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Application of a Manipulative Media-Assisted Group Investigation Model to Improve Collaboration Among Students at Keleyan 1 Public Elementary School

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Abstract

This classroom action research aims to improve fifth-grade students' conceptual understanding of spatial figures and collaboration skills at Keleyan 1 Public Elementary School by implementing the Group Investigation model assisted by manipulative media. The research addresses two key problems: students' low comprehension of abstract geometric concepts and limited participation in collaborative group activities. The study was conducted using Kurt Lewin's action research model, carried out over two cycles involving 35 students and a classroom teacher. The instruments used were collaboration observation sheets and conceptual understanding tests. Data were analyzed using descriptive statistics, including percentage comparisons and gain score analysis. Prior to the intervention, 88.6% of students had not met the Minimum Competency Criteria, and only 11.4% showed a high level of collaboration. After two cycles of intervention, students demonstrating high collaboration increased to 40%, and those with low collaboration decreased to 17.1%. Additionally, the average gain score for conceptual understanding reached 0.60, which falls under the moderate improvement category. The findings indicate that the Group Investigation model, when integrated with role assignment, structured collaboration, and the use of concrete, manipulative media, can effectively enhance both cognitive and social dimensions of mathematics learning. This approach provides a promising strategy for fostering active learning in elementary education.

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Introduction

Basic education plays an important role in shaping children's logical and social thinking skills. Mathematics, particularly spatial geometry, develops logical, analytical, and spatial thinking skills that are essential for solving everyday problems (Ratnasari et al., 2017). However, understanding these abstract concepts is often hindered by a lack of concrete media and insufficient student collaboration (Sari & Putri, 2021). The social education approach places collaboration at the core of learning, with Vygotsky's theory (1978) and Johnson & Johnson's theory (2014) emphasizing the role of social interaction and individual responsibility. Vygotsky's theory explains that collaboration within the Zone of Proximal Development aids in the internalization of concepts, while Johnson & Johnson's theory highlights the key elements of effective collaboration. The Group Investigation model is highly relevant as it encourages active collaboration through stages from exploration to evaluation. The use of manipulative media for concrete spatial construction also supports conceptual understanding and spatial representation. This collaborative interaction helps students transform abstract concepts into concrete ones while developing essential thinking and social skills in elementary education.

Solid geometry is part of the fifth-grade elementary school curriculum and is often considered difficult by students because mathematics is perceived as intimidating, particularly when it comes to solid geometry. This is often the case because students have difficulty visualizing the volume of solid shapes, which are typically only explained in two dimensions in textbooks. In this rapidly advancing technological era, the use of digital media serves as an alternative bridge to address the challenges of teaching mathematics, particularly in the area of solid geometry, which requires visual aids to facilitate understanding of concrete shapes in the teaching and learning process.

From the results of interviews at SDN Keleyan 1, it was found that many students had difficulty understanding spatial structures, especially in analyzing shapes and calculating area and volume accurately. In addition, cooperation among students in groups was not optimal; students were expected to understand spatial structures through concrete media and actively work together in groups. However, in reality, there was still a significant gap between these expectations and the actual conditions in the field. To address this issue, the use of cooperative learning models as educational tools presents a potential solution, emphasizing group work that fosters collaboration and the collective utilization of individual potential. One relevant method is the Group Investigation model, which supports supportive interaction, effective communication, and the stimulation of students' critical thinking skills (Muhsetyo, 2009).

One of the challenges in mathematics learning at the elementary school level is the low level of students' understanding of spatial figures. This is due to the limited use of real media by teachers in learning, as well as the lack of active student participation

in group activities. This condition hinders the development of students' spatial thinking skills, which should be honed through direct interaction with three-dimensional objects.

According to data from the 2022 National Assessment, the numeracy literacy skills of elementary school students in Indonesia are still in the low category, especially in the areas of spatial reasoning and geometry. School exam results in some regions also indicate that questions related to three-dimensional shapes often constitute the section with the lowest student success rates. Therefore, it is important to implement learning strategies that can overcome visual barriers and encourage collaboration among students, such as through the cooperative learning model based on group investigation (Group Investigation), which enables s

This study is in line with the research conducted by Kadek Sri Trisna Devi et al., 2021, which used a classroom action research method carried out in two cycles. This study also noted improvements in student activities and engagement during the learning process. This success is attributed to the Group Investigation model, which enables students to actively discuss, collaborate in groups, and solve problems independently. Based on the research findings, it can be concluded that by using the Group Investigation learning model in this study, learning can be more organized and engaging. Therefore, this research is important to assess the effectiveness of implementing real-world media based on the Group Investigation model in enhancing students' understanding of spatial geometry concepts and their ability to collaborate in groups in fifth-grade elementary school classrooms.

Method

This research aims to find solutions to the challenges faced by 5th-grade students at SDN Keleyan 1 in understanding spatial shapes and the lack of cooperation in the classroom. Initial observations indicate that many students struggle to understand three-dimensional geometric shapes, and often there are passive students who prefer to rely on proactive classmates, which affects the disparity in learning outcomes. This research takes place at SDN Keleyan 1, Socah District, Bangkalan Regency, focusing on 5th-grade students and the homeroom teacher, Mrs. Siti, from March 10, 2025, until completion. We will use the Kurt Lewin Model Classroom Action Research as the main approach. The series of approaches in the classroom action research applied in this study refers to Kurt Lewin's scheme. The details of each element include:

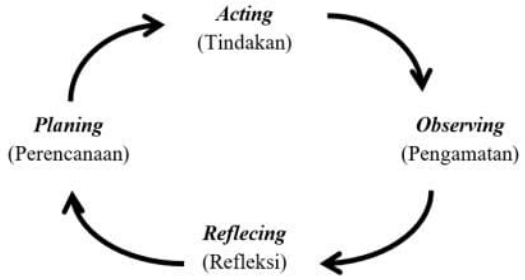

Figure 1. Kurt Lewin's classroom action research model
Adopted from Depdiknas (Putri, Suandhi, and Putra 2017).

As part of the PTK, we set clear success criteria in each cycle. Quantitatively, our target is for at least 75% of students to achieve a minimum score of 70 on the final test cycle of spatial building materials, and at least 80% of students to show active participation in group activities. Qualitatively, we hope to see changes in passive students who begin to ask more questions, contribute ideas, and engage in group discussions. Additionally, we want to see an improvement in the quality of harmonious collaboration where each member contributes, as well as a deeper and more applicative conceptual understanding of spatial structures among the students. Data collection and analysis, we will use qualitative research methods. Data will be collected through observation (using structured observation sheets and field notes to record interactions and participation), interviews (with selected teachers and students to explore their experiences and perspectives), and document analysis (such as student worksheets and formative/summative test results). The collected data will be analyzed descriptively and thematically to identify patterns and meanings behind the observed phenomena. To ensure the validity of the findings, we will apply data triangulation, which involves comparing information from various sources to corroborate each other. In an effort to address student passivity, we will provide scaffolding or gradual assistance, such as assigning specific roles within groups or prompting participation with questions. Group formation will be done heterogeneously, combining students with different abilities so that they can help and learn from each other, thus optimizing the collaboration process.

Results and Discussion

Results

Before the intervention, several main substance issues were identified, namely the low understanding of spatial concepts with an average pretest score of 61.4, far below the Minimum Completeness Criteria (70), low collaboration shown by 62.9% of students, unequal participation in groups marked by the dominance of one student and the passive attitude of other members, and the lack of concrete media to understand

three-dimensional shapes. The absence of role division or collaborative guidance in previous learning. This issue indicates the unmet cognitive needs of students at the concrete operational stage according to Piaget's theory, which asserts that abstract understanding can only be achieved with the help of concrete objects or manipulative media.

Table 1. Descriptive Statistics of Research Results

Stages	Average value	SD	% Of Students Completed (≥70)	% High collaboration	% Low collaboration
Pretest	61,4	6,32	11,4%	11,4%	62,9%
Cycle I	69,1	5,85	54,3%	25,7%	28,6%
Cycle II	77,3	4,94	85,7%	40,0%	14,3%

$$Gain = \frac{Posttest - Pretest}{100 - Pretest} = \frac{77,3 - 61,4}{100 - 61,4} = 0,412\ (Medium\ category)$$

Table 2. The improvement in collaboration skills is also reflected in the following four indicators:

Collaboration indicators	Cycle I	Cycle 2	% Improvement
Active participation	42,9%	71,4%	+28,5%
Listen and respond	50,0%	68,5%	+18,5%
Fair distribution of tasks	60,0%	80,0%	+20,0%
Help friend in groups	40,0%	85,7%	+45,7%

The Quantitative Collaboration Evaluation was conducted using an instrument with 4 indicators, with a maximum score of 15 per student. The range of evaluative classification includes In cycle I, 12–15 = High, 10–11 = Medium, <10 = Low. In cycle II, 40% of students are in the high category (14 students), 45.7% of students are in the medium category (16 students), and 14.3% of students are still in the low category (5 students). The research results align with Piaget's theory, which states that elementary school-aged children (7–11 years) are at the concrete operational stage. At this stage, children can only understand abstract mathematical concepts such as spatial figures if supported by real media. The use of manipulative media in Group Investigation learning has been proven to support this cognitive development. Furthermore, these results also reinforce Vygotsky's views on the Zone of Proximal Development, where collaboration among students and the teacher's role as a facilitator can help students understand concepts beyond individual reach.

The assessment of student collaboration is based on four main aspects: active participation in discussions, the ability to listen and respond to opinions, fair and proportional task distribution, and the willingness to help group members. A score of 1 indicates passive or low involvement, a score of 2 indicates occasional or uneven

involvement and response, and a score of 3 reflects active involvement, positive responses, fair task distribution, and initiative in helping without being asked. Therefore, a total score of 4–7 is classified as low collaboration, 8–10 as moderate, and 11–12 as high.

Based on the developed theoretical approach, students' achievement in mathematics, particularly in the realm of spatial geometry, is still considered low. This can be understood through the lens of Piaget's cognitive development theory, which places elementary school students in the concrete operational phase, where understanding abstract concepts heavily relies on the presence of real objects as a cognitive bridge (Kurniawati & Hidayati, 2021).

This research aims to improve the mathematics learning outcomes of fifth-grade students at SDN Keleyan 1 on spatial building materials through the Group Investigation learning model assisted by manipulative media. Before the implementation of the action, the researcher conducted preliminary observations through interviews with the teacher, classroom observations, and a pretest. The pretest results show that most students have not yet achieved learning completeness, with an average score of 61.4. In the observation of group collaboration, variations in scores among groups were found based on four indicators: participation, responsibility, communication, and cooperation. The assessment scores indicate that two groups (Group 2 and 5) fall into the low collaboration category (scores 6–7), while three groups (Group 1, 4, and 6) demonstrate high collaboration (scores 11–12). This can be seen in the following graph:

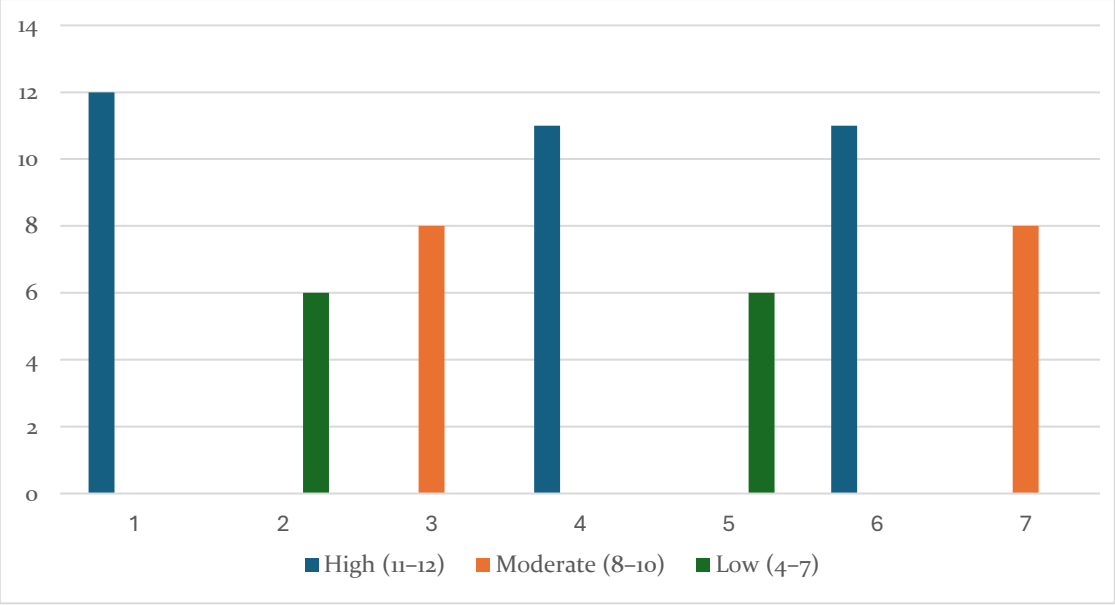

Figure 1. Student score graph by group

Although some groups like groups 1, 4, and 6 show good cooperation, some students in other groups still demonstrate low collaboration. Factors causing low

collaboration include a lack of communication skills and the dominance of one student in the group, as well as a lack of experience working in teams. For example, group 2 shows one-way communication, where one student dominates the discussion and the other members are passive. Group 5 experiences an uneven distribution of tasks, where students with lower abilities tend not to be involved in the problem-solving process. This shows that the conventional learning model has not succeeded in building healthy teamwork habits in that class.

Moreover, it should be criticized that the initial assessment of collaboration is conducted by the classroom teacher who also acts as the facilitator. This has the potential to introduce bias in the assessment, as teachers tend to evaluate based on previous experiences or perceptions of the students, rather than consistently applying objective criteria. To minimize this bias, the involvement of independent observers or the use of video recordings for more objective analysis is necessary.

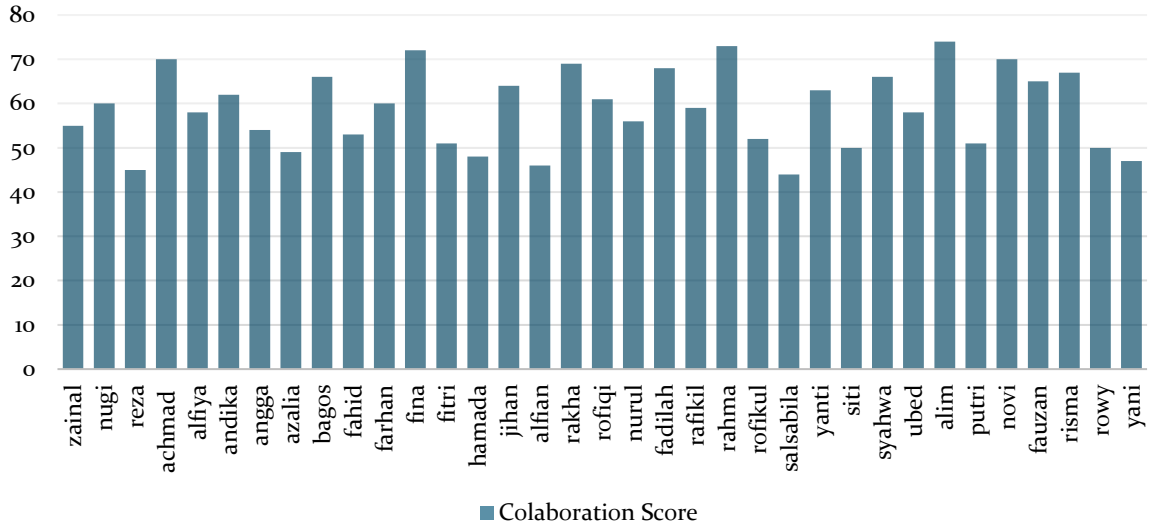

Figure 2. Cycle 1 diagram of student success

Observation in Cycle 1 with the help of manipulative media showed an increase in student activity and engagement, but the results were not satisfactory. Some students have not been able to cooperate well, where not all members are active and some dominate the discussion while others are passive. The distribution of tasks is also uneven, so only some students are doing the work. This indicates the need for improved teacher guidance and group management so that all students are actively involved and have a better understanding of the material. Thus, although there has been progress, the results of Cycle 1 have not fully met the learning objectives.

Improvement of Student Collaboration through the Group Investigation Model. In the implementation of Cycle 2, the main focus of the actions is to enhance the collaboration skills of fifth-grade students in mathematics learning on spatial building materials. This is done as a follow-up to the evaluation results of Cycle 1, where most

students were still in the low collaboration category. The Group Investigation learning model continues to be used, but its implementation has been enhanced with more systematic strategies and the support of manipulative media to encourage more effective group interactions.

Action Planning Steps to enhance student collaboration include assigning clear roles for each group member (leader, note-taker, presenter, data collector, and process evaluator), providing a collaboration guide sheet containing indicators of successful collaboration (participation, responsibility, communication, and cooperation), involving students in group reflections to evaluate their cooperation, and the teacher providing direct guidance to groups that show communication barriers. The implementation of the learning activity is carried out in two sessions. Students are divided into heterogeneous groups based on previous observations. They were assigned the task of investigating the characteristics of three-dimensional shapes with the help of manipulative media. The teacher acts as a facilitator, providing stimulus questions, and observing collaborative behavior. Student Collaboration Observation The assessment of collaboration is based on four indicators: Active participation in discussions, Ability to listen and respond to peers' opinions, Fair and proportional task distribution, Willingness to help other group members.

The results of the observation in Cycle 2 show a significant improvement in student collaboration during the learning process, where out of 35 students, 14 students (about 40%) fall into the good category with scores of 13-15, able to work together effectively with active participation, positive communication, balanced task distribution, and willingness to help peers. As many as 16 students (45.7%) fall into the moderate category with scores of 10-12, showing fairly good collaborative abilities but still needing improvement, while 5 students (14.3%) fall into the low category with scores of 6-9. The Cycle 2 observation of mathematics learning with the Group Investigation model shows a significant increase in students' collaboration skills, where active participation increased by 71.4%, listening and responding ability rose by 68.5%, fair task distribution increased by 80%, and the willingness to help group members saw the highest increase.

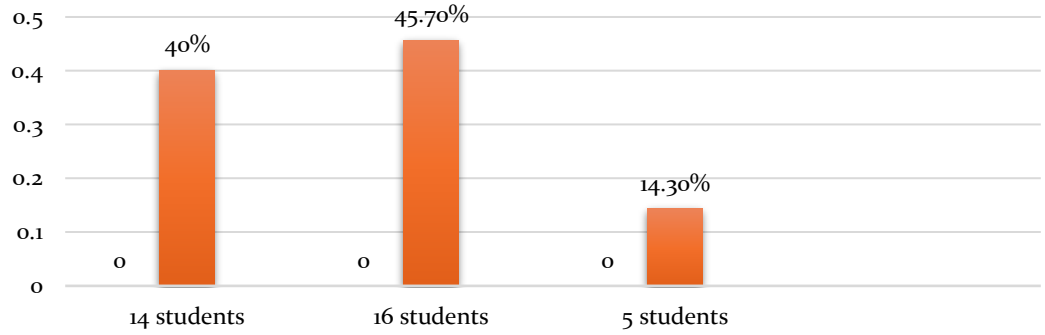

Figure 3. Cycle 2 percentage diagram for each student

The improvement in student collaboration through the implementation of the Group Investigation learning model has been supported by various studies in the 2022–2023 period. For example, Ainiyah et al. (2022) in their study found that the implementation of the Group Investigation model is effective in enhancing students' interpersonal skills, which include the ability to communicate and work together in groups. This research shows that students involved in the Group Investigation model demonstrate significant improvements in collaborative skills compared to students who follow conventional learning.

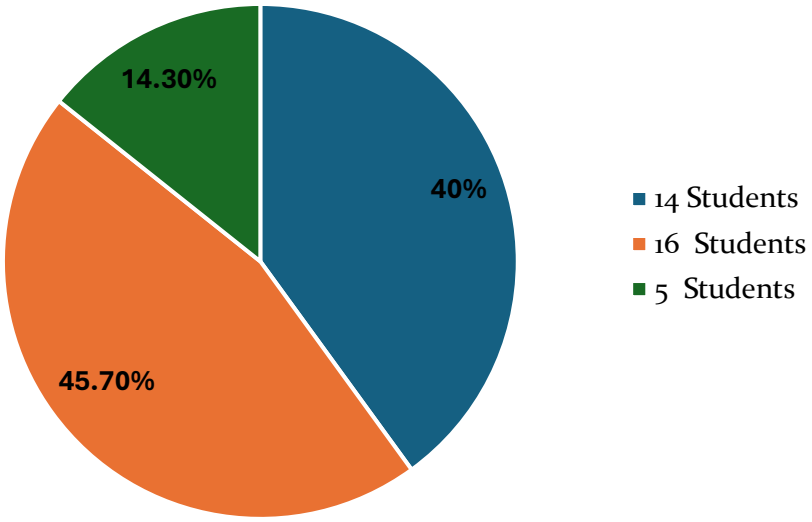

Figure 4. Cycle 2 pie chart in percentage of each student

Discussion

The results of Cycle 2 observations showed a significant improvement in the collaboration skills of fifth-grade students at Keleyan 1 Public Elementary School after the implementation of the Group Investigation model with systematic strategies and manipulative media. Most students were more active in discussing, sharing opinions, and fulfilling their roles responsibly, making the group work atmosphere more conducive and productive. The category of student collaboration has improved, with 40% falling into the good category, 45.7% into the moderate category, and only 14.3% into the low category, showing a significant decrease from Cycle 1. Students are also more open in communication, helping each other, and focused on completing tasks, so these actions effectively improve collaboration skills through a structured Group Investigation approach.

Reflection on the observation results shows that the implementation of the Group Investigation model with enhanced group work strategies successfully fostered students' collaboration skills, marked by active discussions, fair role distribution, openness in expressing and receiving opinions, and a more directed and productive work atmosphere. Therefore, although there are still students who need guidance,

overall collaboration in learning has significantly improved, and the Group Investigation approach has proven effective in developing these skills.

The results of this study are in line with the findings of Devi et al. (2021) and Yuliyanti et al. (2021), which demonstrate the effectiveness of the Group Investigation model in improving students' collaborative skills and mathematics learning outcomes. Unlike previous studies that only emphasized cognitive aspects, this research highlights the integration of cognitive and social aspects with explicit role division, the use of collaboration guidelines, and group reflection, thereby proving that the Group Investigation approach is effective in creating a participatory, productive, and meaningful group work atmosphere. The substantive problem that initially posed a major obstacle can be overcome through a systematic Group Investigation-based intervention. The addition of descriptive statistical support strengthens the validity of the results, while theoretical connections and critical comparisons with previous research deepen the significance of the findings in this study.

Conclusion

Based on the results of Classroom Action Research over two cycles, the application of the Group Investigation learning model assisted by manipulative media effectively improved the collaboration skills of fifth-grade students at Keleyan 1 Public Elementary School in spatial geometry. Initially, the majority of students (62.9%) showed low collaboration, and only 11.4% collaborated well. After the intervention in Cycles I and II, there was a significant improvement, with 40% of students in the good category, 45.7% in the moderate category, and only 14.3% still in the low category. The systematic Group Investigation model, which includes role division, collaboration guidelines, group reflection, and the use of manipulative media, successfully created an interactive, participatory, and productive group work environment. However, this study has limitations such as limited duration and potential bias from the teacher's role as both implementer and observer. The implementation of the Group Investigation model may also face challenges in different school contexts with varying resource conditions. Therefore, further research is recommended to test the effectiveness of this model over a longer period and in various school environments, as well as to examine bias mitigation strategies to strengthen the validity of the findings.

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Authors' Note

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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