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# Strengthening mathematics learning motivation in elementary students through numbered heads together cooperative learning supported by ice-breaking activities

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**Abstract**

**Background:** Student motivation in elementary mathematics learning often decreases when classroom instruction relies mainly on teacher-centered approaches. Combining cooperative learning with ice-breaking activities may help create a more engaging and emotionally supportive learning environment.
**Aim:** This study aimed to examine whether the Numbered Heads Together cooperative learning model supported by ice-breaking activities could improve students' motivation to learn mathematics compared to conventional instruction.
**Method:** A quasi-experimental study with a nonequivalent control group design was conducted involving 36 third-grade students from two public elementary schools. The experimental group received mathematics instruction using the Numbered Heads Together model integrated with ice-breaking activities, while the control group was taught using conventional methods. Students' learning motivation was measured through a validated Likert-scale questionnaire administered before and after the intervention. The data were analyzed using descriptive statistics and an independent samples t-test.
**Results:** Both groups demonstrated an increase in learning motivation after instruction; however, the improvement in the experimental group was higher than that of the control group. Statistical analysis confirmed a significant difference in posttest motivation scores between the two groups.
**Conclusion:** The findings indicate that integrating ice-breaking activities into Numbered Heads Together cooperative learning can strengthen elementary students' motivation to learn mathematics by fostering active participation and a positive classroom atmosphere.

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## INTRODUCTION

Low learning motivation in elementary mathematics classrooms has recently become a growing concern in educational practice (Schukajlow et al., 2023; Zhu & Kaiser, 2022). Mathematics is frequently presented in a procedural and rigid manner, which can discourage students from engaging meaningfully at an early stage (Bobis et al., 2021; Corrêa & Haslam, 2021). This condition is particularly critical at the elementary level, where students begin to form lasting attitudes toward mathematical learning. Early experiences marked by boredom or anxiety may shape negative perceptions that continue into later schooling. In many classrooms, students tend to remain passive and depend heavily on teachers' explanations. Such learning situations restrict opportunities for exploration, discussion, and active sense-making. Consequently, students often fail to relate mathematical ideas to their everyday contexts. For this reason, strengthening learning motivation at the elementary level has become an important educational priority.

The urgency of this issue is closely associated with instructional practices that are still widely applied in elementary schools (Chiu et al., 2021; Duarte et al., 2023). Teacher-centered approaches continue to dominate classroom instruction, positioning students primarily as recipients rather than active contributors (Woods et al., 2022). These practices can reduce students' sense of ownership

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and involvement in the learning process. Continuous exposure to passive learning environments may gradually weaken intrinsic motivation. Elementary students, who naturally need interaction and variety, are especially vulnerable to monotonous teaching methods. When lessons lack variation, students' attention and enthusiasm tend to decline rapidly. This situation emphasizes the importance of instructional strategies that actively involve learners. Without active engagement, attempts to improve mathematics learning outcomes may remain limited.

An additional concern relates to the developmental characteristics of elementary students (Anderson et al., 2021; Chen et al., 2022). At this stage, students are highly sensitive to social interaction and emotional conditions within the classroom (Huang & Lajoie, 2023; Poulou & Denham, 2023). Learning designs that overlook these characteristics risk neglecting students' affective needs. Motivation in learning is influenced not only by cognitive understanding but also by emotional security and social connection. Feelings of anxiety or disconnection often reduce students' willingness to participate. In contrast, a supportive classroom environment can promote confidence and curiosity. Instructional approaches that ignore emotional dimensions may unintentionally weaken learning motivation. Therefore, balancing cognitive and affective aspects of instruction is essential in elementary education.

In response to these challenges, cooperative learning has gained attention as an instructional alternative (Bada & Jita, 2022; Keramati & Gillies, 2022). By emphasizing collaboration and shared responsibility, cooperative learning encourages students to take an active role in learning activities (Colomer et al., 2021; T. Zhou & Colomer, 2024). The Numbered Heads Together model, for instance, promotes individual accountability within group work. This structure minimizes unequal participation and reduces the dominance of certain students. In mathematics classrooms, peer interaction allows students to exchange ideas and clarify understanding through discussion. Cooperative learning also supports students' social development, which is vital at the elementary level. Nevertheless, cooperative learning does not automatically lead to high motivation. Its success depends largely on how students experience the learning environment.

The emotional atmosphere of the classroom remains a critical but often underestimated factor influencing learning motivation (Ishida & Sekiyama, 2024; Kılıç et al., 2021). Even carefully planned cooperative activities may be ineffective if students feel uncomfortable or disengaged (Gedamu & Shewangezaw, 2022). Elementary students commonly experience changes in attention during learning activities. When instructional demands increase without emotional support, students may quickly lose focus. Ice-breaking activities can function as short interventions to restore attention and enthusiasm. These activities help ease tension and prepare students emotionally for learning. By providing moments of relaxation, ice-breaking activities may improve students' readiness to engage. Consequently, emotional support strategies deserve greater consideration in instructional planning.

Despite their potential value, ice-breaking activities are sometimes perceived as supplementary rather than instructional. This perception can be problematic, particularly in elementary classrooms where emotional engagement strongly influences learning outcomes (Hartikainen et al., 2021; Martins et al., 2022). Ice-breaking activities should not be viewed merely as entertainment. When applied purposefully, they facilitate smoother transitions into learning activities. They also contribute to a classroom atmosphere that supports cooperation and participation. Without such affective support, even interactive instructional models may lose effectiveness. Therefore, re-evaluating the pedagogical role of ice-breaking activities is necessary. Their strategic integration may enhance the overall impact of cooperative learning.

Another important issue is the limited attention given to learning motivation as a central research outcome (Pekrun & Marsh, 2022; Vu et al., 2022). Many studies prioritize academic achievement while positioning motivation as a secondary concern (Abildaeva et al., 2022; Costa et al., 2024). This perspective overlooks the role of motivation as a foundation for sustained learning.

In elementary education, motivation often precedes achievement rather than results from it. Motivated students tend to engage more deeply and persist in learning tasks. Conversely, low motivation can undermine even well-designed instruction. Research that directly examines motivational outcomes is therefore needed. Such investigations can clarify how instructional strategies influence students' willingness to learn.

Considering these challenges, exploring instructional approaches that integrate cognitive structure and emotional support has become increasingly important (Chew & and Cerbin, 2021; Kong & Wang, 2024). The combination of Numbered Heads Together cooperative learning and ice-breaking activities offers a promising instructional direction. This approach addresses both active participation and emotional readiness in mathematics learning. It aligns with the developmental needs of elementary students, who benefit from interaction and enjoyment. Investigating this combination is timely given persistent concerns regarding low motivation in mathematics classrooms. Empirical evidence is required to examine its effectiveness in authentic learning contexts. Understanding how these strategies interact may inform more holistic instructional practices. Accordingly, this study seeks to address the urgent need to strengthen learning motivation in elementary mathematics education.

Recent discussions on mathematics learning motivation consistently underline the importance of learning environments that encourage student involvement. Soe et al. (2025) argue that autonomy-supportive classrooms can enhance students' engagement and achievement in mathematics. In a related vein, Wijaya et al. (2025) reveal that motivation is closely intertwined with growth mindset, grit, anxiety, and self-efficacy. These psychological dimensions are further connected to long-term educational trajectories, as shown by Park et al. (2025), who link intrinsic motivation in mathematics to students' interest in STEM careers. Beyond psychological factors, instructional design has been shown to play a decisive role. Fauzi et al. (2025) demonstrate that gamified and joyful learning models can foster mathematical literacy and motivation. Similarly, Liu et al. (2025) report that AI-supported learning environments enhance interaction and learning attitudes in mathematics classrooms. Technological enrichment through augmented reality has also been found to increase engagement Kaźmierczak et al. (2025), although Yurt (2025) cautions that motivational outcomes vary according to individual learning styles. Social and contextual dimensions further shape motivation. Qin et al. (2025) highlight the influence of peer relationships and socio-emotional competence, while Z. Zhou et al. (2025) emphasize the combined roles of parental responses and teachers' instructional practices. In contrast, Dadandı (2025) shows that negative peer experiences may weaken students' persistence and effort. Taken together, these studies point to a clear research gap in examining how structured cooperative learning models can be strengthened through affective strategies, such as ice-breaking activities, in elementary mathematics learning.

Learning motivation is a foundational element in elementary mathematics education because it shapes students' willingness to engage, persist, and develop positive attitudes toward the subject. In many classrooms, instructional practices continue to prioritize procedural mastery, often overlooking students' emotional readiness and engagement during learning activities. Cooperative learning models such as Numbered Heads Together are designed to promote interaction and individual accountability, yet their implementation may not fully address students' fluctuating attention, confidence, and emotional comfort. Elementary learners, in particular, require learning experiences that feel supportive and inviting in order to participate actively. Ice-breaking activities offer a pedagogical means to reduce tension, reorient attention, and create a positive classroom atmosphere. When these affective strategies are intentionally embedded within cooperative learning, they may enhance students' motivation to engage in mathematical tasks. This study is therefore grounded in the need to explore an instructional approach that attends simultaneously to participation structure and emotional support. Such an approach is expected to be especially relevant for strengthening motivation in elementary mathematics classrooms.

Although learning motivation has been widely discussed in mathematics education, existing research leaves several important questions unresolved. Much of the literature examines motivational factors separately, focusing on instructional models, learner characteristics, or classroom climate in isolation. This fragmented approach provides limited insight into how multiple instructional and affective elements might work together to support motivation. In addition, many motivation-focused studies are situated at the secondary or tertiary education levels, while elementary mathematics classrooms remain comparatively underrepresented. This is a critical limitation, as students' attitudes toward mathematics often begin to form at the elementary stage and can influence their future learning trajectories. Furthermore, practical classroom strategies that are easy to implement and require minimal resources are rarely examined in an integrated manner.

Finally, research seldom investigates the combination of structured cooperative learning and affective regulation strategies as a unified instructional design. Cooperative learning emphasizes participation and accountability, yet may not sufficiently address students' emotional readiness. Conversely, ice-breaking activities are frequently treated as peripheral rather than as intentional components of instruction. The lack of empirical studies examining this integration reveals a clear gap that warrants systematic investigation in elementary mathematics learning contexts. the identified rationale and research gaps, this study aims to examine the effect of integrating Numbered Heads Together cooperative learning with ice-breaking activities on elementary students' motivation to learn mathematics. The study seeks to compare students' learning motivation in classrooms that implement this integrated instructional approach with those that rely on conventional teaching methods. It is hypothesized that students who experience Numbered Heads Together cooperative learning supported by ice-breaking activities will demonstrate higher levels of learning motivation than students taught through traditional instruction. By positioning motivation as the primary outcome, this study intends to contribute meaningful empirical evidence to the development of instructional practices that balance cognitive organization and affective support in elementary mathematics education.

## METHOD

### Research Design

This study was designed as a quasi-experimental investigation employing a nonequivalent control group approach. The design was chosen to accommodate the natural classroom setting, where random assignment of students was not practically possible. Two intact third-grade classes were involved, with one class designated as the experimental group and the other as the control group. Mathematics instruction in the experimental group was conducted using the Numbered Heads Together cooperative learning model combined with ice-breaking activities, whereas the control group followed conventional teacher-centered instruction. To capture changes in students' learning motivation, measurements were administered before and after the instructional intervention. This approach allowed for a systematic comparison of motivational outcomes while preserving the authenticity of everyday classroom practices. The sequence of research activities, from problem identification to data analysis, is illustrated in Figure 1.

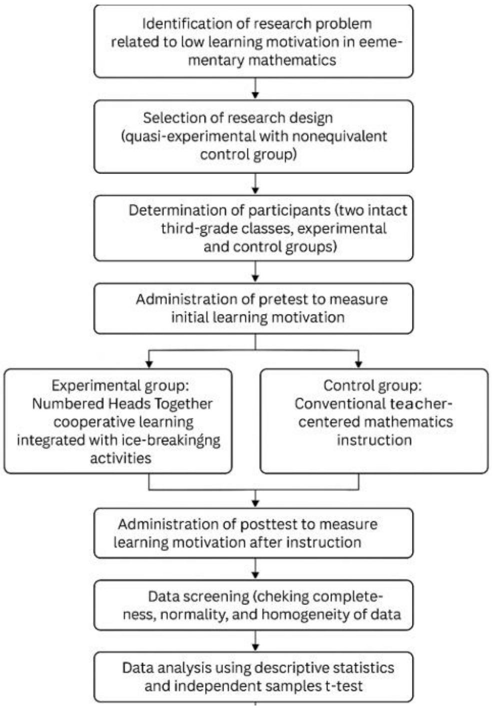


**Figure 1.** Research methodology flowchart

## Participants

The participants consisted of 36 third-grade elementary school students drawn from two public elementary schools. The students were divided into an experimental group and a control group, each comprising 18 students. Participants were selected using intact classroom grouping to preserve natural learning conditions. Both groups were comparable in terms of age and general academic background based on school records. Prior to the intervention, the students had experienced similar instructional practices in mathematics. Permission to conduct the study was obtained from school authorities and classroom teachers. All participant information was treated confidentially throughout the research process.

## Instrument

Learning motivation was measured using a questionnaire developed to capture key dimensions of students' motivation in mathematics learning. The instrument consisted of Likert-scale items addressing students' interest, participation, persistence, and enthusiasm during mathematics lessons. The questionnaire was administered to both groups before and after the instructional intervention. Content validity was ensured through expert judgment by experienced elementary educators. Reliability testing was conducted to confirm the internal consistency of the instrument. The questionnaire served as the primary data collection tool for assessing changes in students' learning motivation.

## Data Analysis

Data analysis involved both descriptive and inferential statistical procedures. Descriptive statistics were used to summarize students' motivation scores, including mean values and standard deviations for pretest and posttest results. Prior to hypothesis testing, normality and homogeneity tests were conducted to ensure that the data met the assumptions for parametric analysis. An independent samples t-test was then applied to compare posttest motivation scores between the experimental and control groups. This analysis aimed to determine whether a statistically significant difference in learning motivation existed as a result of the instructional intervention. The results of the analysis were used to address the research objectives and test the proposed hypothesis.

# RESULTS AND DISCUSSION

## RESULTS

This section presents the empirical findings of the study based on descriptive statistics, assumption testing, and hypothesis testing. All analyses were conducted using IBM SPSS Statistics version 25, and the results are reported according to the sequence of statistical procedures.

### Descriptive Analysis of Learning Motivation

The descriptive statistics of students' learning motivation before and after the intervention are presented in Tables 1 and 2. These tables summarize the number of participants, minimum and maximum scores, mean values, standard deviations, and variances for both the control and experimental groups.

**Table 1.** Descriptive Statistics of Pretest Scores

| Group | N | Min | Max | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|
| Control Class | 19 | 43 | 56 | 49.53 | 3.907 | 15.263 |
| Experimental Class | 17 | 55 | 60 | 55.06 | 3.010 | 9.059 |

Table 1 indicates that prior to treatment, the experimental group had a higher average motivation score than the control group. This difference reflects the initial condition of students before the learning intervention was applied.

**Table 2.** Descriptive Statistics of Posttest Scores

| Group | N | Min | Max | Mean | Std. Deviation | Variance |
|---|---|---|---|---|---|---|
| Control Class | 19 | 43 | 56 | 50.63 | 3.148 | 9.912 |
| Experimental Class | 17 | 53 | 60 | 57.47 | 2.211 | 4.890 |

As shown in Table 2, both groups experienced an increase in learning motivation after the instructional process. The control group showed a modest increase from a mean score of 49.53 to 50.63, while the experimental group demonstrated a larger increase from 55.06 to 57.47. This indicates that the improvement in learning motivation was more pronounced among students who participated in cooperative learning assisted by ice-breaking activities.

### Normality Test

Prior to conducting inferential analysis, a normality test was performed to ensure that the data met the assumptions required for parametric testing. The Shapiro–Wilk test was applied because the sample size in each group was fewer than 50. The results of the normality test are presented in Table 3.

**Table 3.** Normality Test Results

| Data Set | Sig. |
|---|---|
| Control Class Pretest | > 0.05 |
| Control Class Posttest | > 0.05 |
| Experimental Class Pretest | > 0.05 |
| Experimental Class Posttest | > 0.05 |

The significance values for all datasets exceeded 0.05, indicating that the pretest and posttest scores in both groups were normally distributed.

### Homogeneity Test

After confirming normality, a homogeneity test was conducted to examine whether the variances of posttest scores between the control and experimental groups were equal. The results of the Levene test are presented in Table 4.

**Table 4.** Homogeneity Test Results

| Variable | Sig. |
|---|---|
| Learning Motivation | 0.252 |

The significance value of 0.252 is greater than 0.05, indicating that the variances of the posttest scores in both groups were homogeneous.

## Hypothesis Testing

Once the assumptions of normality and homogeneity were satisfied, hypothesis testing was carried out using an independent samples t-test. The results of this analysis are summarized in Table 5.

**Table 5.** Independent Samples T-Test Results

| t | df | Sig. (2-tailed) | Mean Difference |
|---|---|---|---|
| -7.156 | 33 | 0.000 | -6.681 |

The significance value obtained from the t-test was 0.000, which is lower than the significance level of 0.05. This result indicates a statistically significant difference in learning motivation between the experimental group and the control group. Therefore, the null hypothesis was rejected, and the alternative hypothesis was accepted. These findings demonstrate that the cooperative learning model assisted by ice-breaking activities had a significant effect on students' learning motivation in elementary mathematics.

## DISCUSSION

The results of this study indicate that learning motivation in elementary mathematics is closely linked to how instructional activities are organized and experienced by students. The higher motivation found in the experimental group suggests that instructional structures requiring active involvement can reduce passive learning habits. This finding is consistent with the perspective of Soe et al. (2025), who argue that motivation increases when students experience agency in the learning process. In classrooms where students are expected to contribute, attention and engagement tend to improve. The Numbered Heads Together model creates this expectation by assigning responsibility to every group member. Students cannot rely solely on peers, which encourages continuous involvement. This condition may explain why students showed greater enthusiasm during learning activities. Therefore, participation structure appears to be a key contributor to motivational improvement.

In addition to participation, emotional readiness plays an equally important role in shaping motivation. The use of ice-breaking activities likely helped students enter learning situations with reduced tension and improved focus. This interpretation aligns with Wijaya et al. (2025), who emphasize the relationship between motivation, anxiety management, and self-efficacy. When students feel less anxious, they are more willing to express ideas and engage in group discussion. Ice-breaking activities may function as emotional transitions that prepare students for collaborative tasks. Such preparation is especially important for elementary learners, who are sensitive to classroom atmosphere. Without emotional comfort, instructional strategies may not reach their full potential. Thus, emotional support complements cognitive structure in sustaining motivation.

The findings can also be understood in relation to intrinsic motivation development. Park et al. (2025) suggest that early motivational experiences influence students' long-term engagement with learning domains. Although this study did not examine future outcomes, increased motivation at the elementary level may shape more positive attitudes toward mathematics. When students experience success and enjoyment, they are more likely to persist in challenging tasks. Cooperative learning environments support this process by normalizing discussion and error as part of learning. Students learn that participation is valued over mere correctness. This sense of acceptance may strengthen intrinsic motivation. Over time, such experiences could influence students' willingness to engage with mathematics. Therefore, early motivational support is pedagogically significant.

Instructional enjoyment also emerged as an implicit factor in the observed motivational gains. The findings resonate with Fauzi et al. (2025), who highlight the motivational benefits of joyful learning designs. In this study, enjoyment was introduced through simple, non-digital ice-breaking activities. These activities provided variation and reduced monotony in classroom routines. When learning feels enjoyable, students are more likely to sustain attention. Cooperative learning further amplifies this enjoyment by allowing social interaction. Enjoyment, in this sense, is not entertainment but a condition that supports engagement. This suggests that motivation can be enhanced without sophisticated technological tools. Thoughtful instructional planning remains central.

Interaction among students also contributed to motivational development. Liu et al. (2025) emphasize that interaction-rich learning environments improve attitudes and engagement. Although their work focuses on technology-supported interaction, the present study demonstrates similar effects through face-to-face collaboration. Numbered Heads Together encourages dialogue and explanation among peers. Ice-breaking activities may further lower barriers to interaction by fostering openness. When students feel comfortable speaking, interaction becomes more meaningful. This interaction helps students stay cognitively engaged. As engagement increases, motivation naturally follows. Therefore, interaction functions as an important motivational pathway.

Situational interest is another lens through which the results can be interpreted. Kaźmierczak et al. (2025) argue that interactive experiences increase situational interest in learning. In the present study, situational interest may have emerged from varied learning activities and collaborative tasks. Ice-breaking activities introduced novelty that captured students' attention. Cooperative learning sustained this attention through structured participation. Together, these elements created a dynamic learning environment. Such conditions are particularly suitable for elementary students. Situational interest may serve as an initial trigger for deeper motivational engagement. This helps explain the stronger motivational outcomes in the experimental group.

Learner diversity must also be considered when interpreting the findings. Yurt (2025) notes that motivation-related variables are influenced by individual learning styles and preferences. Cooperative learning allows flexibility in how students contribute to group work. Some students may prefer speaking, while others engage through listening or problem solving. Ice-breaking activities may reduce pressure on students who are initially reluctant to participate. This flexibility enables broader student involvement. As more students feel included, overall motivation increases. Thus, the instructional approach appears adaptable to diverse learner characteristics. This adaptability enhances its practical relevance.

Social dynamics within the classroom further contextualize the results. Qin et al. (2025) emphasize that peer relationships and socio-emotional competence influence learning interest. Cooperative learning naturally promotes peer interaction and mutual support. Ice-breaking activities may strengthen these relationships by creating shared positive experiences. When students feel socially connected, they are more willing to engage academically. A supportive peer environment reduces fear of making mistakes. This social safety encourages participation. Increased participation, in turn, supports motivation. Therefore, social context is inseparable from motivational development.

Teacher practices also intersect with students' motivational experiences. Zhou et al. (2025) highlight that instructional approaches influence mastery-oriented motivation. The present study shows that instructional choices, such as cooperative learning and affective support, signal what is valued in the classroom. When participation and effort are emphasized, students may adopt more positive motivational orientations. Ice-breaking activities reinforce the message that the classroom is a supportive space. Teachers who intentionally design such environments can influence students' motivation. This suggests that motivation is shaped through pedagogical decisions. It is not solely a student characteristic. Instructional design therefore carries motivational responsibility.

Finally, the findings should be considered alongside potential social risks in classroom settings. Dadandı (2025) demonstrates that negative peer experiences can reduce students' persistence and effort. Although this study did not directly examine peer conflict, the instructional approach used may help mitigate such risks. Structured cooperative learning reduces exclusion by assigning clear roles. Ice-breaking activities may further promote positive interaction. These features contribute to a safer classroom climate. When students feel socially secure, motivation is more likely to develop. Consequently, the instructional approach examined offers both academic and socio-emotional benefits. This reinforces its relevance for elementary mathematics education.

**Implications**

The results of this study suggest that learning motivation in elementary mathematics can be deliberately shaped through thoughtful instructional design. The positive effect of combining the Numbered Heads Together model with ice-breaking activities indicates that motivation should be viewed as an instructional outcome that can be planned and managed. For classroom practice, this implies that teachers may strengthen students' engagement by integrating cooperative structures with simple activities that support emotional comfort. Such strategies are realistic to implement within regular classroom constraints and do not depend on advanced technological tools. The findings also imply that effective mathematics instruction at the elementary level requires attention to both participation structure and classroom atmosphere. From an institutional perspective, teacher training programs may benefit from emphasizing motivational strategies alongside pedagogical content knowledge. Overall, this study reinforces the idea that motivation-oriented instruction plays a crucial role in supporting meaningful learning experiences in mathematics.

**Limitations**

Several limitations should be considered when interpreting the findings of this study. The sample size was relatively limited and drawn from a specific educational context, which may affect the extent to which the results can be generalized to broader populations. The use of a quasi-experimental design meant that participants were not randomly assigned, leaving open the possibility that initial group differences influenced the outcomes. The intervention was conducted over a short instructional period, making it difficult to determine whether the observed motivational gains would persist in the long term. In addition, learning motivation was assessed through questionnaire responses, which rely on students' self-perceptions and may not fully capture their actual engagement. The study did not examine other learning variables, such as achievement or cognitive performance, that could interact with motivation. These constraints indicate that the results should be interpreted as context-specific rather than universally applicable.

**Suggestions**

Future studies may extend this line of research by involving larger samples from varied educational settings to enhance external validity. Researchers could adopt longitudinal approaches to explore whether motivational improvements are sustained across longer instructional periods. Further investigation might also examine the relationship between increased motivation and other learning outcomes, including conceptual understanding and problem-solving skills. Incorporating qualitative methods, such as classroom observations or student reflections, could enrich understanding of how students experience cooperative learning and ice-breaking activities. Additional studies may compare different cooperative learning models combined with various affective strategies to identify optimal instructional combinations. From a practical standpoint, future research could focus on how teachers adapt these approaches in classrooms with diverse student characteristics. Such efforts would contribute to a deeper and more nuanced understanding of motivation-centered mathematics instruction.

## CONCLUSION

The findings of this study demonstrate that students' motivation to learn mathematics at the elementary level can be meaningfully enhanced through instructional approaches that combine active collaboration and emotional support. The use of the Numbered Heads Together cooperative learning model, when accompanied by ice-breaking activities, creates learning conditions that encourage participation and reduce student passivity. Students exposed to this instructional combination showed stronger motivation than those who experienced conventional teaching practices. This suggests that motivation is responsive to how learning activities are structured and experienced in the classroom. Instruction that promotes shared responsibility while maintaining a comfortable learning atmosphere allows students to engage more confidently with mathematical tasks. The results underline the importance of addressing motivational factors alongside instructional content in elementary mathematics education. By integrating cooperative interaction with affective readiness, teachers can foster more positive learning experiences. In this way, the study reinforces the view that thoughtfully designed instruction plays a central role in strengthening students' willingness to learn mathematics.

## AUTHOR CONTRIBUTIONS STATEMENT

**Anggraini** was responsible for the overall research process, including the formulation of the research problem, design of the study, data collection, and data analysis. She also prepared the initial manuscript draft and integrated the research findings into a coherent academic article.

**Muhammad Fendrik** contributed by providing academic supervision throughout the research process, particularly in refining the research design, validating the data analysis procedures, and offering critical feedback on the interpretation of results.

**Intan Kartika Sari** supported the study by guiding the development of research instruments, reviewing the methodological rigor, and assisting in improving the clarity and structure of the manuscript. All authors collaboratively reviewed the final version of the manuscript and approved it for submission.

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