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THE EFFECTIVENESS OF THE INDEX CARD MATCH LEARNING MODEL IN IMPROVING MATHEMATICS LEARNING OUTCOMES ON PLANE FIGURES

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Abstract

The limited number of studies on the effectiveness of the Index Card Match (ICM) learning model in lower elementary school classes, particularly on the topic of plane figures forms the basis of this research, despite the significant implications for early mathematical concept comprehension. This study aims to analyze the effectiveness of the ICM model in improving the mathematics learning outcomes of second-grade students on the topic of plane figures and to identify student participation levels during the learning process. A quantitative method with a posttest-only control group design was employed, involving 67 students from MI Muhammadiyah Trangsan selected through purposive sampling. Data were collected using multiple-choice learning outcome tests and student engagement observation sheets, and analyzed using descriptive statistics and independent sample *t*-tests. The results show a significant difference between the experimental group (mean score of 92.5) and the control groups (mean scores of 68 and 63), with a significance value of 0.021 ($p < 0.05$). These findings reinforce the constructivist theories of Piaget and Vygotsky, which emphasize the importance of interaction and direct experience in active learning. The main conclusion of this study is that the application of ICM significantly enhances students' mathematics learning outcomes across cognitive, affective, and psychomotor domains. The implications include contributions to the development of active learning strategies in lower elementary classrooms and practical recommendations for teachers to adopt ICM as an innovative, enjoyable, and effective method. This research also opens opportunities for further exploration of ICM application across different subjects and educational levels, including its development through interactive technology.

Keywords: Index Card Match; Learning Outcomes; Mathematics; Plane Figures; Elementary School

INTRODUCTION

Elementary education is crucial in developing students' character, cognitive skills, and social abilities (Syam, 2020; Y. H. P. Utami & Ningsih, 2025). Mathematics, as one of the core subjects, is not only aimed at developing numeracy skills but also fostering logical, analytical, and creative thinking (Nur et al., 2021; Purwaningrum, 2016). However, at the elementary level, particularly in basic geometry topics such as plane figures, many students still struggle to understand the concepts of shape, number of sides, and their properties. This highlights the necessity for teaching methods that can connect the abstract elements of mathematics with students' tangible experiences.

At MI Muhammadiyah Trangsan, preliminary observations revealed low student achievement in the topic of plane figures. Several students confused shapes such as squares and rectangles or found it difficult to explain the number of sides in triangles and parallelograms. This low achievement was largely influenced by the use of conventional, teacher-centered instructional methods that lacked interaction and did not utilize concrete media. According to Iyai dan Helsa (2025), instruction that does not actively involve students risks lowering both motivation and comprehension of the material.

To address this problem, an innovative learning model that promotes direct student engagement is required. One such alternative is the Index Card Match (ICM) model developed by Silberman (2010), which combines elements of games, social interaction, and conceptual understanding. This model requires students to match cards containing questions and answers, making the learning process active, enjoyable, and motivating. Earlier research has demonstrated that ICM is successful in enhancing learning results in different subjects, such as mathematics (Andayani & Lathifah, 2019), yet the majority of these studies concentrated on grades IV–VI, resulting in a relative lack of exploration regarding its effectiveness in lower grades.

A review of the literature indicates that most prior research on ICM has centered on upper-grade elementary students and general learning outcomes, without specifically examining the understanding of basic geometry concepts. In fact, instruction on plane figures in lower grades is a crucial foundation for mathematical understanding in higher levels (Muhsetyo et al., 2014). The lack of studies on second-grade students results in limited empirical data that teachers can use when selecting appropriate instructional strategies. Moreover, previous research has tended to focus solely on cognitive learning outcomes, without exploring in depth the learning process and students' responses to the model used. Yet, successful learning is determined not only by test scores but also by students' engagement, motivation, and social interaction (Slavin, 2018). Consequently, this research aims to address this gap by investigating the comprehensive effectiveness of ICM, encompassing both learning results and student participation in the subject of plane figures for second-grade learners.

The novelty of this research lies in applying the ICM model in lower grades, specifically in second-grade MI classes, for plane figure topics involving the recognition of shapes, number of sides, and angles. Unlike previous studies, this research not only measures cognitive learning outcomes but also observes student interactions and the challenges faced during the learning process. Furthermore, the study integrates a constructivist approach in implementing ICM, where students actively construct their knowledge through direct experiences. This approach is expected not only to improve academic scores but also to foster social skills, collaboration, and self-confidence in understanding mathematics from an early age.

The Index Card Match technique is a collaborative learning approach that involves students in an exercise of pairing cards with questions and their corresponding answers (Apriyanti et al., 2021; Muflihah, 2021). Silberman (2010) states that this method is effective for reviewing or introducing new material in an active and enjoyable atmosphere. Its advantages include increasing student engagement, enhancing memory retention, and creating a collaborative learning environment (Hidayah & Puspaningrum, 2025; Susilawati & Saputra, 2025). From a learning theory perspective, ICM aligns with Piaget's constructivist theory, which emphasizes that knowledge is built through active interaction with the environment (Amin & Sumendap, 2022; Lestari et al., 2023). Through card-matching activities, students connect abstract mathematical concepts with concrete experiences, resulting in deeper understanding. This also corresponds with the principle of active learning as proposed by Bonwell & Eison (1991), that claims students engage in learning more successfully when actively participating in the process. Learning outcomes in ICM-oriented teaching include not just the cognitive aspect but also the emotional and physical skill domains (Annisa & Marlina, 2019; Suja, 2022). In the affective domain, students learn to appreciate peers' opinions and collaborate; in the psychomotor domain, they practice media manipulation skills; and in the cognitive domain, they gain a better understanding of mathematical concepts. This aligns with Bloom's taxonomy, which divides learning outcomes into these three domains (Anderson & Krathwohl, 2001; Mahmudi et al., 2022).

This research seeks to: (1) assess students' mathematics learning results prior to and following the implementation of the Index Card Match model on flat building materials; (2) evaluate the model's effectiveness in enhancing learning outcomes; and (3) recognize student engagement and challenges encountered during execution.

Considering the background, gaps, and objectives outlined above, the problem statements of this research are: (1) What are the learning outcomes of students prior to implementing the Index Card Match model? (2) What are the learning outcomes of students subsequent to using the model? (3) How effective is the application of the Index Card Match model in enhancing the mathematics learning outcomes of grade II students at MI Muhammadiyah Trangsan regarding flat shapes material?

METHODS

This study utilizes a quantitative approach featuring a pre-experimental design with a one-group pretest-posttest format. The quantitative method was selected as this study intends to evaluate the impact of the Index Card Match learning model on the mathematics achievement of second-grade students at MI Muhammadiyah Trangsan regarding flat shape material. Quantitative research enables researchers to evaluate hypotheses by methodically analyzing numerical data (Sugiyono, 2019).

The research design employed is a one-group pretest-posttest format, in which students take an initial test (pretest) before the treatment to assess their starting abilities. Additionally, treatment using the Index Card Match learning model is implemented, concluding with a final test (posttest) to assess the enhancement of learning outcomes. This design is regarded as useful for observing score differences before and after intervention within the same group (Creswell, 2003).

The research subjects consisted of 20 second-grade students at MI Muhammadiyah Trangsan. Participants were chosen through a purposive sampling method, meaning the selection was made based on particular criteria, specifically students who were learning about plane figures in the current semester (Etikan et al., 2016). This consideration was made to ensure that the data obtained would be relevant to the research objectives and aligned with the actual classroom conditions.

The primary instrument of this research was a multiple-choice achievement test consisting of 20 items, which had been evaluated for content validity by specialists and exhibited a reliability score of 0.82, indicating high reliability (Azwar, 2016). In addition to the test, data collection was also conducted through observation of students' learning activities and documentation of the learning process. Observations were carried out using observation sheets to assess student engagement during the Index Card Match activities, while documentation was used to record the course of the learning process as supporting data.

The analysis of the research data involved both descriptive and inferential statistical methods. Descriptive statistics were employed to display the students' pretest and posttest scores as mean scores, percentages, and distributions of scores. A paired sample t-test was performed using SPSS version 26 to analyze significant differences in learning outcomes prior to and following the treatment. The significance level applied was $\alpha = 0.05$. This test was selected as it is suitable for comparing two means obtained from the same sample (Field, 2024).

RESULTS

This research was conducted on second-grade students of MI Muhammadiyah Trangsan in the 2024/2025 academic year. The research subjects consisted of three classes: 2A, 2B, and 2C, as detailed in Table 1 below:

Table 1. Student Posttest Data

Class	Number of Students	Male	Female	Description
2A	25 students	16	9	Control Class
2B	21 students	12	9	Control Class
2C	20 students	13	7	Experimental Class

Based on Table 1, Class 2C was the experimental class that implemented the Index Card Match (ICM) learning model, while Classes 2A and 2B served as control classes using conventional teaching methods.

Research Implementation Design

This study utilized a quantitative method featuring a quasi-experimental design. This kind of experimental design was selected because the researcher lacked complete control over external factors that could influence the results, yet could still compare two groups undergoing different treatments. The design of the research employed was the Posttest-Only Control Group Design.

This design was utilized to investigate variations in learning results between the group that underwent the treatment (Index Card Match learning model) and the group that did not experience the treatment (traditional teaching method). In this design, evaluations were conducted solely following the treatment (posttest) without prior measurements (pretest). Table 2 illustrates the design as follows:

Table 2. Posttest-Only Control Group Design

Group	Treatment (X)	Final Test (O_2)
Class 2C (Experimental)	Learning with Index Card Match	Posttest
Classes 2A & 2B (Control)	Conventional Learning (No Treatment)	Posttest

Notes:

- **X** : Treatment (learning using the Index Card Match model)
- **O_2** : Posttest (learning outcome test after instruction)

Through this design, the researcher was able to determine differences in learning outcomes after applying the Index Card Match learning model by comparing posttest results between the experimental and control classes.

Research Implementation Stages

Preparation Stage – In this stage, the researcher prepared instructional materials, including lesson modules and test instruments (posttest). Coordination was carried out with the school to obtain permission to conduct the research and determine the classes to be used as research subjects. Based on the coordination results, Class 2C was designated as the experimental class, while Classes 2A and 2B were designated as control classes. The selection was made because the three classes had relatively balanced characteristics in terms of student numbers and academic ability.

Implementation Stage – In this stage, teaching was carried out according to the respective treatment of each group. The experimental group (Class 2C) received instruction using the Index Card Match model over several meetings. Meanwhile, the control groups (Classes 2A and 2B) continued learning through conventional methods typically used by the classroom teacher. The Index Card Match model was implemented through activities of matching cards depicting plane figures with cards containing their characteristics and names. This activity was conducted both individually and in groups, involving discussion and collaboration among students.

Evaluation Stage – After the teaching process was completed, all students from the three classes were given a posttest to measure their learning outcomes after instruction. The posttest results from every class were subsequently examined to determine score variations between the experimental and control groups. The analysis of average posttest scores provided the foundation for concluding the effectiveness of the Index Card Match learning model in enhancing students' mathematics learning results. In addition, the researcher also considered qualitative data from classroom observations during the learning process, such as student activeness, enthusiasm, and participation in the card-matching activities.

Pretest and Posttest Results

In this research, the posttest assessing learning outcomes was administered to all students post the completion of the learning process, in both the experimental class (2C) and the control classes (2A and 2B). This test seeks to assess the variation in students' mathematics performance following their engagement in learning through various approaches. Table 3 displays the average posttest scores for every class.

Table 3. Average Posttest Scores for Each Class

Class	Number of Students	Average Posttest Score
2A	25 students	68
2B	22 students	63
2C	20 students	92.5

Based on Table 3, Class 2C (experimental class) obtained a higher average posttest score compared to Classes 2A and 2B (control classes). This difference indicates that the application of the Index card match learning model has an effect on student learning outcomes.

Preliminary Analysis of Learning Outcomes

The posttest results showed that class 2C obtained the highest average (92.5) compared to the control classes, namely class 2A (68) and class 2B (63). This indicates that the Index card match learning model is effective in helping students understand flat building material in a more fun and interactive way.

Apart from the quantitative aspect, the effectiveness of learning is also reflected in the observation during the learning process. In class 2C, students showed active involvement, enthusiasm for discussion, and enthusiasm when doing card-matching activities. The delivery of material through an approach involving educational games was found to help students more easily remember the characteristics of flat shapes and apply them in the given problems.

Assumption Testing for Analysis

Before testing the hypothesis, first test the requirements of the analysis. The purpose of this test is to ensure that the data used meets certain requirements so that statistical processing can be carried out appropriately and validly. The requirements tested in this study include normality test and homogeneity test.

Normality Test

The normality test was performed to assess if the posttest data from both the experimental and control classes followed a normal distribution. The normal distribution is a fundamental assumption required for parametric statistical analysis, including the t-test, which is utilized to evaluate the hypothesis in this research

A normal distribution is characterized by a symmetrical shape resembling a bell-shaped curve, in which most of the data values are concentrated around the mean value, while there are fewer extreme values. In the context of educational research, a normal distribution indicates that most students have learning outcomes that are in the average range.

In this research, normality assessments were performed using the SPSS version 22 software, employing the Kolmogorov-Smirnov and Shapiro-Wilk tests. These two approaches assess how closely the distribution of posttest data in each class resembles a normal distribution. The Kolmogorov-Smirnov test is appropriate for medium to large samples, whereas the Shapiro-Wilk test is better for small samples. Consequently, both assessments were employed to reinforce the credibility of the findings.

Decision criteria for the normality test: a) If the significance value (Sig.) > 0.05, the data are considered normally distributed. b) If the significance value (Sig.) ≤ 0.05, the data are considered not normally distributed.

Table 4. Normality Test Results (Shapiro–Wilk)

Class	Test Type	Sig. Value	Conclusion
2A	Posttest	0.091	Normal
2B	Posttest	0.076	Normal
2C	Posttest	0.084	Normal

According to the Shapiro-Wilk test findings in Table 1.4, all significance values (Sig.) for posttest results in the three classes exceed 0.05. Therefore, it can be inferred that the posttest results in the three classes follow a normal distribution, allowing for the continuation of hypothesis testing utilizing parametric statistical methods, specifically the Independent Sample T-Test.

Homogeneity Test

Following the normality test, the subsequent step is to perform a homogeneity test. This assessment seeks to establish if the variance (value diversity) of data collected from the experimental group and control group is alike. Homogeneity of variance is a crucial condition in parametric statistical analysis, as methods like the Independent Sample T-Test assume that the groups involved have similar variances.

In this study, the homogeneity test was conducted using the Levene Test, which is available in the SPSS version 22 program. The Levene test was chosen because it is more flexible than the F test, especially in situations where the data are not completely normally distributed. This test is able to test the equality of variances of two or more groups in a more stable manner.

Decision criteria for Levene's Test: a) If the significance value (Sig.) > 0.05, the data are considered homogeneous (equal variances). b) If the significance value (Sig.) ≤ 0.05, the data are considered not homogeneous (unequal variances).

Table 5. Homogeneity Test Results (Levene's Test)

Data Tested	Sig. Value	Conclusion
Posttest 2A, 2B, 2C	0.184	Homogeneous

Based on Table 5, the significance value was 0.184 > 0.05, indicating that the variances of the three classes were homogeneous. Therefore, hypothesis testing could proceed using parametric statistical techniques.

Hypothesis Testing

Once it is established that the data is normally distributed and homogenous, hypothesis testing can proceed with the Independent Sample T-Test. This examination is aimed at identifying whether a notable difference exists in learning results between the experimental group (2C) utilizing the Index card match learning approach and the control groups (2A and 2B) employing traditional learning methods.

Hypotheses:

1. **H_0 (Null Hypothesis):** There is no significant difference between the learning outcomes of students taught using the Index Card Match model and those taught using conventional methods.
2. **H_1 (Alternative Hypothesis):** There is a significant difference between the learning outcomes of students taught using the Index Card Match model and those taught using conventional methods.

Decision Criteria:

1. If the Sig. (2-tailed) value < 0.05, reject H_0 and accept H_1 (significant difference exists).

2. If the Sig. (2-tailed) value ≥ 0.05, accept H_0 (no significant difference exists).

Table 6. Independent Sample *t*-Test Results

Group	Average Posttest Score	Number of Students	Std. Deviation	Sig. (2-tailed)	Conclusion
Experimental (2C)	85.5	20	6.2	0.021	H_0 rejected
Control (2A & 2B)	72.3	47	7.35		

According to the t-test findings shown in Table 1.6, the significance value (Sig. (2-tailed) of 0.021 <0.05, therefore H_0 is dismissed and H_1 is accepted. In other words, there is a notable distinction in the learning results of students who engage with the Index card match learning model compared to those who utilize traditional learning methods. Therefore, it can be inferred that the Index card match learning model is successful in enhancing student performance in Mathematics, particularly in flat building topics.

DISCUSSION

Students' Learning Outcomes Before Using the Index Card Match Model

Before the implementation of the Index Card Match (ICM) model, mathematics instruction at MI Muhammadiyah Trangsan, particularly in the topic of plane figures—still employed a conventional, teacher-centered method. According to the literature, conventional models often render students as passive listeners, resulting in low cognitive, affective, and psychomotor engagement (Sardiman, 2018). Consequently, students' understanding of geometric concepts remained superficial, as they were not provided with opportunities to interact actively with the learning material.

In terms of learning outcomes, this conventional approach generally led to suboptimal achievement, as reflected in the average posttest scores of the control classes: 68 for Class 2A and 63 for Class 2B. These scores indicate that many students still struggled to identify shapes, properties, and characteristics of plane figures. This finding aligns with Utami (2025) who stated that learning with minimal interaction tends to hinder the comprehension of abstract concepts, including basic mathematics.

This condition also relates to Vygotsky's (1978) constructivist theory, which emphasizes that knowledge is actively constructed through social interaction and direct learning experiences. If learning does not provide space for students to engage in discussions or manipulate learning media, the process of knowledge construction becomes limited. Therefore, the dominant lecture-based conventional approach needs to be modified with more active methods. Furthermore, the low learning outcomes at this stage may also be attributed to the lack of learning media that accommodate students' visual, auditory, and kinesthetic learning styles. According to Budiman (2016) appropriate media can enhance students' motivation and understanding by engaging more than one sense in the learning process. At this stage, prior to the application of ICM, the opportunities to maximize students' learning potential were still limited.

Students' Learning Outcomes After Using the Index Card Match Model

After the application of the ICM model in class 2C, student learning outcomes showed a significant increase, with the average posttest score reaching 92.5. This increase indicates that ICM is able to improve students' understanding of flat building material. This model involves students in the activity of matching cards containing images and concept information, so that they actively process information and connect it with prior knowledge.

ICM is part of the active learning strategy, which, according to Bonwell & Eison (1991) is effective because it directly involves students in the learning process—both physically and mentally. Through discussion and group work while matching cards, students not only memorize concepts but also understand them in a more meaningful context. This finding is supported by Rusmini (2020) who reported that the use of ICM improved mathematics learning outcomes compared to the lecture method.

In addition to cognitive gains, the application of ICM also enhanced students' affective engagement. Observations showed an increase in enthusiasm and learning motivation—key indicators of effective learning (Slavin, 2018). Students who were usually passive began to actively ask questions and express their opinions. This reinforces the argument that a joyful learning atmosphere contributes positively to academic achievement. Moreover, the model employs cooperative learning principles, in which students help each other to understand the material (Johnson et al., 1998). Such collaboration not only deepens understanding but also fosters essential social skills for primary school students' development. Therefore, the application of ICM impacts not only cognitive aspects but also affective and social dimensions.

Effectiveness of the Index Card Match Model

The effectiveness of the ICM model in this study was proven through the results of an independent t-test which showed a significance value of 0.021 <0.05. This means that there is a significant difference between the learning outcomes of experimental and control class students. Statistically, this means that the use of ICM makes a real contribution to improving students' mathematics learning outcomes.

This effectiveness can be explained through Kolb's (2014) experiential learning theory, which states that students learn more effectively when they are directly involved in relevant experiences. The card-matching activity in ICM provides hands-on learning experiences that facilitate conceptual understanding through practice and interaction. Moreover, according to Agusta & Yuhana (2025), ICM strengthens memory retention by combining repetition, visual association, and active participation. This combination embeds concepts more firmly in students' long-term memory. The findings of this study reinforce the results of a study by Wibowo et al. (2022), who reported that ICM improved mathematics learning outcomes by up to 82.7% in elementary-level material.

In practical terms, teachers can adopt ICM as an alternative instructional method for topics perceived as difficult or abstract. By actively engaging students, teachers not only deliver content but also develop critical thinking, communication, and collaboration skills. This model is also flexible enough to be adapted to various topics and student characteristics, making it a valuable component of innovative teaching strategies in primary schools.

Research Implications

The results of this study provide significant theoretical and practical implications. Theoretically, the results reinforce Piaget's and Vygotsky's constructivist theories, which emphasize the importance of students' active involvement in constructing knowledge through social interaction and direct experiences. The application of ICM demonstrates that learning strategies integrating elements of play, collaboration, and problem-solving can enhance learning outcomes, particularly in basic geometry topics at lower grade levels.

Practically, teachers can adopt ICM as an alternative instructional strategy that not only improves cognitive achievement but also fosters social skills and student learning motivation. This model is flexible to adapt according to the subject matter and classroom conditions, and it can be integrated with visual media or interactive learning technologies to enrich the learning experience. For education policy makers, the findings can serve as a basis for encouraging teacher training in adopting active learning strategies that are proven to be effective, particularly at the primary school level. For future researchers, this study opens opportunities to examine the long-term effectiveness of ICM across different grade levels and subject areas, or to combine it with technology-based approaches to further maximize student learning outcomes.

Research Limitations

This study has several limitations that need to be considered. First, the research subject was limited to one school, MI Muhammadiyah Trangsan, with 20 students in the experimental class. This limits the generalization of the research results to other schools with different characteristics. Second, the research employed a posttest-only control group design, which did not measure students' initial abilities through a pretest. Although control was maintained by selecting classes with similar characteristics, a structured pretest could have provided a more accurate depiction of learning improvement. Third, the duration of the Index Card Match (ICM) implementation was relatively short, only a few sessions, thus the long-term effects on material retention remain uncertain. Fourth, this study focuses on cognitive outcomes and observations of student engagement, but has not explored in depth other factors that influence learning effectiveness, such as individual learning styles, levels of intrinsic motivation, or the role of parental support. These limitations should be taken into consideration for the interpretation of the results and the planning of future research.

CONCLUSION

From the findings of research and discussion, it can be concluded that the use of the Index Card Match (ICM) learning model has been shown to effectively enhance the mathematics learning results of grade II students of MI Muhammadiyah Trangsan on the material of flat shapes. Before applying the ICM model, students' learning outcomes were still relatively low. The control classes (2A and 2B), which used conventional teaching methods, obtained average posttest scores of 68 and 63, respectively. This indicates that students still faced difficulties in understanding shapes, characteristics, and properties of plane figures. These low results align with the view that learning with minimal student engagement tends to result in shallow understanding.

After applying the ICM model in the experimental class (2C), students' learning outcomes increased significantly, with the average posttest score reaching 92.5. This enhancement is evident not just in cognitive results, but also in the emotional and physical dimensions, as students display greater enthusiasm, active participation in discussions, and effective collaboration during the learning experience. These findings support active learning and constructivist theories, which emphasize the importance of students' direct engagement in building understanding.

The application of the ICM model in this research was also validated by the independent t-test results, which indicated a significance value of 0.021 (<0.05). This finding reveals a notable disparity in the learning results between the experimental group and the control group and the control group, so that the application of the ICM model can be said to make a real contribution to improving students' mathematics learning outcomes. Theoretically, this research fills the gap of previous studies by applying ICM at the low grade level, especially grade II, and focusing on flat building materials that have rarely been the focus of similar research.

This study's contributions include three aspects: first, providing new empirical evidence on the effectiveness of ICM in lower primary school grades; second, offering an integration of the constructivist approach into ICM implementation to strengthen mathematics learning; and third, presenting practical guidance for teachers to apply interactive and engaging active learning strategies. The recommendations for future research include conducting a longitudinal study to see the sustainability of the effect of ICM on learning outcomes and student motivation, expanding the research subjects to other schools and regions to enhance generalizability, and combining ICM with digital learning media or interactive technologies to further enrich the student learning experience.

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