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An Experimental Study on Improving First-Grade Students' Mathematical Learning Achievement and Social Awareness Through an Instructional Approach Based on Constructivist Theory and Collaborative Learning

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Abstract

Purpose: The purpose of this study is to investigate the effects of instructional methods based on Constructivist theory and cooperative learning on first-grade students' mathematical learning achievement and social awareness. **Method:** A natural sample of 30 children aged 6-7 years old was cluster-randomized into an experimental group. Mathematical Learning Achievement Tests and Social Awareness Assessment Scale were used to assess mathematical learning achievement and social awareness before and after 15 sessions of instruction based on Constructivist theory and cooperative learning. **Results:** 1) After a certain period of learning or training, the experimental group showed improvement in Mathematical Learning Achievement (M=20.6, SD=1.40). Compared to the pretest, there was a significant improvement in students' performance in the posttest ($t(29) = 12.51$, $p < 0.05$). 2) After a certain period of learning or training, the experimental group showed improvement in Social Awareness (M=16.5, SD=1.14). Compared to the pretest, there was a significant improvement in students' performance in the posttest ($t(29) = 17.88$, $p < 0.05$). **Conclusion:** The instructional methods based on Constructivist theory and cooperative learning can enhance first-grade students' mathematical learning achievement and social awareness.

Keywords: constructivist theory, collaborative learning, mathematical learning achievement, social awareness, first-grade students

1. Introduction

In the rapidly evolving field of education, innovation and improvement in teaching methods have become crucial drivers for educational reform. Particularly in the realm of foundational education, enhancing students' learning achievements and cultivating their social awareness have emerged as pivotal areas of inquiry among educational practitioners. Samritin et al. (2023) found that blended learning models in online education positively influenced students' mathematical learning achievements, while DEMİRCİ et al. (2022) and Nwauzoije et al. (2023) established a significant positive correlation between peer relationships and social awareness. In recent years, Constructivist theory and Cooperative learning methods have garnered widespread attention for their distinctive pedagogical principles and practical efficacy, recognized as effective instructional strategies in achieving these educational objectives.

Constructivist theory emphasizes learning as a process where individuals interact with their environment to collectively construct knowledge (Topolovčan, 2023). Under this theoretical framework, teachers transition from being mere transmitters of knowledge to assuming roles as guides and facilitators. Students, likewise, shift from passive recipients of knowledge to actively constructing and accumulating knowledge through interactions with their environment and peers. This interaction encompasses not only student-environment interactions but also exchanges and collaboration among students and between students and teachers. Such instructional approaches encourage students to exhibit agency and initiative, fostering their interest and creativity to enhance learning outcomes. Recent research has increasingly focused on the impact of Constructivist theory on students' academic achievement and social cognition (Kim, 2005; Azzarito & Ennis, 2003).

Cooperative learning methods emphasize collaboration and interaction among students, fostering active engagement and mutual learning through activities such as group discussions and collaborative inquiries. This approach not only contributes to improved academic performance but, more importantly, cultivates students' social awareness. In the process of cooperative learning, students learn to respect and understand others, communicate effectively, and collaborate, essential qualities for success in modern society (Luna Scott, 2015).

Bruer (1999) contends that for first-grade students, this phase represents a critical period for acquiring foundational knowledge and developing social awareness. During this stage, the application of Constructivist theory and Cooperative learning methods can effectively enhance students' mathematical learning achievements and foster their social awareness. For instance, teachers can design group-based activities where students collaboratively explore mathematical problems, fostering teamwork and communication skills. This approach not only enhances students' mathematical performance but also cultivates their collaborative mindset and teamwork spirit.

Furthermore, this instructional approach facilitates holistic student development. Through cooperative learning, students are required to demonstrate creativity, communication skills, and problem-solving abilities, contributing to their comprehensive growth. Moreover, through collaboration and interaction with others, students gain better understanding and respect for others, fostering positive social attributes.

This study aims to explore the impact of instructional strategies based on Constructivist theory and Cooperative learning methods on improving first-grade students' mathematical learning achievements and nurturing their social awareness. This integrated instructional approach not only emphasizes students' knowledge acquisition but also prioritizes their holistic development and social adaptability. Through experiential learning methods combined with group cooperation and inquiry-based learning activities, students' interest and motivation are stimulated, leading to improved academic performance while cultivating their social awareness and collaborative skills. This instructional strategy aligns with modern educational paradigms and meets the demands of society for talent cultivation. Thus, it warrants further investigation and implementation by educational practitioners.

2. Literature Review

2.1 Constructivist Theory

Mayer (1996) delineated a revolution in educational psychology commonly referred to as constructivist learning theory. Constructivism draws its roots from cognitive processing theory and the ideas of Vygotsky, Piaget, and Bruner (Rannikmäe et al., 2020). Piaget's and Bruner's cognitive perspectives elucidate how objective knowledge structures are internalized through the interaction of individuals with cognitive structures. The widespread dissemination of Vygotsky's cultural-historical development theory is foundational to the evolution of constructivism. The behaviorist's objectivist perspective, prevalent in teaching, posits learning as the reinforcement of chains linking stimuli and responses. Educators aim to impart knowledge of the objective world, while learners strive to achieve educators' set objectives and gain the same understanding throughout the transmission process.

Constructivism represents a deepening and refinement of cognitivism. Early indications of constructive thinking were evident in Piaget's and Bruner's theories, but their cognitive learning perspectives primarily focused on transforming objective knowledge structures into cognitive structures through individual interactions. Piaget (1954, 1983) advocated that children's cognitive development is grounded in intuitive concepts, forming new concepts and structures through comprehensive processing, constituting the core mechanism of cognitive structure formation. Children's cognitive development involves four aspects: schemata, assimilation, accommodation, and equilibrium, manifested in the sensorimotor, preoperational, concrete operational, and formal operational stages. All individuals undergo these four consecutive stages, with a fixed developmental sequence (Babakr et al., 2019). Although differences exist between adjacent stages, they are a natural consequence of the transition from quantitative to qualitative changes in thinking.

Vygotsky emphasized the influence of socio-cultural history on psychological development, highlighting the role of activity and social interaction in the development of higher mental functions (Kholmogorova, 2016). The realization of higher mental functions stems from the internalization of external actions through avenues such as education, daily life, play, and labor. Inner intellectual activities can be externalized through practical operations, thus embodying subjective cognition objectively (Gredler, 2012). Human activity plays a crucial role in this process. Vygotsky distinguished between two levels of individual development: the actual development level and the potential development level. The disparity between the two is known as the zone of proximal development (ZPD) (Vygotsky & Cole, 1978).

Bruner emphasizes the significance of knowledge structures, regarding them as fundamental concepts within disciplinary domains, encompassing the mastery of general principles and attitudes towards learning methods (Wen, 2018). Understanding these principles facilitates the comprehension, retention, and transfer of disciplines, thereby narrowing the gap between knowledge domains (Gick & Holyoak, 1987). Bruner contends that the foundations of any discipline can be adequately taught to individuals of any age, emphasizing the value of intuitive thinking as the bedrock of creative thinking. Intuitive thinking, grounded in familiar knowledge domains and structures, enables leaps, advances, and shortcuts, yet subsequent conclusions still necessitate reevaluation through comparative analytical methods.

Osborne & Wittrock (1985) introduced the Generative Learning Model, a learning process model that holds significant implications for understanding the learning process. They argue that learning involves the learner's cognitive processes and cognitive structures, encompassing semantic and abstract processes, representation or verbal memory, attention, and motivation. Cunningham (1992) asserts that learning involves the construction of internal mental representations, rather than simply transferring knowledge from external sources to memory, emphasizing learning as the processing of novel information, thereby constructing new cognitive models. Modern constructivists share similar views with Piaget and early Bruner but place more emphasis on unstructured experiential backgrounds. However, some tend to overemphasize unstructured experiences, neglecting the abstract and conceptualizing roles of concepts.

Drawing from previous ideological assimilations, constructivists have proposed numerous innovative teaching concepts, such as emphasizing learners' agency and constructiveness during the learning process (Lester et al., 1999), differentiating between elementary and advanced learning (Tobias & Duffy, 2009), criticizing the inappropriate extension of teaching strategies for elementary learning to advanced learning in traditional education (Wilson, 1996), and advocating cooperative learning and situational teaching (Darnis & Lafont, 2015), among others. These ideas have had profound effects on advancing educational reforms. However, traditional teaching emphasizes the certainty and universality of knowledge, emphasizing analysis and abstraction, which are necessary and reasonable at the elementary stage. Completely denying them would lead to confusion in teaching order. While advocating situational teaching, it is important to oppose the blanket rejection of abstraction and generalization, as abstract training is considered useless and one-sided, contradicting the notion of comprehensive education.

Students can begin with the accumulation of practice and concrete experiences or build upon indirect experiences, existing knowledge, theories, and conclusions, supplemented by sensory experiences. From the perspective of educational functions, learning through indirect experiences predominates, as students' learning cannot solely rely on direct experiences (Fazio & Zanna, 1981). Therefore, teachers need to closely integrate school education with real-life experiences and students' existing knowledge during the teaching process.

In the process of instructional design, constructivists advocate against oversimplifying teaching and divorcing it from real-life contexts, thus avoiding simplistic to complex linear logic. Instead, comprehensive tasks should be provided to guide students in problem-solving. Students are required to autonomously discover subtasks and the necessary knowledge and skills to accomplish them. Murphy & Lassaline (2013) posit that knowledge comprises a network structure composed of core concepts, including facts, concepts, and generalizations, and learning can commence from any part of this network. Teachers can guide students in addressing practical problems or start with rules. Initially, selecting issues relevant to children's life experiences and providing tools conducive to understanding and problem-solving is essential. Subsequently, students explore individually or in groups to discover the required knowledge and skills, ultimately achieving problem resolution.

Teaching should be based on students' existing knowledge foundation rather than rigidly filling gaps. Teachers should consider students' current cognition as the starting point for generating new knowledge, guiding them to expand their experiences from existing knowledge systems (Wette, 2010). The role of teachers transcends that of knowledge transmitters; they must also prioritize the cultivation of students' self-understanding. This involves listening to students' viewpoints, exploring the underlying reasons, and guiding them in adjusting or enriching interpretations. The instructional process should revolve around the learner, emphasizing their agency, while also acknowledging the guiding role of the teacher. Stefani (1998) asserts that teachers should transition into facilitators and collaborators of learners. Teachers facilitate and propel students in constructing meaning, while students take on an active role in information processing and learning.

2.2 Collaborative Learning Theory and Practice

Collaborative learning, as an educational model, garners significant attention from constructivists, aligning with Vygotsky's emphasis on the role of social interaction in children's psychological development (Bonk &

Cunningham, 1998). Constructivists posit that learners interpret phenomena in their unique ways, resulting in diverse perspectives due to variations in cognitive styles, experiential backgrounds, and thinking habits, thereby fostering the value of collaborative learning.

In collaborative learning models, learners no longer confront knowledge in isolation but instead co-construct understanding through interaction and communication with peers. This interactive process enables learners to perceive multiple facets of phenomena, compensating for individual cognitive limitations. Collaborative learning encourages active participation and the expression of one's viewpoints while also listening to others' opinions (León & Castro, 2017). Through this process, learners not only enhance their critical thinking skills but also learn from others' strengths, leading to complementary advantages. Collaborative learning emphasizes that understanding is not singular but rich and comprehensive. During the learning process, learners, through collaboration, can fully explore the essence of phenomena and interpret them from multiple dimensions. Consequently, understanding evolves from a static outcome to a continuous deepening and expansion process, fostering learners' holistic development and cultivating teamwork and communication skills.

Collaborative learning emerged in the United States during the 1970s, initially rooted in social psychology experiments, exploring effective collaborative principles and designing corresponding teaching strategies aimed at facilitating the understanding and integration of students from diverse racial and cultural backgrounds, striving for the highest goals. With the introduction of the self-determination theory, collaborative learning was elucidated as meeting psychological learning needs and facilitating student growth (GP et al., 2020). From the mid-1970s to the mid-1980s, collaborative learning made substantial progress, evolving into an innovative and effective teaching strategy. Due to its notable improvements in classroom atmosphere, widespread enhancement of student academic performance, and promotion of students' development of positive non-cognitive abilities, collaborative learning quickly garnered attention in the educational field, becoming one of the mainstream contemporary teaching theories and strategies. Throughout this process, proponents of cooperative learning provided valuable insights into collaborative learning theory and empirical research. Although emphasizing different aspects, these insights generally fall into two tendencies: one represented by Slavin, emphasizing the reinforcement of collaborative learning motivation and the role of collective rewards; the other represented by the Johnson brothers, focusing on guiding students through the collaborative learning process and developing their cooperative skills.

Slavin (1980; 1985; 1990) advocates that cooperative learning has led to a transformation in traditional classroom instruction, primarily evident in the shift of learning tasks from individualized to collaborative, the gradual weakening of teacher authority, and the transition of reward mechanisms from competitive to cooperative. Collaborative learning can draw inspiration from cooperative learning. In a cooperative reward system, whether students receive rewards depends not only on individual performance but also on the overall performance of their groups. This reward mechanism is conducive to promoting learning behaviors. Therefore, Slavin explicitly points out that effective cooperative learning requires two conditions: collective rewards and individual accountability. Additionally, Slavin attempts to integrate cooperative learning with personalized instruction, incorporating individual learning into group learning and allowing students to learn different units at their own pace. The completion of learning units by each group is periodically recorded, and additional scores are awarded based on the quality of completion. This approach cleverly combines individual responsibility with collective accountability and incorporates the advantages of personalized instruction, catering to students' varying learning levels.

The Johnson brothers extensively explore various cooperative skills, emphasizing the importance of communication skills, trust building and maintenance, conflict management, and leadership (Johnson et al., 1994; Johnson & Johnson, 2009). They also analyze seven key steps in teaching students cooperative skills: firstly, guiding students to recognize the importance of cooperative skills; secondly, assisting students in understanding the meanings and application processes of various cooperative skills; thirdly, guiding students in practical exercises to practice cooperative skills; ensuring that each student receives feedback during the practice process; encouraging continuous practice to achieve proficiency; creating situations for students to successfully apply cooperative skills; and finally, promoting the habitual application of cooperative skills to achieve automatic application. Additionally, they emphasize the importance of collective processing and group self-assessment and self-regulation mechanisms. Through group members collectively assessing group activities and discussing improvement measures, effective skills can be reinforced in a timely manner, further enhancing the proficiency and spontaneity of skill application.

By the late 1980s, collaborative learning had not only become an effective means and method for organizing classroom teaching but had also gradually permeated various levels of school management, giving rise to

distinctive collaborative school models. The concept of collaborative schools proposed by Slavin (1987) has expanded the connotation of collaboration far beyond the scope of classroom instruction, extending to all-round collaboration among students, teachers, school administrators, and parents. Collaborative schools prioritize cooperation as the core principle of classroom organization and build comprehensive cooperation mechanisms among students, teachers, administrative leaders, and teacher-student and teacher-administration relations based on this principle. Meanwhile, collaborative schools emphasize the integration of regular education and special education, as well as the connection between school education and home education, forming a new educational trend where all school staff, students, families, and communities collaborate closely. In collaborative schools, emphasis is not only placed on students' growth and development but also on providing strong support for the professional growth of teachers and school officials, thereby creating a learning and working environment full of humanistic care, vitality, and harmonious coexistence between teachers and students (Zepeda, 2014).

However, in current pedagogical practices, the advocated and implemented modes of interaction primarily revolve around bilateral interaction between teachers and students, while the interaction among students themselves remains largely overlooked, resulting in a lack of or fundamentally absent multidirectional interactive modes in the teaching process (Watters & Diezmann, 2016). Some even perceive the interaction among students as nonconstructive negative factors or disruptive forces. The reasons for this situation are manifold, with the influence of theoretical misconceptions being particularly noteworthy.

Influenced by traditional educational notions, the relationship between teachers and students is typically regarded as the most crucial relationship in teaching, with the belief that students' mastery of knowledge and intellectual development mainly depend on interaction with teachers. Many domestic scholars currently perceive teaching as a "bilateral activity process between teachers and students," which essentially reflects this mindset. However, cooperative learning theory argues that simplifying teaching, a complex phenomenon, to a process involving only bilateral interaction between teachers and students is overly simplistic. In fact, teaching encompasses not only the bilateral interaction between teachers and students but also various forms of interaction such as unidirectional interaction, multidirectional interaction, member interaction, etc., all of which constitute an organic unity in the teaching process, reflecting a composite activity characteristic.

The interactive perspective of modern collaborative learning stems from a reflection on traditional views of teaching interaction. Collaborative learning theory advocates that the teaching process should be viewed as a process of information interaction. From the perspective of modern educational information theory, interactive forms in teaching can be roughly divided into four types: first, unidirectional, which perceives teaching as a process of teachers transmitting information to students, where teachers are information transmitters and students are information recipients (Neo & Neo, 2004); second, bilateral, emphasizing teaching as a process of information interaction between teachers and students, focusing on bilateral interaction and timely feedback (Telio et al., 2015); third, multidirectional, viewing teaching as a process of interaction among teachers, students, and among students themselves, emphasizing multilateral interaction and shared knowledge mastery (Cooper & McIntyre, 1994); fourth, member-based, advocating teaching as a process of equal participation and interaction between teachers and students, focusing on teachers as ordinary members of the group engaging in activities with other members, rather than being the sole source of information (Thomas et al., 2012).

3. Method

3.1 Research Purpose

This study aims to investigate the effects of instructional methods based on constructivist theory and cooperative learning on enhancing the mathematical learning achievement and social awareness of first-grade students. Constructivist theory emphasizes students' construction of their own knowledge systems through interaction with others and practical experiences, while cooperative learning emphasizes students' abilities to collaborate, share resources, and solve problems within small groups. By integrating these two instructional methods, we anticipate cultivating a more proactive learning attitude and a deeper understanding of mathematics among first-grade students.

3.2 Research Hypotheses

H1: First-grade students' mathematical learning achievement improved compared to before the study based on constructivist theory and collaborative learning teaching methods.

H2: First-grade students' social awareness improved compared to before the study based on constructivist theory and collaborative learning teaching methods.

3.3 Participants

The participants consisted of a natural class of 30 students (18 males, 12 females) enrolled in a public primary school in China. Their ages ranged from 6 to 7 years old, and all were receiving compulsory education in China.

3.4 Research Variables

Independent Variable: An instruction based on constructivist Theory and collaborative Learning.

Dependent Variables: The mathematical learning achievement and social awareness

3.5 Intervention

This study employed a single-group pretest-posttest experimental design to explore the specific effects of integrating Constructivist Theory and Cooperative Learning in mathematics instruction on the mathematical learning achievement and social awareness of first-grade students. The experiment was conducted in a natural class of a regular primary school in China. Initially, students' initial abilities in mathematical learning achievement and social awareness were assessed using specially designed tests and scales. Subsequently, instructional interventions based on Constructivist Theory and Cooperative Learning were introduced to stimulate students' interests and enhance their mathematical learning achievement and social awareness. Throughout the instructional process, students engaged in collaborative learning environments to acquire mathematical knowledge and promote mutual learning and cognitive exchange. The study also focused on students' acceptance and participation in the new instructional methods to comprehensively evaluate teaching effectiveness.

The entire instructional process spanned 15 sessions, with each session lasting 45 minutes. Following the conclusion of instruction, a posttest was conducted to assess the extent of improvement in students' mathematical learning achievement and social awareness. By comparing pretest and posttest data, this research aims to delve into the potential impacts of instructional methods grounded in Constructivist Theory and Cooperative Learning on the mathematical learning achievement and social awareness of first-grade students, thereby offering valuable experiential support and reference for future educational practices.

3.6 Research Instrument

(1) Mathematical Learning Achievement Tests

To assess changes in students' academic performance before and after targeted training, researchers developed a set of the Mathematical Learning Achievement Tests （MLAT） based on the Chinese compulsory education mathematics curriculum standards. This test paper aims to evaluate students' proficiency in number recognition, addition and subtraction operations, as well as shapes and spatial understanding. It is divided into three sections, each comprising 8 questions.

The section on number recognition assesses students' cognitive abilities related to basic numbers. Students are required to choose specific numbers, determine the parity of numbers, and rewrite the given digits. The addition and subtraction operations section tests students' fundamental arithmetic skills, including simple addition, subtraction, and combination operations, to evaluate their computational abilities when dealing with numbers. The shapes and spatial section primarily focuses on students' recognition of basic geometric shapes. By selecting the correct shapes, matching shape names, and identifying shape characteristics, students demonstrate their understanding of spatial perception and geometric shape recognition.

(2) Social Awareness Assessment Scale

The Social Awareness Assessment Scale (SAAS) comprises four core dimensions: Collaboration and Teamwork, Empathy and Caring for Others, Social Skills and Friendliness, and Sense of Social Responsibility (Table 1). This scale offers detailed feedback to assessors, aiming to assist individuals in identifying and improving deficiencies in social awareness, thereby ensuring the scientific validity and fairness of the assessment process. The widely recognized Likert scoring method is employed to ensure objectivity and accuracy in scoring. Scores for each dimension range from 1 to 5, with a total of 20 points. Evaluated by five experts in the field, the scale was deemed to possess good validity.

Table 1. Social Awareness Assessment Scale Evaluation Dimensions

Dimensions	Assessment
Collaboration and Teamwork	To measure students' participation and ability to work with others in group activities
Empathy and Caring for Others	To focus on the student's ability to be attentive to the needs and emotions of his/her peers and to demonstrate a willingness to help others.
Social Skills and Friendliness	To assess focuses on students' social behaviors, including their ability to begin communication with their peers and their ability to be kind to others.
Sense of Social Responsibility	To understand students' awareness of school rules and responsibilities and their ability to fulfill assigned responsibilities within the group.

3.7 Data Analysis

Statistical analyses of academic achievement in mathematics and social awareness scores were conducted in this study using IBM SPSS 27.0. The data collected in this study were compared by analysis of variance (ANOVA) and t-test to compare the differences between pre- and post-experiment. The level of significance was set at $P < 0.05$ and Cohen's d was set at Cohen's d= 0.2, 0.5, and 0.8, representing small, medium, and large effect sizes, respectively.

3.8 Ethical Approval

Informed consent was obtained from all participants, who were fully informed of the purpose, process, potential risks and their rights and interests before participating in the study. Ethical regulations and guidelines were adhered to in order to protect the rights and privacy of the participants.

4. Results and Analysis

4.1 Mathematical Learning Achievement Tests Results and Analysis

Table 2 presents the experimental results of MLAT. From the data in the table, it is evident that in the pretest data of the experimental group, M=17.67, SD=2.14, with pretest scores ranging from 13 to 23 points. In the posttest data, the average score of the experimental group increased to 20.6 points, SD=1.40, indicating an improvement in Mathematical Learning Achievement after a certain period of learning or training. Posttest scores ranged from 18 to 24 points. To explore whether there was a significant difference between the scores of the two tests, we conducted a paired samples t-test on the experimental group. The results showed that $t(29) = 12.51$, $p < 0.05$, Cohen's d=2.28, indicating a large effect size. This is statistically significant. Therefore, compared to the pretest, students' performance in the posttest showed a significant improvement. Based on these results, we can accept Hypothesis 1.

Table 2. The results of Mathematical Learning Achievement Tests

Variable	**M**	**SD**	**t**	**df**	**P**	**Cohen's d**
PRO-TEST	17.67	2.14	12.51*	29	0.000	2.28
POST-TEST	20.6	1.40				

*P < 0.05

4.2 Social Awareness Assessment Scale Results and Analysis

Table 3 presents the experimental results of SAAS. From the data in the table, it is evident that in the pretest data of the experimental group, M=13.97, SD=1.61, with pretest scores ranging from 11 to 18 points. In the posttest data, the average score of the experimental group increased to 16.5 points, SD=1.14, indicating an improvement in social awareness after a certain period of learning or training. Posttest scores ranged from 15 to 19 points. To explore whether there was a significant difference between the scores of the two tests, we conducted a paired samples t-test on the experimental group. The results showed that $t(29) = 17.88$, $p < 0.05$, Cohen's d=3.26, indicating a large effect size. This is statistically significant. Therefore, compared to the pretest, students' performance in the posttest showed a significant improvement. Based on these results, we can accept Hypothesis 2.

Table 3. The results of Social Awareness Assessment Scale

Variable	M	SD	t	df	P	Cohen's d
PRO-TEST	13.97	1.61	17.88*	29	0.000	3.26
POST-TEST	16.5	1.14				

*P < 0.05

5. Discussion

The results of this study strongly indicate that the instructional approach based on constructivist theory and cooperative learning significantly contributes to the enhancement of first-grade students' mathematical learning achievement and social awareness. Significant improvements were observed in students' mathematical learning achievement during the post-test, suggesting the effectiveness of this instructional approach in facilitating students' learning and comprehension in the mathematical domain. Moreover, the enhancement in social awareness was also validated through the post-test, indicating that this instructional approach not only focuses on the impartation of subject knowledge but also fosters students' social skills and awareness.

These findings are consistent with previous research, which has elucidated the positive effects of instructional approaches based on constructivist theory and/or cooperative learning. For instance, Puntambekar (2006) emphasized the significance of analyzing collaborative interactions in understanding how students develop shared knowledge and construct their own understanding through collaboration. Additionally, Seau et al. (2018) discussed an instructional initiative on multimodal oral expression skills based on socio-cultural learning theory and multicultural education, finding that cooperative learning techniques positively impacted various aspects of students' oral expression skills. This further supports the effectiveness of constructivist theory and cooperative learning methods in educational practice.

However, despite the significant improvements observed, there are still some issues that warrant further investigation. Firstly, due to objective constraints, we were unable to implement the same instructional methods in a control group, thus hindering the precise determination of whether the observed improvements stemmed solely from our instructional strategies. The presence of a control group aids researchers in excluding other potential factors that may influence changes in outcomes, such as time effects and differences in learning environments (Van de Vijver & Leung, 1997). The lack of a control group may impede the ability to ascertain whether the observed improvements are genuinely attributable to the intervention of instructional strategies or to other influences. To enhance the reliability of our study, future research could adopt more rigorous experimental designs, including the establishment of control groups, to validate our research findings.

Secondly, the primary focus of this study was on first-grade students. However, Renninger (1992) suggests that significant differences exist among students of different grades in terms of cognitive development, learning needs, and interests, which may lead to variations in their responses to instructional methods. Therefore, future research could consider expanding the sample coverage to examine the universality of various instructional methods across different age groups and whether their instructional effects vary among various grades of students.

The implementation and sustainability of instructional methods are another aspect that requires careful consideration. Although significant progress was witnessed in the short term, the long-term effects remain uncertain. The implementation of instructional methods is not a one-time event but requires extensive exploration and practice (Kumaravadivelu, 2001). Short-term achievements may stem from students' adaptation and acceptance of new methods; however, whether such improvements can be sustained in the long term requires further observation and research. The focus lies in whether this instructional approach can be continually adjusted and optimized to meet students' needs and educational environments. Future research could evaluate the long-term effects of this instructional method by tracking participants' learning progress. This includes not only tracking students' academic performance but also paying attention to their learning interests, attitudes, and even career planning. Additionally, assessing the long-term impact of instructional methods provides valuable feedback for further optimizing instructional methods, thereby enhancing their implementation effects (LaVelle et al., 2020). This is not only important for educators but also for policymakers.

Furthermore, further exploration can be conducted into the applicability of instructional methods based on constructivist theory and cooperative learning in different subjects and curriculum settings. For example, in theoretical subjects such as chemistry and physics, can this instructional method effectively assist students in understanding and mastering abstract concepts? In practical subjects such as experimental sciences and

engineering, can this instructional method promote the development of students' practical skills and innovation awareness? These questions necessitate further in-depth research and exploration.

6. Conclusion

In conclusion, the findings of this study highlight the considerable impact of instructional strategies grounded in constructivist theory and cooperative learning principles on first-grade students' academic achievement and social development. The results reveal substantial improvements in both mathematical learning achievement and social awareness following the implementation of these pedagogical approaches. However, it is essential to acknowledge certain limitations, such as the absence of a control group and the focus on a specific grade level, which call for cautious interpretation of the findings. Future research endeavors should aim to address these limitations by adopting rigorous experimental designs, expanding sample coverage across diverse age groups, and conducting longitudinal studies to examine the sustained effects of instructional methods over time. By advancing our understanding of the efficacy and applicability of constructivist theory and cooperative learning practices in diverse educational contexts, educators and policymakers can better inform instructional decision-making and ultimately enhance student learning outcomes and socio-emotional well-being.

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Authors contributions

Zhu Yanqiu developed the main idea of this research, wrote the manuscript, developed the research tools, and analyzed the results. Assistant Professor Dr. Athirarch Nankhantee and Associate Professor Dr. Nirat Jantharajit revised and improved the writing quality of the manuscript, developed the research methodology, and rechecked the manuscript before submission. All authors read and approved the final manuscript.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed consent

Obtained.

Ethics approval

The Research Ethics Committee of Nakhon Phanom University

The journal’s policies adhere to the Core Practices established by the Committee on Publication Ethics (COPE).

Provenance and peer review

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Data availability statement

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Data sharing statement

No additional data are available.

Reference

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