest University.

Zhu, X. H. (2023). The application of cooperative learning model in junior middle school mathematics classroom teaching. **Middle School Mathematics** (10), 95-96.

Appendixes

Appendix A
List of Specialists and Letters of Specialists Invitation for IOC Verification

List of Specialists and Letters of Specialists Invitation for IOC Verification

Name of Experts	Position/Office
1. Fangkamol Pethkliang	Faculty of Education Bansomdejchaopraya Rajabhat University
2. Sasikanchana Yenaeng	Dean of the Graduate School Bansomdejchaopraya Rajabhat University
3. Yu Miao	School of Art Inner Mongolia University for Nationalities

Appendix B
Official Letter

Ref.No. MHESI 0643.14/1634

Bansomdejchaopraya
Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

25 December 2023

RE: Invitation to validate research instrument

Dear Assistant Professor Fangkamol Pethkliang

Mr.Dong Juncan is a graduate student in Master of Education Program in Curriculum and Instruction of Bansomdejchaopraya Rajabhat University. He is undertaking research entitled "Using Cooperative Learning Model to Improve Mathematics Logic Ability for Senior High School Students"

The thesis adversity committee has considered that you are an expert in this topic. Your recommendations would be useful for further improvement of this research instrument.

We respectfully request your assistance in validating a research instrument that is attached to this message. We would be grateful for any help you can provide in this matter. We would like to express our sincere appreciation for your time and expertise. If you have any questions or concerns, please do not hesitate to contact Mr.Dong Juncan at 252626015@qq.com

Thank you for considering our request

Sincerely,

(Assistant Professor Akaranun Asavarutpokin)
Vice Dean, For Dean of the Graduate School

Bansomdejchaopraya Rajabhat University
Tel.+662-473-7000 ext. 1814
www.bsru.ac.th

Ref.No. MHESI 0643.14/1635

Bansomdejchaopraya
Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

25 December 2023

RE: Invitation to validate research instrument

Dear Assistant Professor Dr.Sasikanchana Yenaeng

Mr.Dong Juncan is a graduate student in Master of Education Program in Curriculum and Instruction of Bansomdejchaopraya Rajabhat University. He is undertaking research entitled "Using Cooperative Learning Model to Improve Mathematics Logic Ability for Senior High School Students"

The thesis adversity committee has considered that you are an expert in this topic. Your recommendations would be useful for further improvement of this research instrument.

We respectfully request your assistance in validating a research instrument that is attached to this message. We would be grateful for any help you can provide in this matter. We would like to express our sincere appreciation for your time and expertise. If you have any questions or concerns, please do not hesitate to contact Mr.Dong Juncan at 252626015@qq.com

Thank you for considering our request.

Sincerely,

(Assistant Professor Akaranun Asavarutpokin)
Vice Dean, For Dean of the Graduate School

Bansomdejchaopraya Rajabhat University
Tel.+662-473-7000 ext. 1814
www.bsru.ac.th

Ref.No. MHESI 0643.14/1636

Bansomdejchaopraya
Rajabhat University
1061 Itsaraparb Hirunrujee
Thonburi Bangkok 10600

25 December 2023

RE: Invitation to validate research instrument

Dear Associate Professor Dr.Yu Miao

Mr.Dong Juncan is a graduate student in Master of Education Program in Curriculum and Instruction of Bansomdejchaopraya Rajabhat University. He is undertaking research entitled "Using Cooperative Learning Model to Improve Mathematics Logic Ability for Senior High School Students"

The thesis adversity committee has considered that you are an expert in this topic. Your recommendations would be useful for further improvement of this research instrument.

We respectfully request your assistance in validating a research instrument that is attached to this message. We would be grateful for any help you can provide in this matter. We would like to express our sincere appreciation for your time and expertise. If you have any questions or concerns, please do not hesitate to contact Mr.Dong Juncan at 252626015@qq.com

Thank you for considering our request.

Sincerely,

(Assistant Professor Akaranun Asavarutpokin)
Vice Dean, For Dean of the Graduate School

Bansomdejchaopraya Rajabhat University
Tel.+662-473-7000 ext. 1814
www.bsru.ac.th

Appendix C
Research Instruments

Lesson Plan 1

Contents

Concept of set

Objective

Part 1: To use cooperative learning model to improve mathematics conceptual understanding ability for senior high school students.

Part 2**:** To compare students' conceptual understanding ability before and after the implementation based on cooperative learning model.

The researchers conducted the research in the following order:

Part 1: To use cooperative learning model to improve mathematics conceptual understanding ability for senior high school students.

1. Deepen conceptual understanding: In cooperative learning, students need to discuss and explore mathematical concepts together with their peers. Through interaction and communication, they can understand concepts from different angles and grasp their essence and connotation more deeply. This multi-angle and multi-dimensional way of learning helps to break the single mode of thinking and improve students' overall cognition of mathematical concepts.

2. Increase learning interest and motivation: Cooperative learning provides students with a positive and interactive learning environment and allows students to learn mathematics in a relaxing and pleasant atmosphere. Through collaborative problem solving, students can experience the joy of success, thereby enhancing their confidence and interest in learning mathematics. At the same time, communication and cooperation with peers can also stimulate students' learning motivation and make them more active in math learning.

3. Cultivate teamwork and communication skills: Cooperative learning emphasizes cooperation and interaction among students and requires students to play their own role in the team and complete tasks together. This way of learning helps to develop students' teamwork spirit and communication skills, so that they learn to listen to others, respect the views of others, and be able to play their own strengths in a team.

4. Promote thinking development and innovation: In cooperative learning, students need to constantly think, explore and discover, which helps to promote their innovation ability. Through communication and discussion with peers, students can stimulate new thinking angles and methods, thereby expanding their thinking space and innovation ability.

5. Improve learning effect and performance: Cooperative learning model enables students to learn mathematics in a relaxing and pleasant atmosphere, improve their learning interest and motivation, and promote their thinking development and innovation ability. These factors work together to improve students' learning effect and achievement, so that they can get better results in math learning.

To sum up, it is of great significance to use cooperative learning model to improve senior high school students' mathematics conceptual understanding ability, which not only helps to improve students' mathematical literacy and comprehensive ability, but also lays a solid foundation for their future development.

Unit 1. Concept of set (4 hours)

Step 1: Role assignment

Role assignment teaching is a teaching method based on role playing and assignment of tasks, which emphasizes student participation and interaction. In this teaching method, teachers can assign different roles and tasks to students according to their interests and characteristics, so that students can learn and master knowledge in the process of completing tasks.

1. The role of the teacher.

1) Determine the role of students: Teachers can assign different roles to students according to their personality, ability, interest and other factors. For example, some students may be good at presentation and communication and can act as leaders or debriefers in group discussions; Some students may be thoughtful and analytical, and can act as the main force of problem solving or research. Through reasonable role allocation, teachers can give full play to the advantages of each student and improve the overall learning effect.

2) Clarify student responsibilities: In the process of role arrangement, teachers should clarify the responsibilities and tasks of each student. For example, in the group discussion, each student should have their own speech and contribution. In a group study or project, each student should assume corresponding responsibilities and tasks. Clear responsibilities and tasks can help students better engage in learning and improve learning results.

3) Provide guidance and support: After the role is assigned, the teacher should provide the necessary guidance and support to the student. For example, for students who are leaders, teachers can give them some advice on organization and management. For the students who are the main force of problem solving or research, the teacher can provide some guidance on problem solving ideas or

research methods. At the same time, teachers should also pay attention to students' learning process and difficulties, and give timely help and support.

4) Promote role conversion and cooperation: In the process of role arrangement, teachers should also focus on promoting students' role conversion and cooperation. For example, group leaders or problem solvers can be changed regularly, giving each student the opportunity to try out different roles and tasks; At the same time, it can also encourage cooperation and communication among students, promote knowledge sharing and thinking collision.

2. The role of students.

1) Understand roles and responsibilities: When teachers assign roles and tasks to students, students should listen carefully and understand their roles and responsibilities. This means that students need to be clear about what their tasks are, what work needs to be done, and how their role contributes to the overall learning process.

2) Accept challenges and take responsibility: Students should accept their role and take responsibility. This may mean that they need to take on some leadership responsibilities, or actively speak up in group discussions, or contribute their own thinking and solutions to group research. Students should understand that they can enhance their learning ability and overall quality. By accepting challenges and taking responsibility.

3) Participate and collaborate actively: Regardless of the student's role, they should actively participate and collaborate with other students. In group discussions, students should actively express their own opinions, listen to the opinions of others, and try to reach a consensus. In group research, students are expected to share their knowledge and experience, help others solve problems, and get inspired by the ideas of others.

In general, students should understand their roles and responsibilities, accept challenges and take responsibility, actively participate and collaborate. Through these actions, students can better participate in the learning process and improve their learning ability and comprehensive quality.

Step 2: Task setup

In order to give students a preliminary understanding of the basic concepts of sets, teachers can design some basic tasks, such as asking students to list some examples of sets in their daily life, or asking them to describe some simple math problems in the language of sets.

1. The role of the teacher.

1) Design targeted exercises: To help students consolidate the basic concepts, representations, and rules of the set, teachers can design a series of targeted exercises. These exercises can cover different difficulty levels to meet the learning needs of different students.

2) Organize group discussion: In order to promote interaction and communication among students, teachers can organize group discussion activities. In the group discussion, students can share their understanding of the concept of set, problem-solving methods, and deepen their understanding of the concept of set through brainstorming.

3) Carry out practical activities: In order to help students understand and master the concept of set, teachers can design some practical activities, such as organizing students to play games of set operation and building models of set relations. These activities can help students combine theory with practice and deepen their understanding of the concept of sets.

4) Assign homework: In order to consolidate students' learning results, teachers can assign some homework and ask students to complete it independently or with their parents. These assignments can be a review of the set concept, an extension of the class content, etc.

2. The role of students.

Before accepting the new set concept, students should preview and have a preliminary understanding of the basic concept, representation and operation rules of sets. This helps students to better follow the teacher's pace and participate more actively in discussions in class.

1) Active participation in class: In class, students should maintain a high degree of attention and actively participate in various activities organized by teachers, such as questions, discussions, group cooperation, etc. Through active participation, students can gain a deeper understanding of set concepts and exercise their thinking and expression skills.

2) Complete exercises and tasks: Students should carefully complete the exercises and tasks assigned by the teacher. These exercises can help students consolidate what they have learned and deepen their understanding of set concepts. In the process of completing the task. Students should pay attention to thinking and exploring, and try to use the knowledge to solve practical problems.

3) Reflection and summary: After completing the task, students should reflect and summarize in a timely manner. Reflection can help students realize their

shortcomings and mistakes in the learning process so as to adjust their learning methods and strategies in time. Summary can help students to sort out and summarize the knowledge, and form a systematic knowledge framework.

In short, students should keep a positive attitude and active learning behavior when teaching the concept of high school set. Through the steps of preview, participation in class, completion of tasks, reflection and summary, students can better understand and master the set concept and improve their learning ability and comprehensive quality.

Step 3: Group discussion

As an important branch of mathematics, set theory provides a rigorous logical foundation for mathematics and other disciplines. For beginners, understanding the concept of a set can be a challenge. As an effective teaching method, group discussion can encourage students to participate actively, think actively, and deepen their understanding of the set concept in the communication.

1. The role of the teacher.

1) Clarify the objectives of group work: Teachers first need to clarify the objectives of group work, and ensure that each student is clear about what tasks they need to accomplish in the group and how these tasks relate to the learning of set concepts.

2) Organize groups and assign roles: Teachers can divide students into different groups according to their abilities, interests and personality traits, and assign one or more roles to each group, such as group leader, recorder, spokesman, etc. This helps to ensure that each student can use their strengths in the group and actively participate in the discussion and learning.

3) Provide guidance and support: In the process of group cooperation, the teacher should provide necessary guidance and support. They can answer students' questions, lead them to think deeply about set concepts, and provide feedback and suggestions to help students improve their understanding and application.

4) Promote communication and collaboration: Teachers should encourage students to actively communicate and collaborate in groups to share their ideas and insights. They can organize group discussions and provide questions or challenges to stimulate students' thinking and facilitate interaction between them.

5) Monitor and evaluate group performance: Teachers should pay close attention to the performance of the group and evaluate their cooperation and learning outcomes. They can observe student participation, quality of discussion, task completion, etc., in order to make adjustments or provide additional support if

necessary.

6) Summary and evaluation: At the end of the group work session, the teacher should summarize and evaluate the whole process. They can review group performance and outcomes, emphasize the importance of ensemble concepts, and encourage students to continue applying these concepts in their future studies.

In general, in the process of teaching the set concept of senior high school, teachers should play the role of organizer, instructor, facilitator, supporter and evaluator in group cooperation to ensure the effectiveness of group cooperation and students' learning outcomes.

2. The role of students.

Active participation in the discussion: Within the group, students should actively participate in the discussion and share their understanding and ideas about the set concept. They should not hesitate to express their own opinions, but also respect and listen to the opinions of other panelists.

1) Collaborative task completion: Students should collaborate with group members and work together to complete the task by depending on the group's goals and assigned tasks. They should give full play to their strengths and contribute to the group while accepting suggestions and help from others.

2) In-depth learning of set concepts: Students should study set concepts in depth through discussion and practice during the process of group work. They should take the initiative to ask questions, seek answers, and deepen their understanding and application of the set concept in practice.

3) The resolution of conflict and disagreement: In group discussions and cooperation, disagreements or conflicts may arise. Students should actively seek solutions to problems with an open and inclusive attitude and avoid escalating differences into conflicts.

4) Careful record and summary: Students should carefully record the process and results of group discussions and cooperation for future review and summary. They should summarize their performance and gains in group cooperation as well as areas for improvement to prepare for future learning.

In general, in the group work session, students should actively participate in discussions, collaborate on tasks, learn set concepts in depth, resolve conflicts and disagreements, and carefully record and summarize what to learn. Through these actions, students can enhance their learning ability and overall quality while contributing to the success of the group.

Step 4: Result report

Results reporting is a method of teaching in which students demonstrate their learning by completing practical tasks or projects. This method can stimulate students' learning interest and motivation, and help them combine theoretical knowledge with practical application, and improve their understanding of concepts. In the teaching of set theory, students can deepen their understanding of set concept in practice through the teaching of results reporting,

1. The role of the teacher.

1) Preparation and planning: Before the results are reported, the teacher should fully prepare and plan. They need to be clear about the purpose, content, format and timetable of the report and ensure that all students have a clear understanding of the requirements and expectations of the report.

2) Guidance and support: Teachers should provide students with the necessary guidance and support to help them collate and analyze the learning outcomes of set concepts. They can organize group discussions and provide questions or challenges to stimulate students' thinking and facilitate interaction between them.

3) Offering opportunities to demonstrate: Teachers should provide opportunities for students to demonstrate their learning by presenting themselves in class or in public at school. This not only increases students' motivation to learn, but also helps them exercise their expression skills and self-confidence.

In general, in the process of teaching the set concept, teachers should play a guiding and supporting role in the process of reporting result to ensure the smooth progress of the report and the effective learning of students

2. The role of students.

1) Organize learning outcomes: Students need to review and organize their own results in the process of learning set concepts. This may include class notes, assignments, transcripts of group discussions, individual or group research projects, etc. Students need to ensure that these results demonstrate a clear and methodical understanding and application of set concepts.

2) Prepare the content of the presentation: Students are expected to prepare the content of the presentation, which may include a short introduction, main learning points, examples or case studies, and application or reflection on set concepts. Students should ensure that the content of the presentation is logical and coherent, and can hold the attention of the audience.

3) Practice presentation and presentation: Students need to practice their presentation skills to ensure they can communicate fluently and confidently during the presentation process. They can improve their presentation skills by giving simulated speeches and practicing with group members.

4) Engage in interaction and discussion: Students should actively participate in interaction and discussion during the presentation process. They should be prepared to answer questions from the audience as well as provide constructive feedback and suggestions on other students' reports.

5) Provide reflection and improvement: At the end of the presentation, students should reflect on their performance, assess their own presentation content and presentation skills, as well as their understanding and application of set concepts. They should identify their strengths and weaknesses and make plans to improve learning and presentation skills.

In general, students need to organize learning outcomes, prepare report content, practice presentation and presentation skills, engage in interaction and discussion, and reflect on and improve their performance. Through these actions, students can better demonstrate their understanding and application of set concepts while improving their learning and presentation skills.

Step 5: Teaching comment

In the teaching process, teachers should pay attention to cultivating students' problem-solving ability. Through the design of challenging and practical problems, students are guided to analyze and solve problems, so as to cultivate their independent thinking and problem-solving ability.

1. The role of the teacher.

1) Collect and analyze feedback: Teachers gather feedback from students, colleagues, or others involved in teaching about the teaching effectiveness. This may include the assessment of the student's understanding of the set concept, the acceptance of teaching methods, the effect of classroom interaction, etc. Teachers will carefully analyze the feedback to understand the strengths and weaknesses of the teaching results and areas for improvement.

2) Assess teaching objectives: The teacher will assess whether the teaching objectives have been achieved, that is, whether the students have really mastered the set concept. This can be assessed by the student's homework completion, classroom performance, test results, etc. If the teaching goal is not fully achieved, teachers need to think about how to adjust the teaching strategy to better help students grasp the set concept.

3) Reflect on teaching methods and strategies: Teachers will reflect on whether the methods and strategies used in the teaching process are effective. For example, they may think about which teaching methods are more likely to stimulate students' interest in learning, which strategies are more effective in helping students understand set concepts, etc. Through reflection, teachers can continuously optimize the teaching methods and strategies and improve the teaching effect.

4) Prepare an improvement plan: Based on the results of the teaching review, the teacher will prepare an improvement plan. This may include adjusting teaching content, improving teaching methods, and providing more practical opportunities. The purpose of the improvement program is to better meet the learning needs of students and help them better grasp the set concept.

5) Share and exchange experiences: Teachers also share and exchange teaching experiences with other teachers. By sharing successful teaching cases and discussing problems and challenges in the process of teaching, teachers can learn from each other and make progress together so as to continuously improve their teaching level and ability.

In general, in the process of teaching review, the main tasks of teachers are to collect and analyze feedback, evaluate the achievement of teaching objectives, reflect on teaching methods and strategies, prepare improvement plans, and share and exchange experiences. These tasks are helpful for teachers to fully understand the teaching effect, optimize the teaching strategy and improve the teaching quality.

2. The role of students.

1) Provide feedback: Students can provide feedback to teachers about the teaching process. This includes feedback on their level of understanding of set concepts, clarity of class presentation, adaptability of teaching methods, and so on. Student feedback is crucial for teachers to improve teaching mode.

2) Participate in the discussion: Students can actively participate in the discussion during the teaching review session. They can put forward their own doubts or difficulties in understanding the concept of set, and communicate and discuss with teachers or other students. By participating in discussions, students can gain a deeper understanding of set concepts and exercise their thinking and presentation skills.

3) Assess your own learning: Students can take advantage of the opportunity for teaching reviews to assess their own learning outcomes. They can review their performance in the learning process of set concepts, think about their progress and shortcomings, and make a learning plan accordingly.

4) Make suggestions: Students can make suggestions to teachers based on

their own learning experience. These suggestions can relate to teaching content, teaching methods, classroom management and so on. Students' suggestions help teachers to improve teaching and improve teaching effect.

5) Reflect learning strategies: During the teaching review process, students can reflect on their own learning strategies. They can think about which learning methods are more effective for learning set concepts and which methods need to be improved. By reflecting and adjusting learning strategies, students can learn set concepts more efficiently.

In general, in the teaching review process, students can actively participate in teaching review by providing feedback, participating in discussions, evaluating their own learning, making suggestions and reflecting on learning strategies, etc., to promote their own learning and teachers' teaching improvement.

Instructional media

1. China People's Education Press textbooks and PowerPoint.
2. Open online courses
3. Video on the web platform

Measurement and evaluation

1. The Practicum Evaluation Form was used to assess the students’ mastery of the course.
2. Observation forms were used to assess students’ participation.

Assessment Form for the Validity of Lesson Plan

Research topic: Using cooperative learning model to improve mathematics logic ability for senior high school students**.**

Objectives:

1: To use cooperative learning model to enhance mathematics conceptual understanding ability for senior high school students.

2: To compare students' mathematics conceptual understanding ability before and after the implementation based on cooperative learning model.

Directions:

Please assess the congruence between components of lesson plan based on cooperative learning model by putting √ in the box according to the following criteria.

Rating is +1. There is an opinion that "Consistent to relevant. "

Rating is 0. There is an opinion that "Not sure it consistent to relevant. "

Rating is -1. There is an opinion that "Inconsistent with relevant. "

No.	Questions	Assessment results			suggestion
		+1	0	- 1	
1	The teaching content is related to the learning objectives.				
2	The learning objectives and themes are aligned.				
3	The learning activities are related to cooperative learning model.				
4	Assignment of work is related to the topic of study.				
5	There are a variety of assessments related to learning objectives.				
6	Show the actions related to the subjects.				
7	Measurement and evaluation related to objectives				

Lesson Plan 2

Contents

Basic relationships between sets

Objective

Part 1: To use cooperative learning model to improve mathematics logic deduction ability for senior high school students.

Part 2**:** To compare students' mathematics logic deduction ability before and after the implementation based on cooperative learning model.

The researchers conducted the research in the following order:

Part 1: To use cooperative learning model to improve mathematics logical deduction ability for senior high school students.

1. Promote deep understanding: Mathematical logical reasoning is not only about memorizing formulas and solving steps, but also requires a deep understanding of mathematical concepts, principles and theorems. In cooperative learning, students need to discuss mathematical problems together, explain and elaborate their understanding, and the interactive process helps to deepen the understanding and application of mathematical knowledge, so as to improve the logical reasoning ability.

2. Enhance problem-solving ability: The core of mathematical logic deduction ability lies in problem solving. The cooperative learning model encourages students to face complex mathematical problems through teamwork, develop solutions together and verify their correctness. This process not only exercises students' logical reasoning skills, but also develops their problem-solving strategies, innovative thinking and critical thinking.

3. Promote diverse thinking: Each student can contribute their own unique perspective and way of thinking in cooperative learning, and the diverse exchange of ideas can inspire new inspiration and ideas. By listening to others' opinions, questions, and discussions, students can learn to look at problems from different perspectives, broaden the boundaries of thinking, and thus improve the flexibility and comprehensiveness of logical deduction.

4. Improve communication skills: In cooperative learning, students need to express their own ideas clearly, but also listen to and understand the opinions of others. This communication process not only contributes to mathematical problem solving, but also improves students' oral and written communication skills. Good communication skills are an integral part of the logical reasoning process as they help students effectively communicate and validate their ideas.

To sum up, it is of great significance to use cooperative learning model to improve the mathematical logical deduction ability of senior high school students. It not only helps students achieve better results in mathematics subjects, but also cultivates their comprehensive qualities such as critical thinking, problem-solving ability, diversified thinking, and communication skills.

Unit 2. Basic relationships between sets (4 hours)

Step 1: Role assignment

1. The role of the teacher.

1) Provide clear teaching objectives: First, teachers need to clearly set teaching objectives to ensure that students have a deep understanding of the fundamental relationships between sets. This includes the concepts of inclusion relation, equality relation, subset, proper subset and so on.

2) Design role assignment scheme: According to the teaching content and the characteristics of students, teachers need to design a suitable role assignment scheme. This may include having students to impersonate different sets and demonstrate the relationships between sets through interaction.

3) Assign specific roles and tasks: Teachers will assign designed roles and tasks to students. This needs to take into account students' abilities, interests and engagement and ensure that each student has gains in their role.

4) Provide guidance and support: In the process of role assignment, teachers need to provide necessary guidance and support to students. This may include explaining concepts, answering questions, offering advice, etc. Teachers need to ensure that students can successfully complete the task and learn from it.

5) Monitor and evaluate the effect of role assignment: In the process of role assignment, teachers need to monitor the performance of students and evaluate the effect of role assignment. If problems or deficiencies are found, teachers need to adjust the role-assignment plan in time to ensure the teaching effect.

6) Offer summary and feedback: At the end of the role assignment, the teacher is required to provide summary and feedback. This includes a review of the student's performance in the role-assignment process, an assessment of the level of understanding of basic relationships between sets, and suggestions for further learning.

Through effective role assignment, teachers can help students better understand the basic relationships between sets, increase students' engagement and interest in learning, and also provide students with opportunities to demonstrate their abilities.

2. The role of students.

1) Clarify individual roles: Students need to have a clear understanding of their roles and tasks. This may include acting as a particular set, analyzing relationships between sets, or taking on a particular learning task.

2) Prepare relevant content: Depending on the role assigned, students are expected to actively prepare and research relevant content. For example, if playing a particular set, students need to understand the definition of that set, its properties, and its relationship to other sets.

3) Participate in interactions and discussions: Students need to be actively involved in classroom interactions and discussions. This may include working with other students to demonstrate relationships between sets, participate in class debates, or discuss applications of set theory.

4) Provide reflection and summary: After completing the role tasks, students need to reflect on their own learning process and outcomes. This includes assessing the understanding of relationships between sets, thinking about strategies and approaches to solving problem.

5) Accept feedback: Students need to accept feedback from teachers and fellow students. This helps us to know our strengths and weaknesses in understanding set concepts so as to adjust learning strategies and improve learning methods.

By actively participating in the role assignment process, students can gain a deeper understanding of the fundamental relationships between sets and improve their learning effectiveness and engagement. At the same time, it is also a good opportunity to show the ability of improving teamwork and communication skills.

Step 2: Task setup

1. The role of the teacher.

1) Provide clear teaching objectives: First of all, teachers need to clearly set teaching objectives and determine which basic relationships between sets should be mastered by students, such as union, intersection, complement, subset, etc. This will provide clear guidance for setting up the task.

2) Design hierarchical tasks: Teachers will design a series of hierarchical tasks to suit different learning levels and understanding abilities of students. Tasks can range from simple to complex, from concrete to abstract, and gradually guide students to understand and grasp the relationships between sets.

3) Determine the specific content of the task: The teacher will clarify the specific content and requirements of each task, such as analyzing the relationship between a given set, constructing a specific set example, and solving problems

related to the set. Make sure students are clear about the objectives and requirements of the assignment.

4) Offer the necessary resources and support: In order to help students complete the task, the teacher will provide the necessary resources and support. This may include textbooks, reference books, online resources, problem-solving tools, etc. Teachers will also provide necessary guidance and answer students' questions to ensure that students can successfully complete the task.

5) Set up the time and way to complete the task: The teacher will set up the time and way to complete the task such as individual completion or group work, class completion or after-class completion. This will help students to arrange their time reasonably and choose a suitable way of study.

6) Evaluate the effectiveness and feasibility of the task: After setting the task, the teacher needs to evaluate the effectiveness and feasibility of the task. This will help teachers to know whether the difficulty of the task is moderate and whether it can stimulate students' learning interest and motivation so as to adjust the task setting in time.

Through careful design and setting of tasks, teachers can guide students to gradually grasp the basic relationship between sets, and cultivate students' logical thinking ability and problem-solving ability. At the same time, task setting is also an important means to promote students' active learning and exploration.

2. The role of students.

1) Understand task requirements: Students need to listen carefully to the teacher's explanation and understand the specific requirements of the task. This includes the goal of the task, the knowledge required to master, the way to complete the task and the deadline.

2) Participate in task discussion: In the task setting stage, students usually have an interactive discussion with teachers to raise their understanding and questions about the task. Such discussions help to clarify the task requirements and ensure that students have an accurate understanding of the task.

3) Make a study plan: According to the requirements of the task and their actual situation, students need to make a reasonable study plan. This includes determining the time of study, selecting the appropriate learning resources and methods, and planning the steps of task completion.

4) Take the initiative to seek help: Students need to take the initiative to seek help if they encounter problems or confusion in the process of the completion of tasks. This can be done by asking teachers, or by asking classmates for help or

discussion. Actively seeking help can help solve problems and improve learning efficiency.

5) Prepare to complete the task: After defining the task requirements and making a study plan, students need to start preparing to complete the task. This may include reviewing relevant knowledge points, gathering necessary information, and conducting exercises or experiments, etc.

By actively participating in the process of task setting and completion, students can better understand and grasp the basic relationships between sets, and improve learning and problem-solving skills. At the same time, it is also a good opportunity to cultivate independent learning, cooperative learning and critical thinking.

Step 3: Group discussion

1. The role of the teacher.

1) Organize and guide the discussion: The teacher first needs to clearly define the topic and goal of the discussion, and ensure that students can discuss the basic relationships between the sets. In the process of discussion, teachers should always pay attention to the progress of the discussion to ensure that the direction of the discussion is correct and does not deviate from the topic.

2) Provide necessary support: If students encounter difficulties or questions during the discussion, teachers should provide necessary support and help in a timely manner. This may include answering students' questions, providing relevant mathematical knowledge and methods, and guiding students to in-depth thinking.

3) Encourage active participation: In order to make group discussion more effective, teachers should encourage students to actively participate in the discussion and express their own opinions. For active students, teachers should give timely recognition and praise, stimulate the enthusiasm of other students to participate.

4) Observe and record student performance: During the discussion, the teacher should carefully observe and record the student's performance. This helps to understand how well students have mastered the fundamental relationships between sets as well as how they think and express themselves in discussions.

In short, in the group discussion, teachers should play the role of organizer, guide, supporter and evaluator to ensure the effectiveness and depth of the discussion, and help students better understand and grasp the basic relationship between sets.

2. The role of students.

1) Active participation in discussion: Students should actively participate in group discussions and take the initiative to express views and opinions. They should be prepared with examples, questions, or reflections related to the fundamental relationships between the sets and share them with the group members.

2) Cooperation and mutual assistance: Group discussion is a process of cooperation and mutual assistance. Students should work with group members to solve problems and explore relationships between sets. They can ask each other questions, answer questions, and find answers together.

3) Recording and organizing the discussion: During the discussion, students can play the role of note-taker, recording the important ideas, examples and conclusions of the discussion. This helps them to review and summarize the discussion and deepen their understanding of the fundamental relationships between the sets.

4) Thinking and asking questions: Students should think positively during the discussion and ask questions about the relationships between sets. Through questions and answers, they can further clarify concepts and deepen their understanding of relationships between sets.

5) Listening to and respecting the views of others: Group discussion is a multi-interactive process, and students should learn to listen to and respect the views of others. They should listen carefully to the panelists, understand their points of view, and try to communicate and discuss with them.

6) Summarizing and sharing learning results: After the discussion, students can summarize the discussion content together with the group members and share their learning results. They can sort out the key points and difficulties in the discussion and share and communicate with other groups in the class.

By actively participating in group discussions, students can better understand and grasp the fundamental relationships between sets, while improving their ability to cooperate, communicate, and solve problems.

Step 4: Result report

1. The role of the teacher.

1) Clear reporting requirements: Teachers first need to clarify the specific requirements of the results report, including the content, format, time limit, etc. This helps students understand the purpose and framework of the report so that they can prepare it in a targeted way.

2) Providing guidance and support: Teachers should provide necessary

guidance and support to students in the process of preparing the report. This can include helping students organize their thoughts, answering questions, providing information or suggestions. At the same time, teachers should also encourage students to participate actively to improve their self-confidence and expression skills.

3) Organizing reporting activities: In the reporting of results, teachers need to organize students to report. This can include arranging the order of reports, the venue and equipment to provide reports, and ensure the smooth running of reports, etc. At the same time, teachers should also encourage interaction and communication among students to promote knowledge sharing and understanding.

4) Evaluation and feedback: After the student completes the report, the teacher needs to evaluate and give feedback on the report. The evaluation can include the evaluation of students' report content, expression ability, thinking logic and so on. Feedback points out the student's strengths and weaknesses, and provides suggestions for improvement. This helps students to understand their own learning situation and further improve the learning effect.

5) Summary and expansion: After the result report, teachers need to summarize and expand the whole activity. Summary can summarize the student's main ideas and findings, emphasize the importance and application of fundamental relationships between sets; Extension can guide students to further think and explore relevant problems, and cultivate their innovative thinking and problem-solving skills.

In conclusion, in the results reporting process, teachers need to play the role of mentor, organizer, evaluator and extender to ensure the smooth progress of the report and the effective presentation of students' learning results.

2. The role of students.

1) Preparing the content of the report: First of all, students need to carefully prepare the content of the report according to the guidance and requirements of the teacher. This includes reviewing and understanding the fundamental relationships between sets, organizing and analyzing the learning material, and conceiving the structure and logic of the report.

2) Organizing and presenting learning outcomes: Students need to organize and aggregate the knowledge and insights they gain in the process of learning the fundamental relationships between sets. This may include definitions, properties, examples, steps and ideas for solving the problem. In the report, students need to clearly demonstrate their learning results and use supporting materials such as charts, illustrations, examples to help explain and illustrate.

3) Oral presentation: Students are required to offer oral presentations in a predetermined order and schedule. During the presentation, students are expected to articulate their views and insights and use appropriate language and terminology to explain and illustrate the fundamental relationships between sets. At the same time, students also need to answer questions that teachers and classmates may have.

4) Receiving evaluation and feedback: At the end of the presentation, students need to receive evaluation from teachers and feedback from classmates. The assessment may include the answers to the teacher's questions, the ability to understand and apply the content of the report, and so on. Feedback may include students' opinions and suggestions on the content, presentation, logical structure, etc.

5) Summarizing and improving effect: Finally, students need to summarize the experience and lessons learned throughout the reporting process, and make improvements based on feedback. This may include improving the logic and structure of reports, improving presentation skills, deepening understanding of fundamental relationships between sets, and so on.

Through the result reporting process, students can better demonstrate their learning results and understanding depth, and also improve their expression skills, thinking logic and problem-solving skills.

Step 5: Teaching comment

1. The role of the teacher.

1) Review of teaching objectives: Teachers should first review the teaching objectives of this lesson to evaluate whether the expected teaching effect has been achieved. This helps the teacher to understand the students' understanding and application of the basic relationships between sets.

2) Analysis of student performance: Teachers need to analyze students' performance in the result reporting process, including their report content, expression ability, thinking logic and other aspects. This helps teachers to understand students' learning situation and existing problems, and provides targeted guidance for subsequent teaching.

3) Summarizing teaching experience: Teachers need to summarize the experience and lessons in the teaching process, including teaching methods, teaching organization, teaching materials and so on. This will help teachers optimize teaching strategies and improve teaching results.

4) Providing feedback and suggestions: Teachers need to provide feedback

and suggestions to students, point out their problems and shortcomings in the process of learning the basic relationships between sets, and provide suggestions for improvement. This helps students to understand their own learning situation and further improve the learning effect.

5) Planning subsequent teaching: Finally, teachers need to plan subsequent teaching content and teaching methods to ensure that students can fully grasp the basic relationships between sets and lay a solid foundation for subsequent learning.

Through the teaching review, teachers can reflect and summarize the whole teaching process, find the existing problems and shortcomings, and take corresponding measures to improve and optimize. This is helpful to improve the teaching level of teachers and promote the all-round development of students.

2. The role of students.

1) Review content: Students should review the basic relationships between sets learned in this lesson, including the concepts of subsets, proper subsets, equality of sets, and empty sets, as well as their application to practical problems. This helps to consolidate students' understanding and lays the foundation for subsequent learning.

2) Reflect on the learning process: Students need to reflect on their own learning process, including the difficulties and challenges encountered in understanding the fundamental relationships between sets, as well as the strategies and methods employed in the learning process. This helps students identify their shortcomings and look for the ways to improve.

3) Provide teaching feedback: Students can provide teaching feedback to teachers, including opinions and suggestions on teachers' teaching methods, teaching organizations, teaching materials, etc. Students can put forward their views and suggestions on teaching from their own point of view to help teachers improve teaching methods and improve teaching results.

4) Participate in teaching evaluation: Students can also participate in teaching evaluation to assess their own learning outcomes and performance. This helps students understand their own learning status, identify their own shortcomings, and set follow-up learning goals.

5) Plan learning contents: Finally, students need to plan the content and direction of subsequent learning to ensure that they can fully grasp the basic relationships between sets and prepare for subsequent learning.

Through the teaching review session, students can engage more deeply in the learning process, reflect on their own learning strategies and methods, provide teaching feedback, and participate in teaching evaluation. This helps students to improve their overall learning effectiveness and ability.

Instructional media

1. China People's Education Press textbooks and PowerPoint.
2. Open online courses
3. Video on the web platform

Measurement and evaluation

1. The Practicum Evaluation Form was used to assess the students' mastery of the course.
2. Observation forms were used to assess students' participation.

Assessment Form for the Validity of Lesson Plan

Research topic: Using cooperative learning model to improve mathematics logic ability for senior high school students

Objectives:

1: To use cooperative learning model to enhance mathematics logical deduction ability for senior high school students.

2: To compare students' mathematics logical deduction ability before and after the implementation based on cooperative learning model.

Directions:

Please assess the congruence between components of lesson plan based on cooperative learning model by putting √ in the box according to the following criteria.

Rating is +1. There is an opinion that "Consistent to relevant. "

Rating is 0. There is an opinion that "Not sure it consistent to relevant. "

Rating is -1. There is an opinion that "Inconsistent with relevant. "

No.	Questions	Assessment results			suggestion
		+1	0	- 1	
1	The teaching content is related to the learning objectives.				
2	The learning objectives and themes are aligned.				
3	The learning activities are related to cooperative learning model.				
4	Assignment of work is related to the topic of study.				
5	There are a variety of assessments related to learning objectives.				
6	Show the actions related to the subjects.				
7	Measurement and evaluation related to objectives				

Lesson Plan 3

Contents

Basic operations of sets

Objective

Part 1: To use cooperative learning model to improve mathematics critical thinking ability for senior high school students.

Part 2: To compare students' mathematics critical thinking ability before and after the implementation based on cooperative learning model.

The researchers conducted the research in the following order:

Part 1: To use cooperative learning model to improve mathematics critical thinking ability for senior high school students.

Firstly, promote multi-dimensional thinking and in-depth understanding.

Multiple perspectives: The cooperative learning model encourages students to look at math problems from different perspectives, and through group discussions, students are exposed to a variety of perspectives and solutions, thus broadening the boundaries of thinking.

In-depth discussion: In cooperative learning, students are required to engage in in-depth analysis and discussion of their own and others' viewpoints, which promotes a deep understanding of mathematical concepts, principles and theorems and develops the thinking skills necessary for critical thinking.

Secondly, strengthen logical reasoning and argumentation ability.

Logical deduction training: Mathematics is a discipline that emphasizes logical reasoning. In the process of cooperative learning, students need to use logical deduction to analyze and solve problems, and gradually establish a rigorous logical thinking system.

Argumentation enhancement: Students need to learn to construct sound arguments in group discussions, evaluate the reliability and validity of evidence, and draw conclusions based on it. This process significantly improves students' argumentation ability and critical thinking level.

Thirdly, stimulate innovative thinking and critical spirit.

Challenge conventional wisdom: Cooperative learning encourages students to challenge conventional wisdom and problem-solving methods to come up with novel ideas and solutions. This innovative atmosphere helps to cultivate students' innovative thinking and critical spirit.

Critical evaluation: Within a group, students need to learn to critically evaluate the ideas of others and their own, identify strengths and weaknesses, and make suggestions for improvement. This process exercises students' critical thinking skills.

Fourthly. Improve teamwork and communication skills.

Teamwork: Cooperative learning emphasizes the importance of teamwork. In small groups, students need to support each other and work together to complete tasks. This kind of teamwork experience helps to cultivate students' spirit of cooperation and sense of teamwork.

Communication skills: In the process of cooperative learning, students need to express their own ideas clearly, but also learn to listen to and understand the opinions of others. This effective communication mechanism promotes mutual understanding and trust among students, and also provides a good communication environment for the cultivation of critical thinking.

To sum up, it is significant to use cooperative learning model to improve senior high school students' mathematical critical thinking ability by promoting multi-dimensional thinking and deep understanding, strengthening logical reasoning and argumentation ability, stimulating innovative thinking and critical spirit, and improving teamwork and communication ability.

Unit 3. Basic operations of sets (4 hours)

Step 1: Role assignment

1. The role of the teacher.

1) Clarify roles and tasks: First, teachers need to clarify their own responsibilities and tasks in the role arrangement, as well as the roles and responsibilities of students in the process. This helps to ensure the smooth running of the teaching process while developing students' ability to learn independently and cooperatively.

2) Analyze student characteristics: Teachers need to fully understand the characteristics of students' personalities, interests, learning styles, etc., in order to fully consider these factors in the role arrangement. For example, for students who like hands-on practice, they can be arranged to conduct experimental operations or demonstrations. For expressive students, oral presentations or explanations can be arranged.

3) Design suitable roles and tasks: According to the teaching content and the characteristics of students, teachers need to design suitable roles and tasks. These roles and tasks should be able to stimulate students' interest and motivation in learning while understanding and mastering the knowledge and skills of ensemble basic operations. For example, a group task can be designed in which students play different roles in the group and work together to complete an exercise or project of set arithmetic.

4) Provide guidance and support: Teachers are expected to provide necessary guidance and support to students during the course of the role arrangement. This includes explaining task requirements, providing learning resources, answering difficult questions, and more. At the same time, teachers also need to pay attention to the learning process and performance of students, and give timely feedback and suggestions to help them better complete the role tasks.

Through reasonable role arrangement, teachers can stimulate students' learning interest and enthusiasm, and improve their independent learning and cooperative learning ability so as to better achieve the teaching goal.

2. The role of students.

Students need to listen carefully to the teacher's explanation of roles and tasks, understand their role positioning in the class and the tasks they need to complete. This includes understanding the role in the group, the specific requirements of the task, and how to collaborate with other students.

1) Prepare relevant materials and tools: According to the task requirements, students should prepare relevant learning materials and tools. This may include textbooks, notebooks, calculators, or other instruments. Students will better complete the tasks by applying tools and materials.

2) Participate in learning and discussion: Students need to be actively involved in learning and discussion during the process of the role arrangement. This may include expressing one's own opinions in the group, proposing problems or solutions, and discussing with other students. Through active participation, students can better understand the knowledge and skills of set basic operations, and improve their learning and thinking skills.

3) Complete the task carefully: Students need to complete the task assigned by the teacher carefully. This may include completing exercises, writing reports, giving oral presentations, etc. In the process of completing the task, students need to follow the task requirements, seriously think and solve problems, and ensure the quality and accuracy of the task.

By actively participating in the process of role arrangement, students can better understand the knowledge and skills of ensemble basic arithmetic, improve their learning ability and thinking ability, and provide useful feedback and suggestions for teachers' teaching.

Step 2: Task setup

1. The role of the teacher.

1) Build teaching objectives: First of all, teachers need to clearly determine the teaching objectives of this lesson, that is, the knowledge points and skills of the basic operation of the collection that students need to master. This helps teachers to develop targeted tasks to ensure that students can achieve the expected learning results during the completion of the tasks.

2) Analyze students' actual situation: Before setting tasks, teachers need to fully understand students' actual learning situation, including their knowledge reserve, learning style, interest points, etc. This helps teachers to design tasks that meet students' actual level and stimulate their interest in learning.

3) Design tasks with hierarchy: In order to meet the learning needs of different students, teachers need to design tasks with hierarchy. These tasks can range from simple to complex, from basic knowledge to practical application, and gradually guide students to deeply understand and master the basic operation of sets.

4) Ensure the tasks to be practical: In order for students to better understand and apply set basic operations, teachers need to ensure that the designed tasks have practical meaning. This can be done by introducing life examples, practical problems, or connections to other subject areas.

5) Provide necessary guidance and support: Teachers need to provide necessary guidance and support for students in the task setting process. This includes explaining task requirements, providing learning resources, answering difficult questions, and more. At the same time, teachers also need to pay attention to the learning process and performance of students, and give timely feedback and suggestions to help them better complete the task.

6) Assess and adjust tasks: Finally, teachers need to evaluate and adjust the tasks. This includes collecting student feedback, observing student performance and behavior, and analyzing task completion. Based on the assessment results, teachers can adjust and optimize the tasks to better meet students' learning needs and developmental goals.

Through setting up the reasonable task, teachers can stimulate students' learning interest and enthusiasm, improve their independent learning and cooperative learning ability, so as to better achieve the teaching goal. At the same time, setting task also helps to cultivate students' thinking ability, analysis ability and problem-solving ability.

2. The role of students.

1) Clear learning objectives: Students should clearly understand the learning objectives of this lesson, that is, the knowledge points and skills of basic arithmetic collection that they need to master. This helps them engage with tasks in a more targeted manner and ensures that their learning process meets the teacher's expectations.

2) Preview and preparation: Before the task is set, students can preview and understand the basic concepts and knowledge points of this lesson. They can consult textbooks, related materials, or online learning resources to prepare for the task.

3) Participating in task discussion: When the teacher proposes a task, students should actively participate in the discussion and understand the requirements and objectives of the task. They can raise their own questions and suggestions, communicate and discuss with teachers and classmates, and ensure a clear understanding of the task.

4) Making a personal learning plan: Students can make a personal learning plan according to their actual situation and learning goals. This can include setting study times, prioritizing tasks, making practice plans, etc., to ensure that students can effectively complete the task.

5) Independent thinking and problem solving: In the process of completing tasks, students need to think and solve problems independently. They can apply the basic computational knowledge and skills they have learned to analyze problems, find solutions, and try to solve problems themselves.

6) Seeking help and cooperation: If students encounter problems or difficulties that are difficult to solve, students should actively seek help, exchange and discuss with classmates or teachers. They can also cooperate with other students to complete tasks and improve their learning results.

By actively participating in the task, students can better understand the learning objectives and task requirements, and improve learning effect and independent learning ability. At the same time, proper tasks can also cultivate their thinking skills, analytical skills and problem-solving skills, lay a solid foundation for future learning and development.

Step 3: Group discussion

1. The role of the teacher.

Group discussion is an important teaching activity in the process of teaching senior high school mathematics, especially the collection of basic operations. In the group discussion session, teachers should do the following:

1) Design discussion topics: Teachers should design targeted discussion topics according to students' learning progress and course requirements. These topics can be a concept of a collection of basic operations, the application of operational rules, or strategies for solving practical problems.

2) Set up group guidance: Teachers should make reasonable groups according to students' learning styles and characteristics. Ensure that there are different levels of students in each group to promote mutual learning and communication. At the same time, the teacher should appoint a leader for each group, who is responsible for organizing and coordinating the discussion within the group.

3) Provide discussion framework: In order to ensure the smooth progress of discussion, teachers can provide students with a discussion framework, including the goal of discussion, problems to be solved, possible solutions, etc. This helps guide the students to have in-depth discussions around the topic and avoid going off topic.

4) Monitor the discussion process: During the discussion, teachers should pay close attention to the discussion of each group to ensure that the discussion is conducted in an orderly and efficient manner. If it is found that the group discussion deviates from the theme are difficulties, the teacher should give timely guidance and help.

5) Encourage active participation: In order to stimulate students' enthusiasm for participation, teachers should encourage each student to actively participate in discussions and express their views and ideas. For students who are timid or unwilling to speak, teachers can give more encouragement and support to help them overcome psychological barriers.

Through the effective organization and guidance of group discussion, teachers can stimulate students' learning interest and enthusiasm, and improve their independent learning and cooperative learning ability. At the same time, group discussions also help to develop students' communication skills, critical thinking and problem-solving skills.

2. The role of students.

1) Participate in discussion: Students should actively participate in group discussions and express their own views and opinions. They can discuss the basic concepts, operation rules, application examples and so on, and share their understanding and thinking.

2) Communicate with students: In the discussion, students need to listen to other students, respect their views, and communicate with them actively. By listening and communicating, students can learn about different ways of thinking and problem-solving strategies, and broaden their thinking.

3) Solve problem: Students can take advantage of group discussions to solve problems in the basic operations of sets together. They can work together, explore ways to solve problems, and improve the efficiency of problem solving through mutual help and support.

4) Organize and summarize results: After the discussion, students can organize and summarize the results of the group discussion together. They can summarize the key points and difficulties of the basic operation of the set, sum up the experience and skills of solving the problem, so as to better apply in the subsequent study.

5) Raise questions and confusion: During the discussion, if students encounter questions that they do not understand or are confused, they can raise the problems to the group members or teachers in time. By asking questions and puzzles, students can seek help and answers, and deepen their understanding of the basic operations of sets.

6) Learn from each other: Group discussion provides a platform for students to learn from each other. Students can observe the performance and thinking styles of other students and learn from their strengths and experiences to improve their own learning methods and strategies.

By actively participating in the group discussion, students can deepen their understanding and mastery of the basic operation of sets, improve their thinking ability and problem-solving ability. At the same time, group discussion also helps to cultivate students' teamwork spirit and communication skills, which lays a good foundation for future study and work.

Step 4: Result report

1. The role of the teacher.

1) Prepare a reporting framework: Teachers should prepare a clear reporting framework for students and specify what they are expected to present. This can

include, for example, topics discussed, key findings, approaches to solving problems, challenges encountered, and how to solve them.

2) Listen to students' report: In the reporting of results, teachers should patiently and carefully listen to each student's report. This not only helps teachers to understand the level of understanding of students, but also provides opportunities for students to give feedback.

3) Offer feedback: After the student completes the report, the teacher should give timely and specific feedback. The feedback should focus on students' understanding, expression ability and problem-solving strategies. At the same time, teachers should also give recognition and encouragement to students' efforts and progress.

4) Summarize the report: After listening to all the students' reports, the teacher should summarize and summarize the entire discussion and report session. This can help students review and consolidate what they have learned, and it can also provide a basis for teachers to improve their teaching methods.

5) Clarify the report: If there is confusion or ambiguity in the student's report, the teacher should ask questions and clarify in time. This not only helps students deepen their understanding, but also ensures that all students have a clear understanding of what is being discussed.

6) Lead further discussion: If students raise interesting or valuable questions in the presentation, the teacher can lead the class to further discussion. This can not only stimulate students' interest in learning, but also help them to understand more deeply the concepts and applications of the basic operation of sets.

In general, teachers play the role of facilitator, supporter and evaluator in the process of result reporting. They need to help students present content clearly, listen to and evaluate their debriefs, provide feedback and suggestions, and guide them to further discussion and learning.

2. The role of students.

1) Prepare report content: Before the results report, students need to carefully prepare the report content. They can review the topic and focus of the discussion, organize their own thoughts and findings in the group discussion, and prepare relevant examples and exercises. Make sure the report is clear, and highlights the key points and highlights.

2) Present Learning results: In the presentation session, students need to present learning results to the class. They can demonstrate their understanding and mastery through oral presentations, presentation of slides, and sharing of problem-

solving processes. This can include the basic concept of the set, the operation rules of the set, the application examples and so on.

3) Share experiences and strategies: During the process of presentation, students can also share their own experiences and strategies in group discussions. They can tell stories about how they solved problems, overcame confusion, and worked with others. This can not only promote communication and learning within the class, but also help other students get inspiration and reference.

4) Answer questions and interact: At the end of the presentation, students are expected to answer questions and interact with their classmates. This can help students further clarify and understand their own learning outcomes while providing students with the opportunity to demonstrate the ability to change and express themselves.

5) Summarize performance: After the debriefing session, students also need to reflect and summarize their performance. They can review their reporting process and think about their performance in terms of presentation, understanding, problem solving, etc., and areas that need to be improved. This helps students to continuously improve their learning ability and comprehensive quality.

In general, in the results reporting session, students need to demonstrate their learning results and experiences, communicate and interact with classmates, and reflect and summarize their performance. By participating in the results reporting process, students can deepen their understanding and mastery of the basic operation of sets, improve their ability to express themselves and solve problems, and lay a good foundation for future study and work.

Step 5: Teaching comment

1. The role of the teacher.

1) Collect students' feedback: Teachers can collect students' feedback on the teaching content, teaching method, learning difficulty and other aspects through questionnaire survey, oral inquiry or group discussion. This helps teachers to understand students' learning needs and difficulties, and provides a basis for subsequent teaching adjustment.

2) Evaluate students' learning results: Teachers can assess students' mastery of basic set operations through assignments, tests, or exams. This can include students' understanding of basic concepts, mastery of operation rules, and solution of application examples. At the same time, teachers also need to pay attention to the way of thinking and problem-solving strategies displayed by students in the learning process.

3) Reflect on teaching effectiveness: Teachers need to reflect on their teaching effectiveness based on student feedback and evaluation results. They can think about whether the teaching method is appropriate, whether the teaching content is clear enough, and whether the teaching progress is appropriate. At the same time, teachers also need to pay attention to whether they give full play to students' initiative and creativity in teaching, and whether they cultivate students' mathematical thinking ability and problem-solving ability.

4) Develop an improvement plan: On the basis of reflecting on the teaching effect, teachers need to develop an improvement plan. They can adjust the teaching content and methods according to students' learning needs and difficulties, and strengthen students' practical exercises and applied training. At the same time, teachers also need to pay attention to the personalized learning needs of students, and provide different teaching tools or advanced content to meet the different needs of students.

5) Exchange and share with other teachers: Teachers can also exchange and share teaching experience with other teachers. This can promote cooperation and mutual learning among teachers and improve teaching effectiveness and quality.

In general, in the teaching review process, teachers need to comprehensively evaluate students' learning effect and their own teaching effect, collect students' feedback and suggestions, and reflect on and improve their own teaching methods and contents. At the same time, they also need to exchange experiences and share ideas with other teachers to jointly improve the effectiveness and quality of teaching.

2. The role of students.

1) Provide feedback: Students can provide their feedback to the teacher on the content, teaching methods, learning difficulty, etc. They can share their feelings and experiences in the learning process, as well as their opinions and suggestions on teaching content and methods, by filling out questionnaires and participating in oral discussions or group discussions.

2) Evaluate your learning performance: Students can self-evaluate their mastery of basic set operations. They can review their learning process to see if they understand the basic concepts, master the rules of operations, and apply this knowledge to solve practical problems. In addition, they can objectively assess their learning by completing self-tests and participating in classroom quizzes or exams.

3) Participate in discussion and sharing the opinions: In the teaching review section, students can actively participate in discussions and share their learning experiences and problem-solving strategies. They can communicate with their

classmates about the difficulties and solutions encountered in the learning of set basic operations, and share their thinking process and experience in solving problems. Such discussions help to promote communication and cooperation within the class, and help students gain a deeper understanding and mastery of basic set operations.

4) Ask questions and ask for help: If students have questions or confusion in learning the basic operation of sets, they can ask the teacher for help in the teaching comment section. Teachers can give answers and guidance to students' specific problems, help students solve learning problems, and improve learning results.

In general, students can actively participate in the teaching review by providing feedback, evaluating their own learning effects, participating in discussions and sharing the opinions, and asking questions and seeking help from teachers. This not only helps promote communication and cooperation within the class, but also helps teachers better understand students' learning needs and difficulties, and provides a basis for subsequent teaching adjustment.

Instructional media

1. China People's Education Press textbooks and PowerPoint.
2. Open online courses
3. Video on the web platform

Measurement and evaluation

1. The Practicum Evaluation Form was used to assess the students’ mastery of the course.
2. Observation forms were used to assess students’ participation.

Assessment Form for the Validity of Lesson Plan

Research topic: Using cooperative learning model to improve mathematics critical thinking ability for senior high school students

Objectives:

1: To use cooperative learning model to enhance mathematics critical thinking ability for senior high school students.

2: To compare students' mathematics critical thinking ability before and after the implementation based on cooperative learning model.

Directions:

Please assess the congruence between components of lesson plan based on cooperative learning model by putting √ in the box according to the following criteria.

Rating is +1. There is an opinion that "Consistent to relevant. "

Rating is 0. There is an opinion that "Not sure it consistent to relevant. "

Rating is -1. There is an opinion that "Inconsistent with relevant. "

No.	Questions	Assessment results			suggestion
		+1	0	- 1	
1	The teaching content is related to the learning objectives.				
2	The learning objectives and themes are aligned.				
3	The learning activities are related to cooperative learning model.				
4	Assignment of work is related to the topic of study.				
5	There are a variety of assessments related to learning objectives.				
6	Show the actions related to the subjects.				
7	Measurement and evaluation related to objectives				

Appendix D
The Results of the Quality Analysis of Research Instruments

The Measurement Criteria for Mathematics Logic Ability

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Conceptual understanding	1. The concept of sets	Accurately understand the relationship between the elements inside a set, such as whether they are mutually exclusive or ordered, which reflects a deep insight into the internal structure of the concept of a set.	Moderately understand the boundaries of a set, that is, the ability to judge which elements belong to the set and which do not.	Hardly understand the identification of the common features or attributes of the elements in a set, which is fundamental to understanding the concept of a set.

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Conceptual understanding	2. The relationship between elements and sets	Accurately distinguish the relationship between elements and sets, judge whether elements belong to a certain set, and deeply analyze the status and role of elements in the set, as well as the correlation with other elements.	Moderately determine whether an element belongs to a set, and may not be clear about the specific role and relevance of the element in the set.	Hardly understand the relationship between elements and sets, difficult to judge whether elements belong to sets, and hard to analyze the role and relevance of elements in sets.

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Conceptual understanding	3. The characteristics of the elements in the set concept	Accurately understand the common properties and properties of the elements in a set, articulately define and distinguish the set, and accurately identify and apply these features in complex situations.	Moderately understand certain characteristics of the elements in the set, and may not be able to or grasp these characteristics, or may have some difficulty in applying them.	Hardly understand the characteristics of the elements in the set, difficultly to describe or apply these characteristics, and may even be confused about the basic concept of the set.

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Conceptual understanding	4. Classification of set concepts	Accurately classify sets, clearly understand the boundaries and relationships between various sets, and flexibly classify in complex situations.	Moderately understand the classification of sets, and may lack accuracy and depth of classification, or have some difficulty making appropriate classifications in the face of complex situations.	Hardly understand the classification of sets, have difficulty classifying them based on the characteristics of elements, or easily confuse the boundaries of different sets when classifying them.

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Logical deduction	1. Master the symbols and representations of subsets and proper subsets	The relationship and transformation between subsets and proper subsets can be explained clearly, and complex set relations can be analyzed quickly and correct conclusions can be given. The concepts of subsets and proper subsets flexibly solve various mathematical problems.	Be able to understand and distinguish the basic concepts of subsets and proper subsets, and moderately apply these concepts in simple scenarios. For the wider application of subsets and proper subsets in advanced mathematics or in practical problems, it is not deep enough.	The definition of subsets and proper subsets cannot be accurately distinguished, and there is a lack of clear understanding of the relationship and differences between them. It is not possible to correctly determine whether a set is a subset or proper subset of another set.

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Logical deduction	2. Use a coincidence to represent subsets and proper subsets	The use of symbols has reached a level of automation, even when dealing with very complex or abstract set problems.	Use symbols to define subsets and proper subsets and apply them correctly in moderate cases.	Even if the basic symbolic representation method is known, confusion or error often occurs in practice.

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Critical thinking	1. The concept and nature of intersection and union	Use relevant symbols accurately and reflexively, whether simple or complex set problems, quickly and accurately apply " ∩ " to indicate the intersection and " ∪ " to indicate the union, without any hesitation or reference.	Be able to understand and apply basic symbols to represent intersection and union, but may encounter some challenges in practical application.	It is almost impossible to apply the relevant symbols correctly. Even in the face of simple set problems, it takes a lot of time to think and understand.

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Critical thinking	2. Intersection and union of two sets	Analyze and answer a simple or complex question quickly and accurately.	Be able to understand and apply the basic concepts of intersection and union, apply them correctly in some situations.	Have an understanding of the basic concepts of intersection and union, but are often mistaken or confused in practical application.

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Critical thinking	3. The significance of the complete set of mathematics	Be able to quickly identify which elements belong to the complete set and which do not, and be able to accurately apply the concept of the complete set to solve problems.	Have a certain understanding of the basic concepts and properties of the complete set, and can be moderately applied in some common situations.	Unfamiliar with the concept of the complete set of mathematics. It is not clear about the definition of the complete set, that is, a set that includes all the objects of study, and it is not well understood about the nature and application of the complete set.

Evaluation items	Evaluation contents	Score and criterion		
		3	2	1
Critical thinking	4. A complement of a set in a complete set	Quickly and accurately find the complement of a given set in another set (usually the complete set).	In common mathematical problems and situations, it is moderate to identify the complement of a given set in a global set and understand the relationship.	When dealing with problems related to complement sets, it is not possible to identify the complement of a given set in the total set.

Evaluation Standard

Score Range	Quality Level
27-30	Strong
23-26	Relatively strong
18-22	General
14-17	Relatively weak
10-13	Weak

Research Title: Using cooperative learning model to improve mathematics logic ability for senior high school students

Directions:

Please assess the congruence between components of lesson plan based on

cooperative learning by putting √ in the box according to the following criteria.

Rating is +1. There is an opinion that "Consistent to relevant. "

Rating is 0. There is an opinion that "Not sure it consistent to relevant. "

Rating is -1. There is an opinion that "Inconsistent with relevant. "

The Scoring Criteria Analysis of Mathematics Set Course for Expert's IOC

Evaluation Items	Evaluation Content	Expert			IOC Value	conclusion
		1	2	3		
Conceptual understanding (12)	1. The concept of sets	+1	+1	+1	1.00	Suitable for use
	2. The relationship between elements and sets	+1	+1	+1	1.00	Suitable for use
	3. The characteristics of the elements in the set concept	+1	+1	+1	1.00	Suitable for use
	4. Classification of set concepts	+1	+1	+1	1.00	Suitable for use
Logical deduction (6)	1. Master the symbols and representations of subsets and proper subsets	+1	+1	+1	1.00	Suitable for use
	2. Use a coincidence to represent subsets and proper subsets	+1	+1	+1	1.00	Suitable for use
Critical thinking (12)	1. The concept and nature of intersection and union	+1	+1	+1	1.00	Suitable for use
	2. Intersection and union of two sets	+1	+1	+1	1.00	Suitable for use
	3. The significance of the complete set of mathematics	+1	+1	+1	1.00	Suitable for use
	4. A complement of a set in a complete set	+1	+1	+1	1.00	Suitable for use

Appendix E
Certificate of English

BANSOMDEJCHAOPRAYA
RAJABHAT UNIVERSITY

This is to certify that

Mr.Dong Juncan

Achieved BSRU English Proficiency Test (BSRU-TEP) level

B2

Given on 9th August 2022

(Assistant Professor Dr Kulsirin Aphiratvoradej)

Director

Appendix F
Turnitin Plagiarism Check Report

USING COOPERATIVE LEARNING MODEL TO IMPROVE MATHEMATICS LOGIC ABILITY FOR SENIOR HIGH SCHOOL STUDENTS

ORIGINALITY REPORT

6%	2%	3%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to King Mongkut's University of Technology Thonburi Student Paper	1%
2	Lin Li, Yuan Wei, Shuizhen Xiang. "INFLUENCES OF PNF STRETCHING ON PHYSICAL FITNESS IN AEROBIC ATHLETES", Revista Brasileira de Medicina do Esporte, 2023 Publication	1%
3	Boqing Li, Xiaolong Bai, Yongli Zhu. "Study on the Effect of PNF Method on the Flexibility and Strength Quality of Stretching Muscles of Shoulder Joints of Swimmers", Molecular & Cellular Biomechanics, 2021 Publication	1%
4	www.netinbag.com Internet Source	<1%
5	www1.bjgta.org.cn Internet Source	<1%

Chapter 1

ORIGINALITY REPORT

5%	4%	3%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www1.bjgta.org.cn Internet Source	2%
2	"Tutorial for Outline of the Healthy China 2030 Plan", Springer Science and Business Media LLC, 2020 Publication	1%
3	Submitted to Coventry University Student Paper	1%
4	Wei Zou, Chao Wang, Yiwen Luo. "Characteristics and Trends of Medical-Physical Integration Research-Econometric Analysis Based On CNKI Data (1998-2020)", Journal of Physics: Conference Series, 2021 Publication	1%
5	www.ijiet.org Internet Source	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		

Chapter 2

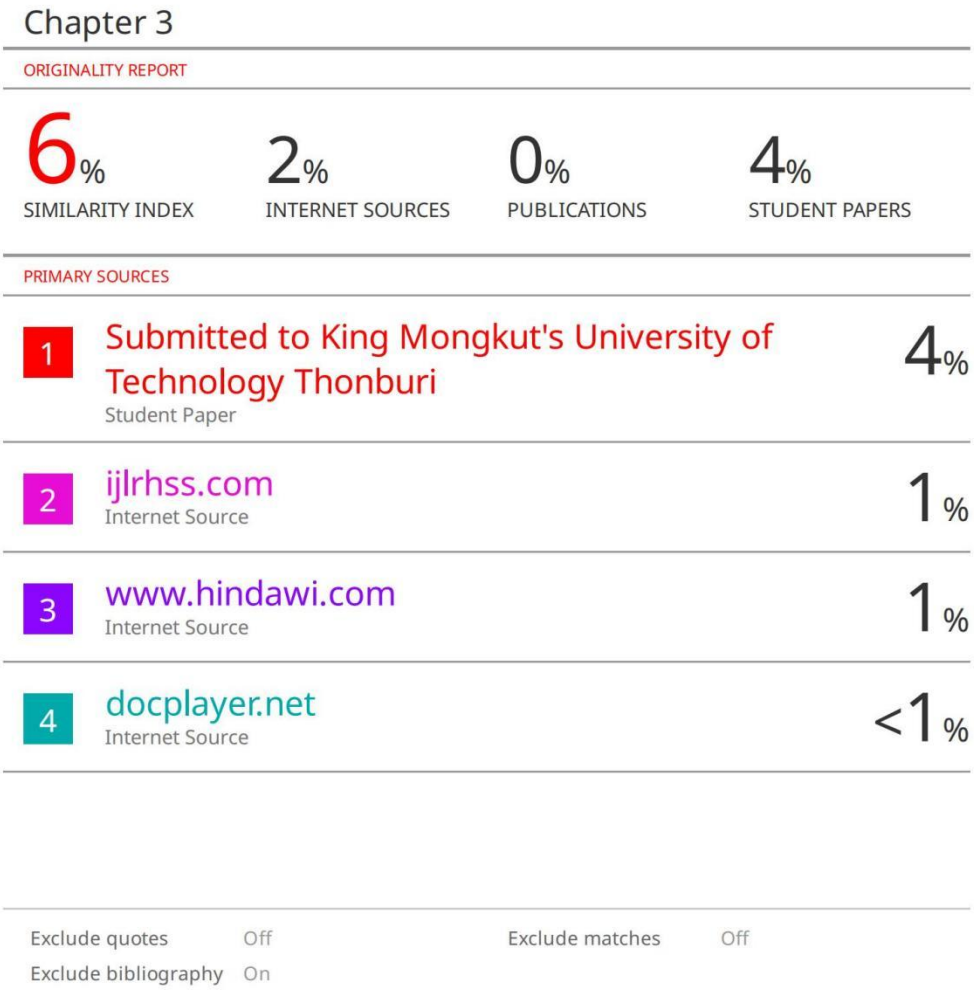
ORIGINALITY REPORT

3%	1%	2%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Boqing Li, Xiaolong Bai, Yongli Zhu. "Study on the Effect of PNF Method on the Flexibility and Strength Quality of Stretching Muscles of Shoulder Joints of Swimmers", Molecular & Cellular Biomechanics, 2021 Publication	1%
2	www.netinbag.com Internet Source	1%
3	Submitted to University of Nottingham Student Paper	<1%
4	Jian Guo, Fan Bu, Shuxiang Guo. "Design of Graphical User Interface for Motor Selection of the Lower Limb Exoskeleton", 2020 IEEE International Conference on Mechatronics and Automation (ICMA), 2020 Publication	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		



Chapter 3

ORIGINALITY REPORT

6%	2%	0%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to King Mongkut's University of Technology Thonburi Student Paper	4%
2	ijlrhss.com Internet Source	1%
3	www.hindawi.com Internet Source	1%
4	docplayer.net Internet Source	<1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		

Chapter 4

ORIGINALITY REPORT

4%	4%	0%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.inceif.org Internet Source	2%
2	mts.intechopen.com Internet Source	1%
3	core.ac.uk Internet Source	1%
4	scholarworks.smith.edu Internet Source	1%

Exclude quotes	Off	Exclude matches	Off
Exclude bibliography	On		

Chapter 5

ORIGINALITY REPORT

7%	0%	6%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Lin Li, Yuan Wei, Shuizhen Xiang. "INFLUENCES OF PNF STRETCHING ON PHYSICAL FITNESS IN AEROBIC ATHLETES", Revista Brasileira de Medicina do Esporte, 2023 Publication	3%
2	Changfeng Ning, Menglu Li, Linna Ge. "The preventive effect of PNF stretching exercise on sports injuries in physical education based on IoT data monitoring", Preventive Medicine, 2023 Publication	1%
3	Submitted to Ventura County Community College District Student Paper	1%
4	Kai Bao, Jie Gao, Xiaomin Zhang, Wen Qi, Xurui Liu, Hao Tian. "The Value of Wearable Sensors in Swimming Flexibility Training under the Background of the Internet of Things", Wireless Communications and Mobile Computing, 2022 Publication	1%

Appendix G

The Document for Accept Research/ Full Paper

MHESI 0643.05/0169

Bansomdejchaopraya
Rajabhat University
1061 Soi Itsaraphap 15,
Itsaraphap Road, Hiranruchi,
Thonburi, Bangkok, Thailand 10600

25th November 2024

Subject: Acceptance Letter

Dear Dong Juncan

We are pleased to acknowledge the submission of your article to The 1st Bansomdejchaopraya National and International Conference (BS2C 2025) under the theme "Synergy of Innovation, Technology and Creativity for Sustainable Prosperity". Following a thorough review process, the anonymous reviewers have highlighted that your paper is highly relevant to the conference theme and is expected to foster meaningful discussions and insights. Based on their recommendations, the Organizing Committee is delighted to inform you that your paper ID: **172-EN-EDU** in the title **"Using cooperative learning model to improve mathematics logic ability for senior high school students"** has been **accepted for oral presentation** on January 17th, 2025 at The 1st Bansomdejchaopraya National and International Conference (BS2C 2025). Additionally, **your work will be published in the BS2C 2025 Proceedings**.

We look forward to your insightful presentation and your active participation in making the conference a success. For more details, please visit the conference website at https://bs2c.bsru.ac.th. If you require any assistance or additional information, do not hesitate to contact the conference secretariat at research@bsru.ac.th.

Yours faithfully,

(Assistant Professor Dr. Kiatikhon Sobhanabhorn)
Director of Research and Development Institute
Bansomdejchaopraya Rajabhat University

1. Introduction

The background of cooperative learning model to improve the ability of mathematical logical ability could be attributed to the promotion of educational reform and the demand of modern society for talent training. Under the background of quality education and intelligent education, mathematics discipline did not simply require students to get high scores, but hoped to cultivate students' comprehensive literacy. Cooperative learning could enable students to form a perfect ability of analysis, summary and problem-solving in the process of cooperative exploration. Cooperative consciousness was the requirement of social development for people, and then fed back to other disciplines to improve students' overall accomplishment (Ren, 2023).

The Ministry of Education issued the "Curriculum Standards for Full Time Compulsory Education (Experimental Draft)" in July 2001 (hereinafter referred as the "Curriculum Standards"). One of the key points of this curriculum reform was to change students' learning methods. The "Curriculum Standards" pointed out that hands-on practice, independent exploration, and cooperative communication were important ways for students to learn. In the basic concept of curriculum standards and the suggestions for curriculum implementation, group cooperative learning had become an important concept (The Ministry of Education, 2001).

With the deepening of education reform, the traditional teaching model has gradually exposed some problems, such as students' lack of initiative, cooperation and communication. In order to change this situation, educators began to explore new teaching modes, among which cooperative learning model had attracted wide attention because of its emphasis on interaction and cooperation. Cooperative learning model not only helped to improve students' learning interest and enthusiasm, but also cultivated students' teamwork and communication ability, so it is widely used in the teaching of various subjects, including mathematics education (Ma, 2023).

In addition, the characteristics of mathematics also provided conditions for the emergence of cooperative learning model. Mathematics was a subject that required logical thinking and reasoning ability. Through cooperative learning model, students could discuss mathematics problems together, exchange problem-solving ideas, and inspire each other, so as to deepen their understanding of mathematics concepts and methods. At the same time, the cooperative learning model could also provide more practical opportunities for students, so that students could exercise their logical thinking ability in the process of solving practical problems (Luo, 2023).

To sum up, cooperative learning model mainly includes the promotion of educational reform, the demand for talent training in modern society and the characteristics of mathematics itself. These factors together promote the emergence of cooperative learning model, and make it become an important way to improve students' mathematical logical thinking ability.

2. Research Objectives

(1) To use cooperative learning model to improve mathematics logic ability for senior high school students.

(2) To compare senior high school students’ mathematics logic ability before and after the implementation based on cooperative learning model.

3. Research Hypotheses (if any)

After implementing cooperative learning model, the students’ mathematics logic ability was improved obviously.

4. Research Methodology

4.1 Research Design

The study period was from March to June 2023 and was divided into the following stages:

(1). In March 2023, three chapters were submitted and defended.

(2). In April 2023, modify and complete the teaching plan, relevant tools and experiments based on cooperative learning model.

(3) The formal research phase was scheduled for May 2023.

(4) In October 2024, the research findings were summarized, the research thesis was completed, and the paper was published.

4.2 Population and Sample

(1) There were 200 senior high school students, No. 2 Senior High School of Panzhou City, Guizhou Province, China, distributed four classes with a class size of 50 students each.

(2) Through a cluster random sampling method, a survey was conducted among 50 students from Class One, Grade One. The class consisted of a mix of high, middle and low lever at No. 2 Senior High School of Panzhou City.

4.3 Research Instrument

Submit the revised curriculum activity plans to 3 experts for review to assess the correctness and completion of factors that can enhance mathematics logic ability for senior high school students.

+1 = Sure that the contents are related to the topics

0 = Not sure that the contents are related to the topics

-1 = The contents are not related to the topics

Table 1 Evaluation results of the course

Using cooperative learning model to improve mathematics logic ability for senior high school students	**Hours**	**IOC**	**Evaluation results**
1) Concept of set	4	1.00	accept
2) Basic relationships between sets	4	1.00	accept
3) Basic operations of sets	4	1.00	accept

The acceptable items must have the IOC values not less than 0.5. The IOC calculated from the validation measures 1.00 each unit.

4.4 Data Collection

The data collection was as follows:

(1) Coordinate with 3 professional scholars experts dispense official document from Bansomdejchaopraya Rajabhat University professional scholar experts and give information about data collection process and research tools: instructional model and checklist form about quality of instructional model for consideration (Index of Objective Consistency: IOC).

(2) Collect data from 3 professional scholar experts and analysis data for consideration (Index of Objective Consistency: IOC).

Table 2 Experimental design

Group	Pretest	Experimental	Posttest
R	O1	X	O2

The meaning of the symbols used in the experimental design

R means Random Sampling

X means Experimental

O1 means Pretest

O2 means Posttest

4.5 Data Analysis

The data were analyzed as follows:

(1) Analyze data to compile and summarize findings of cooperative learning model, mathematics logic ability and students' behavior.

(2) Use cooperative learning model to evaluate mathematics logic ability for senior high school students before and after the experiment, and statistically analyze the data obtained from the experiment by means, standard deviation, and T- test for dependent sample.

Table 3 Scores on mathematics logic ability before and after using cooperative learning model

Number of students	Pretest total score (30)	Posttest total score (30)	Differences between scores (D)
1	14	22	8
2	20	25	5
3	23	29	6
4	20	26	6
5	18	25	7
6	22	28	6
7	21	27	6
8	18	28	10
9	24	26	2
10	16	24	8
11	20	27	7
12	23	29	6
13	18	28	10
14	23	27	4
15	24	28	4

Template for the 1st Bansomdejchaopraya National and International Conference (BS2C 2025) on "Synergy of Innovation Technology and Creativity for Sustainable Prosperity"
Using Cooperative Learning Model to Improve Mathematics Logic Ability for Senior High School Students

Dong Juncan*, Phenporn Thongkamsuk [2], and Supaporn Srihamee[3]

[1]Department of Curriculum and Instruction, Faculty of Education, Bansomdejchaopraya Rajabhat University, Bangkok 10600, Thailand.
[2]Department Curriculum and Instruction
[3]Department Curriculum and Instruction
*drphenpornbsru@gmail.com

Abstract

The purpose of this research was to 1) To use cooperative learning model to improve mathematics logic ability for senior high school students. 2) To compare senior high school students' mathematics logic ability before and after the implementation based on cooperative learning model. The sample group consisted of 50 senior high school students, No. 2 Senior High School of Panzhou City, Guizhou Province, China, who were selected through the cluster random sampling. The research instruments were 1) lesson plans using cooperative learning model, and 2) mathematics logic ability by data analyzed by frequency, percentage, interpretation, mean, and standard deviation for confirmation.

The results revealed the followings:

1. Using cooperative learning model consisted of 5 steps, 1) Task assignment, 2) Setup, 3) Group discussion, 4) Result report, and 5) Teaching comment. The research included three units, totaling 12 hours.

2. After implementing cooperative learning model, it was found that 50 students who enroll in the math course was at good level. The mean was 20.50 before the test, and the mean was 26.60 after the test.

Keywords: Cooperative Learning Model; Mathematics Logic Ability; Senior High School Students

Table 3 (continue)

Number of students	Pretest total score (30)	Posttest total score (30)	Differences between scores (D)
16	19	26	7
17	22	26	4
18	24	29	5
19	16	24	8
20	27	30	3
21	16	22	6
22	23	27	4
23	27	29	2
24	26	30	4
25	22	26	4
26	25	26	1
27	26	29	3
28	19	27	8
29	17	25	8
30	19	27	8
31	18	24	6
32	20	26	6
33	15	24	9
34	17	25	8
35	22	26	4
36	16	28	12
37	20	28	8
38	25	30	5
39	17	28	11
40	20	30	10
41	23	28	5

Table 3 (continue)

Number of students	Pretest total score (30)	Posttest total score (30)	Differences between scores (D)
42	20	22	2
43	22	25	3
44	23	29	6
45	19	25	6
46	24	26	2
47	20	27	7
48	22	28	6
49	12	20	8
50	18	29	11
$\bar{X}$	20.50	26.60	6.10
SD.	3.47	2.30	2.60

As can be seen in Table 3, through the application of teaching theory based on cooperative learning model, average score of mathematics logic ability of senior high school students was 20.50 before experiment, 26.60 after the experiment, with a difference of 6.10 in the average scores, which indicated that the scores had been improved significantly before and after the experiment.

Table 4. Comparison of students' mathematics logic ability before and after using cooperative learning model

Mathematics logic ability	n	full score	$\bar{X}$	SD.	df	t	p
pretest	50	30	20.50	3.47	49	16.61**	.00
posttest	50	30	26.60	2.30			

According to Table 4, through the implementation of cooperative learning model, students' mathematics logic ability significantly improved at the level .01.

5. Research Results and Discussion

5.1 The research results

The research resulted on using cooperative learning model to improve mathematical logic ability course on 50 senior high school students, No. 2 Senior High School of Panzhou City, Guizhou Province, China. The researcher drew a conclusion as follows:

As could be seen in Table 3, through the application of cooperative learning model, average mathematics logic ability for senior high school students was 20.50 before experiment, 26.60 after the experiment, with a difference of 6.10 in the average scores, which indicated that the scores had been improved significantly after the experiment.

According to Table 4, through the implementation of cooperative learning model, students' mathematics logic ability significantly improved. This result supported the research hypothesis and demonstrated a statistically significant improvement at the level .01.

In summary, after the implementation of cooperative learning model, students' mathematics logic ability was improved.

5.2 To use cooperative learning model to improve mathematics logic ability for senior high school students.

5.2.1 Role assignment

Role assignment was a crucial part in cooperative learning. In order to improve the mathematical logic ability of high school students, teachers could divide students into several groups and assign different roles to each group such as group leader, recorder, spokesman, etc. This role allocation helped to develop students' teamwork skills and responsibility, and also ensured that each student could bring out his or her strengths in group activities (Qu, 2024).

5.2.2 Task setup

In order to improve the mathematical logic ability of high school students, teachers should pay attention to the level and challenge of the task when setting cooperative learning tasks. For example, teachers could design some tasks involving logical deduction, comprehensive proof, problem-solving strategies, etc., so that students could constantly exercise and improve their mathematics logic ability in the process of completing the task. At the same time, the difficulty of the task should be moderate, which could not only stimulate students' interest, but also ensure that students achieved certain results in the process of cooperative learning (Ma, 2023).

5.2.3 Group discussion

Group discussion was the core of cooperative learning. In group discussions, students could fully communicate and discuss tasks and jointly find ways and strategies to solve problems. In order to improve the mathematical logic ability, teachers should guide students to pay attention to the logical structure, reasoning process and problem-solving ideas of the problem in the group discussion, so as to help students establish a correct mathematical thinking mode. In addition, teachers could also encourage students to put forward their own opinions and insights in group discussions to develop students' critical thinking and innovation skills (Luo, 2023).

5.2.4 Result report

After completing the group discussion, each group was required to report their discussion results to the class. The process of result reporting could not only show students' cooperative learning results, but also help students exercise their oral expression ability and logical thinking ability. In the reporting process, teachers should ask students to clearly explain the problem-solving ideas, logical reasoning process and achievements, so that other students could understand and use for reference. At the same time, teachers should also give timely feedback and evaluation to students' reports so as to help students further improve their mathematics logic ability (Chen, 2023).

5.2.5 Teaching comment

Teaching commentary was an important link in the process of cooperative learning, which helped teachers to understand students' learning situation and adjust teaching strategies in time. In the process of

comment, teachers should pay attention to the following aspects: Firstly, evaluate students' performance in cooperative learning, including participating enthusiasm, cooperation spirit and contribution degree. Secondly, analyze the effect of improving students' mathematical logic ability in order to provide reference for subsequent teaching. Finally, in view of the problems and difficulties encountered by students in cooperative learning, teaching comment put forward specific suggestions and guidance measures for improvement (Wang, 2023).

In short, it was a systematic and comprehensive process to improve the mathematics logic ability of senior high school students by using cooperative learning model. Through the organic combination of reasonable role assignment, task setup, group discussion, result report and teaching comment, cooperative learning model could effectively promote the development of students' mathematics logic ability, and cultivate students' teamwork spirit and comprehensive quality.

6. Recommendations (If Applicable)

Cooperative learning model is a student-centered teaching method that promotes students' active participation and mutual learning through group discussion and team cooperation. When implementing cooperative learning model, teachers need to put forward application suggestions from the following five aspects.

6.1 Select cooperation content.

When choosing the content of cooperative learning, teachers should give full consideration to students' knowledge background, interests and subject characteristics. The content should be challenging and stimulate students' interest in learning while meeting the teaching objectives and helping to develop students' ability to solve problems. In addition, teachers also need to pay attention to the difficulty of the cooperation content and ensure that students can gain achievement in the cooperation process, and avoid the effect of cooperation based on too simple or complicated task.

6.2 Divide into reasonable groups.

In cooperative learning mode, grouping is a key link. Teachers should make reasonable groups according to the characteristics, abilities and interests of students to ensure that the members of each group are complementary and can promote each other. At the same time, teachers also need to assign clear tasks and roles to each group to ensure that each student can play their own advantages in the cooperation and avoid the phenomenon of "free riding". In addition, teachers also need to pay attention to the dynamic changes of the group and adjust the grouping strategy according to the actual situation to ensure the smooth progress of cooperative learning.

6.3 Change teachers' role.

In the cooperative learning model, the role of teachers has changed from the traditional knowledge imparts to the guide and collaborator of students. Therefore, teachers need to adjust their mentality and teaching methods, give full play to their guiding role, and help students solve the problems encountered in the process of cooperation. At the same time, teachers also need to pay attention to students' needs and psychological changes, give timely care and support, establish a good relationship between teachers and students, and create a good atmosphere for cooperative learning.

6.4 Develop cooperation skills.

Cooperative learning mode requires students to have certain cooperative skills, such as communication ability, coordination ability, leadership and so on. Therefore, when implementing cooperative learning mode, teachers need to pay attention to cultivating students' cooperative skills. Students' cooperation skills can be improved by organizing special training courses and carrying out the

roles. At the same time, teachers also need to infiltrate the cultivation of cooperation skills in daily teaching, so that students can continue to learn and progress in practice.

6.5 Provide multiple evaluation feedback.

Evaluation is an important link in cooperative learning model, which can not only test students' learning results, but also provide feedback and improvement direction for teachers' teaching. When implementing the cooperative learning model, teachers need to adopt multiple evaluation methods, such as self-evaluation, group evaluation, teacher evaluation, etc., in order to have a more comprehensive understanding of students' learning situation and cooperation ability. At the same time, teachers also need to feedback the evaluation results in time to help students understand their own strengths and weaknesses, so as to adjust learning strategies and improve learning results. In addition, teachers need to reflect and improve the cooperative learning mode according to the evaluation results, and constantly improve the teaching strategies and methods.

In short, the application of cooperative learning mode needs to be comprehensively considered from many aspects, including selection of cooperative content, reasonable division of labor in groups, teacher role transformation, training of cooperative skills and multiple evaluation feedback. Only in the aspects, can teachers ensure the effectiveness and efficiency of cooperative learning mode and provide strong support for the all-round development of students.

7. Acknowledgments (If Applicable)

The pursuit of knowledge is perpetual, and my dedication to advancing education and crafting a splendid life will persist. I wish all teachers, students and friends, in Bansomdejchaopraya Rajabhat University, health and happiness in this blossoming day of spring! Learning is never-ending, and I will also continue to strive in the future and write a beautiful life!

8. References

Chen, L. D. (2023). *Optimal strategies for cooperative learning in primary mathematics groups*. Master of Education, Southwest University.

Luo, C. (2023). On the application of cooperative learning model in high school mathematics teaching. *Second Classroom* (D) (10), 52.

Wang, J. N. (2023). *Practical research on mathematics review course under the guidance of cooperative learning in Senior Three*. Master's Thesis, East China Normal University.

Ma, Z. M. (2023). Research on the application of group cooperative learning in high school mathematics teaching. *Questions and Research* (25), 150-152.

Qu, Z. X. (2024). On the construction of group cooperative learning model in junior middle school mathematics teaching. *Enlightenment and Wisdom* (I) (03), 65-67.

Ren, Q. C. (2023). Exploration of the integration of cooperative learning model and junior high school mathematics teaching. *Intelligence* (12), 53-56.

The Ministry of Education. (2001). *Curriculum Standards for Full Time Compulsory Education*. The Ministry of Education Press.

Research Profile

Name-Surname: Dong Juncan
Birthday: October 21, 1981
Place of Birth: Yizi Street, Panzhou City, Guizhou Province

Educational Background:

- Qiannan Normal University for Nationalities, 2004.

Work Experience:

- From December 2004 to now, No. 2 Senior High School of Panzhou City, Guizhou Province.

Office Location:

-

Current Contact Location:

-