Indonesian Journal of Education (INJOE)
Vol. 6 No. 1, (2026), pages: 127~140
https://felifa.net/index.php/INJOE
e-ISSN: 2810-059X

EFFECTIVENESS OF THE JIGSAW TYPE COOPERATIVE LEARNING MODEL IN IMPROVING THE MATHEMATICS LEARNING OUTCOMES OF GRADE V ELEMENTARY SCHOOL STUDENTS

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Abstract

Primary school pupils' mathematics learning outcomes remain a concern, particularly when learning is dominated by lectures and individual assignments with limited peer interaction. This study aims to describe pupils' mathematics learning outcomes before and after implementing the Jigsaw cooperative learning model and to examine its effect on Year 5 pupils at SDN 91 Pacongkang, Liliriaja Sub-district, Soppeng Regency. This quantitative study employed a one-group pre-test-post-test pre-experimental design involving 16 Year 5 pupils selected through saturation sampling. Data were collected using achievement tests and observation sheets and analysed using descriptive statistics, the Paired Sample T-Test, and N-Gain analysis. The results showed that the mean pre-test score was 51.88, with no pupil achieving the minimum pass mark. During implementation, the Jigsaw model, involving expert group discussions and peer teaching, encouraged highly enthusiastic pupil participation. The mean post-test

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score increased to 81.25. The Paired Sample T-Test yielded a t-value of 17.278 with a significance level of 0.000, indicating a significant difference between pre-test and post-test scores. The average N-Gain score was 0.6262, categorised as moderate and reasonably effective. Therefore, the Jigsaw cooperative learning model significantly and reasonably effectively improves pupils' mathematics learning outcomes.
Keywords: Mathematics Learning Outcomes; Jigsaw Cooperative Learning Model; Elementary School.

INTRODUCTION

Mathematics occupies a strategic position within the primary education curriculum as it plays a vital role in developing pupils' logical, systematic, critical and analytical thinking skills. Mathematics teaching is not solely focused on numeracy skills, but also on the mastery of concepts as the foundation for understanding subject matter at subsequent levels of education (Safari & Nurhida, 2024; Sosa-Gutierrez et al., 2023). A high-quality learning process ideally encourages pupils to construct knowledge through active and meaningful learning experiences. The success of this process is reflected in learning outcomes that demonstrate the level of competence mastery in line with the stated objectives. A strong grasp of mathematical concepts from primary school onwards is an essential foundation for pupils in tackling academic challenges at higher levels of education. The reality on the ground shows that these outcomes have not yet been fully and evenly achieved across various primary schools.

Learning outcomes are the primary indicator for assessing the effectiveness of a classroom learning process. Hutabarat et al., (2024) & Kuo et al., (2023) explain that learning outcomes encompass behavioural changes in the cognitive, affective and psychomotor domains following learners' participation in learning activities. The level of learning outcomes is influenced by various factors, including both internal factors such as motivation and prior knowledge, and external factors such as the teaching strategies and models employed by the teacher (Jacob et al., 2020; Susianti & Rahayu, 2024). Teaching models that lack variety and tend to be teacher-centred often result in learners becoming passive, thereby preventing the optimal development of conceptual understanding. This situation has a direct impact on pupils' academic achievement across various subjects, including mathematics. Monotonous learning conditions with minimal peer interaction further widen the gap in conceptual understanding between individuals within the classroom.

The phenomenon of low mathematics learning outcomes is still evident in various primary schools across Indonesia. Learners' difficulties become apparent when tackling questions that require reasoning and the application of concepts to situations differing from the examples provided by the teacher (Widiana et al., 2023; Aisyah et al., 2024). Learners tend to be able to solve routine problems similar to the examples, but encounter difficulties when the problem format is modified even slightly. This indicates

that the learning process has not yet fully encouraged pupils to understand concepts in depth. Reliance on the teacher's explanations means that pupils are not accustomed to discussing and expressing their opinions independently within learning groups. The lack of opportunities for pupils to explain concepts to their peers also slows down the process of internalising mathematical understanding.

Preliminary observations in Year 5 at SDN 91 Pacongkang, Liliriaja Sub-district, Soppeng Regency revealed a similar situation, namely low levels of pupils' achievement in mathematics. The mathematics teaching process at this school is still dominated by lectures and individual assignments, without sufficient variation in teaching methods. Interaction amongst pupils is relatively limited, whilst group discussions have not been consistently facilitated by the class teacher. Some pupils appeared unenthusiastic and tended to wait for the teacher's instructions when completing practice problems. Data from daily tests showed that 75 per cent of Year 5 pupils had not yet achieved the Minimum Pass Mark (KKM) set by the school at 75. This situation is a strong indication of the need to improve learning strategies so that pupils' learning outcomes can improve significantly.

The characteristics of primary school pupils at the concrete operational stage require learning that involves hands-on activities and intensive social interaction. Constructivist theory emphasises that knowledge is formed through experience and collaboration with others within a learning community (Saleem & Kausar, 2021; Nurjamilah et al., 2025). The cooperative learning model offers an alternative capable of facilitating these needs in a more structured manner. Jannah et al., (2022) state that cooperative learning emphasises collaboration within small groups to achieve shared goals, so that each member is responsible for the success of their group. This model is believed to simultaneously enhance pupils' motivation, participation and conceptual understanding. The application of cooperative principles within small groups also develops pupils' social skills, which are beneficial for everyday life.

One type of cooperative learning widely recommended in primary education research is the Jigsaw model. The Jigsaw cooperative model organises pupils into home groups and expert groups with a clear division of responsibilities. Within the Jigsaw cooperative learning model, learners are initially assigned to expert groups, where they focus on acquiring a comprehensive understanding of a designated portion of the learning material. They subsequently return to their home groups and communicate the knowledge they have acquired to their peers. This learning arrangement establishes interdependence among group members while maintaining individual accountability for the learning outcomes. Pacitan (2022) and Jeppu et al. (2023) reported that the Jigsaw model can promote learner interaction and active participation by providing each member with a meaningful role in the learning process. In mathematics education, the model creates a collaborative environment in which learners can articulate their ideas,

discuss alternative approaches, and support one another in developing a deeper conceptual understanding (Alsmadi et al., 2023; Kaewrueang et al., 2025).

Evidence from earlier research indicates that the Jigsaw cooperative learning model can contribute to better mathematics learning outcomes among primary school pupils. Fahmi (2022) found that pupils who participated in Jigsaw-based instruction obtained higher average mathematics marks than those taught using conventional approaches. Similarly, Simanjuntak et al. (2025) and Vives et al. (2025) reported improvements in pupils' learning outcomes, accompanied by greater involvement in collaborative group discussions. Supporting these results, Rahmawati (2021) showed that pupils taught through the Jigsaw approach achieved better academic performance than those receiving conventional lecture-based instruction. Taken together, these studies suggest that Jigsaw cooperative learning offers a promising approach for strengthening mathematics instruction and supporting pupils' achievement across different contexts of primary education. Aritonang and Simanjorang (2024) & Nyantah et al., (2025) added that the Jigsaw model also contributes to strengthening pupils' mathematical communication skills during the learning process.

Research on the Jigsaw cooperative learning model has been widely conducted in various contexts and educational levels; however, no study has specifically examined its impact on the mathematics learning outcomes of Year 5 pupils at SDN 91 Pacongkang. Each educational institution has distinct pupil characteristics and learning conditions; therefore, the effectiveness of a learning model must be re-evaluated in accordance with its respective local context. The limited evidence available from the local educational context indicates a need for further empirical investigation. Accordingly, this study examines the use of the Jigsaw cooperative learning approach among Year 5 pupils at SDN 91 Pacongkang, particularly in mathematics lessons concerning plane figures. The study is designed to determine whether the implementation of this approach can contribute to improvements in pupils' mathematics learning outcomes. A quantitative experimental design is employed, allowing changes in pupils' achievement to be examined by comparing their performance before and after the learning intervention. Through this investigation, the study seeks to generate empirical evidence on the applicability and effectiveness of Jigsaw cooperative learning in primary school mathematics, particularly within the educational context of Soppeng Regency.

The urgency of this research is all the more pressing given that poor mathematics learning outcomes have the potential to cause difficulties for pupils in understanding more complex material at subsequent levels of education. Suboptimal conceptual mastery risks undermining pupils' confidence in mathematics in the long term. Learning innovation through the Jigsaw cooperative learning model is one strategic step towards creating an active, collaborative and meaningful learning environment for pupils. This study aims to describe the mathematics learning outcomes of Year 5 pupils at SDN 91

Pacongkang before and after the implementation of the Jigsaw cooperative learning model, to describe the implementation of this model, and to analyse its impact on pupils' mathematics learning outcomes. It is hoped that this article will make a tangible contribution to efforts to improve the quality of mathematics teaching in primary schools and serve as a reference for teachers in developing more effective and participatory teaching strategies.

RESEARCH METHOD

This study employs a quantitative approach as its primary focus is to measure the effect of an intervention on measurable changes in pupils' learning outcomes. The data obtained are numerical in form, namely test scores, and so the analysis was carried out using systematic statistical procedures. The quantitative approach enables the researcher to draw objective conclusions based on mathematical calculations and hypothesis testing (Sahir, 2021; Lim, 2025). The research design employed was a pre-experimental design using a one-group pre-test–post-test design. This design involved a single group of pupils who were administered a test before the intervention and another test after the intervention had been implemented. The difference in scores between the two tests was used to determine the extent to which the Jigsaw cooperative learning model had an impact on the pupils' mathematics learning outcomes.

The research was conducted at SDN 91 Pacongkang, Liliriaja Sub-district, Soppeng Regency, during the second semester of the 2025/2026 academic year. The research population comprised all 16 Year 5 pupils at SDN 91 Pacongkang, who had varied academic backgrounds. The research sample was selected using saturation sampling as the population size was relatively small, allowing the entire population to be included as research subjects. All these pupils possessed characteristics relevant to the research objectives and were therefore designated as the entire research sample. The independent variable in this study was the Jigsaw cooperative learning model, whilst the dependent variable was the mathematics learning outcomes of Year 5 pupils on the topic of plane figures. The selection of the location and sample was adapted to the school's circumstances, as it provided only one class as the research subject.

Data were obtained through three complementary methods, namely testing, observation, and documentation. The tests served as the principal instrument for assessing pupils' mathematics learning outcomes. Multiple-choice items were administered at two stages, prior to and following the learning intervention, to identify changes in pupils' achievement. Classroom observations were conducted throughout the intervention to examine pupils' participation, patterns of interaction within groups, and their responses to the implementation of the Jigsaw cooperative learning model. Documentary evidence was collected to complement the primary data and included pupils' mark records, photographs of classroom activities, and relevant administrative

records associated with the research process. Before being administered in the field, the test instruments underwent expert validation by two validators using a four-point validation scale. Only instruments that satisfied the established validity and reliability criteria were used for the pre-test and post-test.

The analysis comprised both descriptive and inferential statistical procedures. Descriptive statistics were employed to summarise pupils' performance by examining the minimum and maximum scores, mean scores, and overall achievement levels obtained from the pre-test and post-test. Prior to hypothesis testing, the distribution of the data was examined using the Kolmogorov–Smirnov and Shapiro–Wilk normality tests. As the data satisfied the assumption of normality, a Paired Samples T-Test was subsequently applied to determine whether there was a statistically significant difference between pupils' pre-test and post-test scores (Afifah et al., 2020; Rahmani et al., 2025). In addition, the N-Gain analysis was conducted to assess the magnitude of improvement in pupils' mathematics learning outcomes following the implementation of the Jigsaw cooperative learning model. Statistical analyses were performed using SPSS version 26 to support systematic, accurate, and objective data interpretation.

RESULT AND DISCUSSION

Findings

A. Mathematics Learning Outcomes Prior to the Implementation of the Jigsaw Cooperative Learning Model (Pre-test)

The learners' initial abilities were assessed through a pre-test conducted prior to the implementation of the Jigsaw cooperative learning model on the topic of plane figures. The results of the descriptive statistical analysis showed that the mean score of the pupils' pre-test was only 51.88, with the highest score being 70 and the lowest 30. A standard deviation of 12.63 indicated a considerable variation in ability amongst the pupils at the initial stage of the study. Of the 16 pupils who took the pre-test, not a single pupil (0.00 per cent) was deemed to have achieved the required standard based on the Minimum Passing Criteria (KKM) set at 75. All pupils (100.00 per cent) were deemed not to have achieved the required standard at the pre-test stage, meaning the class's overall achievement rate stood at 0.00 per cent. This situation confirms that the initial ability of Year 5 pupils at SDN 91 Pacongkang to master the subject matter of plane figures still needs to be significantly improved through more innovative learning interventions.

B. Implementation of the Jigsaw Cooperative Learning Model

The Jigsaw learning model was conducted in one instructional meeting with a total duration of 6 × 35 minutes. At the beginning of the lesson, the pupils were divided into home groups, and each pupil was given responsibility for studying one particular aspect of the geometry topic. The assigned topics included finding the areas of parallelograms, triangles, trapeziums, and rhombuses. Pupils who were responsible for the same topic subsequently worked together in expert groups. Within these groups,

they examined the assigned material and completed the relevant activities provided in the Pupil Worksheets (LKPD).

Following the expert-group discussion, the pupils returned to their respective home groups. Each pupil then shared the knowledge acquired in the expert group with their peers, allowing the members to learn from one another through a peer-teaching process. The learning activity concluded with presentations in which selected representatives shared the outcomes of their group discussions with the class. Based on the observations recorded throughout the lesson, the pupils demonstrated a positive response to the learning activities. They appeared enthusiastic and motivated and participated actively in the various stages of the Jigsaw learning process.

C. Mathematics Learning Outcomes Following the Implementation of the Jigsaw Cooperative Learning Model (Post-test)

The post-test was conducted after the intervention to assess the improvement in pupils' learning outcomes on the topic of plane figures. The results of the descriptive statistical analysis showed that the highest post-test score was 100 and the lowest was 70, with a mean score of 81.25. A total of 14 pupils (87.50 per cent) were deemed to have achieved the required standard, whilst 2 pupils (12.50 per cent) were deemed not to have achieved the required standard based on the minimum passing mark set. The post-test standard deviation of 8.27 showed a decrease compared to the pre-test standard deviation of 12.63, indicating that pupils' abilities had become more evenly distributed following the intervention. The class's classical achievement rate at the post-test stage reached 87.50 per cent, far exceeding the classical achievement threshold set by the school. This improvement represents a highly significant change compared to the pre-test results, which achieved a classical achievement rate of just 0.00 per cent.

Table 1. Comparison of Descriptive Statistics for Pre-test and Post-test Results

Descriptive Statistics	Pre-test	Post-test
Sample Size	16	16
Highest Score	70	100
Lowest Score	30	70
Mean	51,88	81,25
Standard Deviation	12,63	8,27
Number of Students Who Passed	0 (0,00%)	14 (87,50%)

Number of Students Who Failed	16 (100,00%)	2 (12,50%)

Source: Researcher's primary data

D. Hypothesis Testing and the Effectiveness of N-Gain

The Shapiro–Wilk test was first applied to assess whether the pre-test and post-test scores satisfied the assumption of normality. The analysis produced significance values of 0.449 for the pre-test and 0.122 for the post-test. Since both values exceeded the 0.05 threshold, the two datasets were considered to meet the normality assumption. Consequently, a parametric test, namely the Paired Samples t-test, was employed to examine the difference between pupils' scores before and after the intervention.

The Paired Samples t-test produced a calculated t-value of 17.278, exceeding the critical value of 2.131 at 15 degrees of freedom and a 0.05 significance level. In addition, the two-tailed significance value was 0.000, which was below 0.05. These results provide sufficient evidence to reject H_0 and support H_1. Thus, the findings indicate that the implementation of the Jigsaw cooperative learning model resulted in a statistically significant improvement in the mathematics learning outcomes of Year 5 pupils at SDN 91 Pacongkang.

Further analysis using the N-Gain test yielded a mean score of 0.6262, indicating a moderate level of improvement. Of the 16 pupils involved in the analysis, 2 pupils (12.50 per cent) achieved a high N-Gain category, whereas the remaining 14 pupils (87.50 per cent) were classified in the moderate category. When expressed as a percentage, the mean N-Gain score was 62.62 per cent, which corresponds to the moderately effective category. Overall, these findings suggest that the Jigsaw cooperative learning model was moderately effective in enhancing the mathematics learning outcomes of Year 5 pupils at SDN 91 Pacongkang, particularly in learning about plane figures.

Discussion

The relatively weak mathematics performance observed in the pre-test reflects the learning conditions identified at the beginning of the study. Mathematics instruction in Year 5 at SDN 91 Pacongkang was largely conducted through teacher-led explanations and individual tasks, providing limited opportunities for pupils to interact and learn collaboratively. Nabillah and Abadi (2021) and Telaumbanua et al. (2025) suggest that limited learning achievement may be associated with instructional practices that are repetitive and provide insufficient opportunities for active pupil involvement. A similar concern was highlighted by Fatmi et al. (2025), who noted that a uniform approach to instruction may create differences in conceptual understanding when pupils enter the

classroom with varying levels of prior knowledge. In the present study, the pupils' initial mathematics performance was substantially below the minimum competency standard (KKM). This condition indicates the importance of introducing learning approaches that provide greater opportunities for participation, interaction, and collaboration. The Jigsaw cooperative learning model is therefore considered relevant because its group-based structure allows pupils to exchange knowledge and engage in social interaction, which may support the development of mathematical concepts that had not previously been fully established.

The classroom implementation of the Jigsaw model was accompanied by considerable enthusiasm and active participation from the pupils. These responses were particularly evident during the expert-group discussions and the subsequent peer-teaching activities conducted in the home groups. The observation is in line with Pacitan (2022) and Jeppu et al. (2023), who explain that Jigsaw learning can promote interaction and learner engagement by giving each group member a specific responsibility in the learning process. Kaewrueang et al. (2025) and Tran and Lewis (2012) further indicate that the model creates opportunities for learners to discuss ideas, share knowledge, and develop their understanding of mathematical concepts through collaboration. Explaining a concept to peers also requires pupils to reorganise and articulate the information they have learned, which may facilitate deeper processing and strengthen conceptual retention. Previous research has similarly identified peer teaching as a useful mechanism for supporting the retention of learning during instructional activities (Chandrasekera et al., 2024; Aritonang & Simanjorang, 2024). Moreover, the division of responsibilities within the expert groups gives pupils an opportunity to become contributors to the learning process. Taking responsibility for particular material may consequently encourage greater confidence when pupils communicate their ideas and explanations to other members of the group.

The improvement in pupils' mathematics learning outcomes from an average of 51.88 in the pre-test to 81.25 in the post-test demonstrates that the Jigsaw cooperative learning model has a significant effect on the mastery of plane figure concepts. The results of the Paired Sample T-Test, which showed a t-calculated value of 17.278—greater than the t-table value of 2.131 with a significance level of 0.000—statistically reinforce this conclusion. This finding is consistent with the research by Hutabarat et al. (2024), which demonstrated that the Jigsaw cooperative learning model has a significant effect on the mathematics learning outcomes of Year 5 primary school pupils. Simanjuntak et al., (2025) & Huang et al., (2024) also found that the Jigsaw model has a positive effect on learning outcomes and increases pupils' participation in group discussions in other subjects. Fasasi & Istifanus (2022) & Fahmi (2022) reported that the Jigsaw model was able to significantly improve pupils' average mathematics marks compared to conventional methods at secondary level. The consistency of these

findings across various educational levels and contexts strengthens the validity and generalisability of the research results obtained in this study.

The two pupils who had not yet achieved the minimum passing mark (KKM) in the post-test were those with the lowest pre-test scores in the class; consequently, the gap between their initial ability and the required standard of achievement was far greater than that of other pupils. This situation is consistent with the theory of individual differences in learning, which states that every pupil has different learning speeds and readiness levels; consequently, not all pupils can achieve the same proficiency target within the same treatment period. Vygotsky's concept of the Zone of Proximal Development explains that pupils with initial abilities far below the class average require a higher intensity of scaffolding and repetition to bridge this ability gap. The implementation of the Jigsaw model, which was carried out in a single session, appears not to have provided sufficient repetition and conceptual reinforcement for pupils with very low initial abilities. The failure of these two pupils to achieve the minimum competency standard (KKM) indicates the need for follow-up in the form of remedial learning or more intensive individual support, rather than suggesting the ineffectiveness of the learning model as a whole. Teachers are advised to pay attention to the individual learning needs of pupils with low initial ability so that the implementation of the Jigsaw cooperative learning model can have a more equitable impact on all pupils in the class.

The practical implications of these findings suggest that primary school teachers should consider implementing the Jigsaw cooperative learning model as an alternative strategy for teaching mathematics, particularly for topics comprising several interrelated subtopics such as plane figures. Erviana et al., (2024) & Aisy (2025) emphasise that the implementation of the Jigsaw model can enhance cooperation amongst pupils whilst strengthening a sense of individual responsibility within learning groups. Saputra et al., (2025) & Nnamani et al., (2023) add that the Jigsaw cooperative learning model is also relevant for application in other subjects such as science, suggesting that the potential for generalising this model across various subjects in primary schools is considerable. Teachers need to ensure the formation of heterogeneous groups and the provision of structured worksheets for each sub-topic so that expert group discussions can proceed effectively and in a focused manner. Further research is recommended to use a quasi-experimental design with a control group and to expand the research sample to other schools so that findings regarding the effectiveness of the Jigsaw model can be generalised more widely.

The positive influence of the Jigsaw model on learning outcomes can be explained through several mechanisms that are interrelated. The structure of expert groups encourages in-depth conceptual mastery, as each learner has specific responsibilities that cannot be replaced by other members. The peer-teaching process reinforces understanding through active repetition and the verbalisation of concepts to

groupmates. Positive interdependence amongst learners fosters intrinsic motivation to study diligently for the sake of the group's overall success. The rich social interaction in group discussions facilitates the collaborative construction of knowledge in line with the principles of social constructivism (Yen & Thao, 2024; Nurjamilah et al., 2025). The Jigsaw cooperative learning model ultimately proved to be an effective and innovative solution for improving the mathematics learning outcomes of Year 5 pupils at SDN 91 Pacongkang.

CONCLUSION

The mathematics achievement of Year 5 pupils at SDN 91 Pacongkang was initially at a very low level. This was reflected in the mean pre-test score of 51.88, with none of the pupils reaching the expected class achievement level. Following the implementation of the Jigsaw cooperative learning model, learning activities were conducted through expert and home groups and were met with a highly positive response from the pupils. The intervention resulted in a substantial improvement in mathematics achievement, with the mean post-test score increasing to 81.25. The Paired Sample T-Test confirmed a statistically significant difference between the pre-test and post-test results, with a calculated t-value of 17.278 exceeding the critical value of 2.131 at a significance level of 0.000. Furthermore, the mean N-Gain score was 0.6262, indicating a moderate level of improvement and an effectiveness category of fairly effective. Based on these findings, primary school teachers may consider the Jigsaw cooperative learning model as an alternative approach to mathematics instruction, particularly when teaching content that consists of several connected subtopics. Further studies should consider adopting a quasi-experimental design involving a comparison group and a larger sample of pupils. Such an approach would provide a stronger basis for examining the effectiveness of the model and would improve the extent to which the findings can be applied to other primary school contexts.

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