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Enhancing Cooperative Learning Strategy among Chinese Secondary Students in Mathematics Classroom: A Case Study in China

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Abstract: Higher-order thinking skills influence the direction of education. This study explored CLS to improve HOTS in secondary school mathematics through a qualitative case study of three teachers. The results of the study showed that the teachers had positive attitudes towards CLS and emphasized group discussion and teacher guidance as effective strategies. The evaluation methodology combined quantitative and qualitative approaches. Challenges included classroom management, teacher competence, and balancing academic achievement. Ongoing professional development and monitoring are critical to the successful integration of HOTS.

Keywords: higher-order thinking skills (HOTS), cooperative learning strategy (CLS), secondary school Mathematics, teacher perspectives

Introduction

The widespread use of artificial intelligence across the board is a wake-up call that future education should be directed toward developing students' higher-order thinking skills (HOTS). To achieve the goal of becoming a world-class science center and global talent hub, China's MOE has issued the Overall Plan for Deepening Education Evaluation Reform in the New Era, which calls for the development of HOTS to be implemented in all stages of education.[1] Mathematics is one of the core subjects in China's compulsory education, and in order to develop HOTS, the Mathematics Curriculum Standard integrates six goals that integrate vision, thinking, language, knowledge, skills, and values with 21st-century learning skills.[2] At the same time, HOTS can prepare students to participate in global competition in the future. However, the new education model has not gained acceptance among all teachers, and teacher-centered instruction continues to dominate.

HOTS include reasoning, reflection, problem solving, decision making, and innovation, derived from Bloom's taxonomy from concrete to abstract knowledge levels.[3] Incorporating HOTS into instructional assessment through inquiry-based learning and deep questioning can improve academic performance.[4] Cooperative Learning Strategies (CLS) promote skill acquisition, collaboration, and social cognition.[5] Group activities foster higher-order thinking, knowledge application, motivation, academic achievement, and social skills.[6] Therefore, secondary school teachers need skills to incorporate CLS in math instruction.

1. Research method

This is a qualitative case study to explore and understand the phenomenon of how teachers infuse CLS in secondary mathematics classrooms. Thus, the researcher selected three teachers participated in the study, and they were chosen by purposive sampling, based on the criteria that they are applying CLS in their lessons, at least one year of teaching

experience and their willingness to participate. Data was collected through three interviews, which each session lasting for about forty minutes. Interviews were transcribed, categorized and, finally themes were formed based on the categories. Triangulation was used for cross-checking and verification of the data.

2. Research participants

Two participants, Mr. Gao and Miss Wang, are mathematics teachers in public secondary schools in Guangzhou, Panyu District. Mr. Gao, a middle-aged teacher with 10 years of experience, teaches classes of 50-60 students. Miss Wang, a young teacher with 2 years of experience, teaches 51 seventh-grade students. The third participant, Mr. Zhang, is a young teacher in a private school in the same district, with one year of experience teaching ninth-grade students in a class of 50 students.

3. Research findings

Findings are based on the focus of the study including teachers' perspective on CLS, application of CLS in secondary school mathematics classroom, evaluation of learning outcomes and HOTS in CLS lessons, challenge of implementation of CLS during the teaching and learning process.

3.1 Teachers' perspective

Overall, participants were positive about the implementation of CLS. All three teachers agreed that CLS is essential in secondary mathematics education. Ms. Wang noted that CLS promotes exploration and discussion in a supportive atmosphere and enhances understanding through peer learning. Ms. Zhang emphasized that the positive and interactive nature of CLS made mathematics more appealing and less intimidating for biased students. However, they also raised some concerns. Ms. Gao mentioned the challenges of managing large classes, while Ms. Wang noted that older teachers had difficulty coping with the new teaching model in a short period of time.

3.2 Application of CLS in secondary mathematics classroom

Respondents offered several effective strategies for applying CLS in math classrooms. They emphasized the importance of interaction, such as rotating among groups to provide guidance (Mr. Gao) and facilitating group discussions for linking theory to practical applications (Miss Wang). Collaborative projects and team-based activities were highlighted as highly effective methods for fostering student interaction (Mr. Zhang). Teacher guidance and feedback were also deemed crucial, clarifying instructions, modeling problem-solving techniques, and encouraging students (Miss Wang), while balancing contributions within groups to ensure no student lags (Mr. Zhang).

3.3 Evaluation

Participants assessed learning outcomes and HOTS using a variety of methods. To begin with, instructors assessed students' understanding of class content through quantitative methods of assignments and quizzes. Ms. Zhang and Ms. Gao assessed students based on their logical approach and response scores, and checked to see if their level of thinking was consistent with their collaborative performance in class. The quizzes, on the other hand, assessed students' ability to respond to a variety of question types, including multiple-choice, computational, and problem-solving questions, and the quiz design was closely aligned with the classroom cooperative learning activities. Moreover, the teacher used qualitative assessment HOTS. Ms. Wang assessed students' thinking level through observation, discussion, and interviews, and based on students' responses in class.

3.4 Challenge

Implementing CLS in secondary school math classrooms faces three main limitations. First of all, classroom management is a challenge, especially in public schools with large classes and students of varying abilities (Mr. Gao). Students' lack of self-management skills also affects task completion (Ms. Wang). Next, teacher competence is critical, requiring proficiency in group dynamics and conflict resolution (Mr. Gao), as well as pedagogical and managerial skills to implement CLS (Mr. Wang). At last, academic achievement is a concern. In private schools that focus on high performance,

the exploratory nature of CLS may conflict with this goal (Ms. Zhang). In China's test-based education system, CLS may lead some students to rely on others, compromising true understanding and mastery (Ms. Wang).

4. Discussion

Teachers are aware importance of HOTS and try to implement CLS in daily instruction practice which is in line with the aspiration of the New Curriculum Stander and the Plan. Moreover, all the participants argue that CLS need to be infused through lessons for students' better mathematics learning outcomes as well as favors class unity.[7] The findings also offer valuable insights into the perspectives of teachers on CLS, its application in secondary school mathematics classrooms, the evaluation of learning outcomes and HOTS, and the challenges associated with its implementation.

Participants generally hold positive views about the implementation of CLS in teaching and learning as suggested by Xie et al., Wang (2023), Cheng (2024). They recognize its potential to create a supportive learning environment where students can engage in active learning and benefit from peer-to-peer interaction.[8] This aligns with existing literature that emphasizes the importance of cooperative learning in fostering deeper understanding and student engagement.[6,9,10] For instance, Mr. Gao believes that CLS is essential in modern education, and Miss Wang highlights how CLS allows students to explore and discuss mathematical concepts, leading to better comprehension.

The study reveals several effective strategies for applying CLS in mathematics classrooms. Teachers find that fostering interaction through group discussions, problem-solving tasks, and collaborative projects is particularly effective. This method helps students connect theoretical concepts with real-world applications, enhancing their understanding and retention of mathematical principles.[11] Teacher guidance and feedback are also crucial in the CLS framework. Adolescents benefit significantly from having teachers clarify instructions, model problem-solving techniques, and offer encouragement.[12] This support may help balance contributions within each group and ensures that no student is left behind. This finding underscores the importance of the teacher's role in facilitating and guiding cooperative learning activities to maximize their effectiveness.

The evaluation of learning outcomes and HOTS in CLS lessons involves both quantitative and qualitative methods. They used the short quizzes and homework s to assess actual students learning outcomes. Qualitative way of assessment is through Qualitative assessments, including observations, discussions, and interviews, are employed to evaluate students' HOTS. These methods provide insights into students' levels of thinking and their ability to apply learned concepts in various contexts. These assessments are closely aligned with the cooperative learning activities conducted in class, ensuring that they accurately reflect students' learning experiences. The qualitative form of assessment seems in line with authentic assessment.[13] These two assessment methods have the potential of improving students thinking level and learning outcomes and overtime could result in creating independent learners.[14]

However, the study identifies three main challenges in the implementation of CLS: classroom management, teacher ability, and concerns about academic achievement. Classroom management is particularly challenging in large classes with diverse learning abilities. In such settings, teachers must address the varying academic needs and behavioral tendencies of a wide range of students.[15] Some students may struggle with self-management and organization, hindering the effectiveness of group work. Teacher ability is another significant challenge. Effective implementation of CLS requires teachers to be skilled in group dynamics and conflict resolution. Therefore, teachers' professional development and continuous in-service training programmed in these areas is crucial for the successful adoption of CLS.[16] Moreover, teachers need to thoroughly understand the concept of CLS and possess strong teaching and management skills to apply it effectively. Lastly, there are concerns about the impact of CLS on students' academic achievement. In an exam-oriented education system like China, there is a risk that some students may rely on their peers to complete tasks, which can impede their individual understanding and mastery of knowledge.[17] This highlights the need for balanced strategies that integrate cooperative learning while maintaining rigorous academic standards. In conclusion, if China truly wants the philosophy behind HOTS to materialize, continuous and serious monitoring and improvement of the program must be undertaken.

Conflicts of interest

The author declares no conflicts of interest regarding the publication of this paper.

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