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Research Article

Improving Mathematics Learning Outcomes Using the Make a Match Learning Model with Number Cards

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Abstract

Mathematics remains one of the most challenging subjects for students, particularly in teacher education programs, where mastery is essential not only for academic success but also for future pedagogical practice. Conventional teacher-centered methods often fail to promote active engagement and deep conceptual understanding, underscoring the need for innovative approaches that combine interaction, collaboration, and enjoyable learning experiences. This study aimed to improve students' mathematics learning outcomes through the implementation of the Make a Match learning model supported by number cards. The research employed a classroom action research design conducted in two cycles, each comprising the stages of planning, action, observation, and reflection. The participants were 28 undergraduate students enrolled in the Department of Primary School Teacher Education, Universitas Doktor Nugroho Magetan. Data were collected using formative tests, observation sheets, and field notes, and were analysed through both quantitative and qualitative approaches. The findings demonstrated a consistent improvement in students' learning outcomes. The mean score increased from 60.71 in the pre-cycle to 72.14 in Cycle I and 83.57 in Cycle II. Similarly, the percentage of students achieving mastery rose from 42.86% in the pre-cycle to 71.43% in Cycle I and 89.29% in Cycle II. Qualitative data supported these results, indicating enhanced engagement, collaboration, and active participation during learning activities. In conclusion, the Make a Match learning model with number cards effectively improved both the process and outcomes of mathematics learning. The study suggests that this strategy not only strengthens mathematical achievement but also fosters essential skills such as cooperation, communication, and problem-solving, making it a promising pedagogical approach for teacher education contexts.

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Introduction

Mathematics is universally acknowledged as a core discipline that underpins students' intellectual development by fostering logical reasoning, problem-solving ability, and critical thinking [1], [2]. In the context of teacher education, mastery of mathematics is particularly significant because it not only influences pre-service

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teachers' academic achievement but also shapes their competence in delivering effective mathematics instruction in primary schools [3], [4]. Ensuring that future educators develop both strong content knowledge and pedagogical skills is therefore essential to meet the demands of modern education systems [5].

Despite its importance, mathematics remains one of the most challenging subjects for students. Many learners experience difficulties in understanding abstract concepts and often demonstrate low levels of motivation, which in turn negatively impacts their academic performance [6], [7]. Within teacher education programs, this issue is exacerbated by the prevalence of traditional instructional practices that rely heavily on teacher-centered approaches. Such methods tend to prioritize rote memorization and algorithmic procedures, resulting in limited engagement, passive learning behaviors, and shallow conceptual understanding [5], [8]. Consequently, there is a need for more student-centered and interactive pedagogical models that can make mathematical learning both meaningful and enjoyable.

The Make a Match learning model, rooted in cooperative learning theory, has emerged as one such innovative strategy. By requiring students to actively engage in matching question and answer cards, the model promotes peer interaction, collaboration, and healthy competition within the classroom [9], [10]. When combined with number cards, this model provides concrete and visual learning aids that help reduce the abstractness of mathematical concepts. Prior studies have demonstrated that cooperative and game-based learning approaches can enhance motivation, reduce anxiety, and improve both the learning process and student achievement in mathematics [10], [11]. However, much of the existing literature has been conducted in primary and secondary school settings, while empirical evidence regarding the systematic use of Make a Match in higher education, particularly within teacher education programs, remains limited.

This research addresses that gap by applying the Make a Match model with number cards in a classroom action research (CAR) setting involving pre-service teachers. The novelty of this study lies in adapting a cooperative game-based strategy typically used in primary or secondary contexts to higher education, specifically to strengthen mathematics learning among prospective primary school teachers. In doing so, the study not only seeks to improve students' academic outcomes but also to model effective pedagogical practices that they can later adopt in their professional teaching careers.

Based on the above background, the objectives of this study are to (1) improve mathematics learning outcomes among students through the implementation of the Make a Match learning model with number cards, and (2) enhance classroom engagement and collaborative learning during mathematics instruction. Accordingly, the research was guided by the following questions:

1. To what extent does the implementation of the Make a Match learning model with number cards improve students' mathematics learning outcomes?
2. How does the application of the Make a Match learning model with number cards influence student engagement and participation during mathematics learning activities?

Methodology

A. Research Design

This study adopted a Classroom Action Research (CAR) approach, which is widely recognized as an appropriate method for systematically improving teaching practices and learning outcomes in real classroom contexts. The CAR framework is based on the cyclical process of planning, action, observation, and reflection, as proposed by Prabandari [12]. In this study, the research was conducted over two cycles, with each cycle designed to refine instructional strategies based on empirical evidence and reflective analysis. Figure 1 presents the design of the classroom action research procedure.

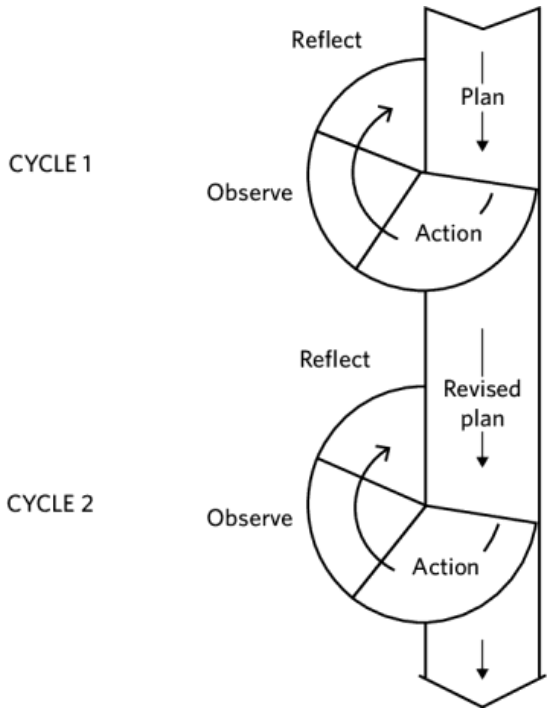


Figure 1. Classroom Action Research Procedure

In the planning stage, the researcher designed lesson plans aligned with the mathematics course objectives, prepared the number cards as the main instructional media, and developed both formative assessment tools and observation sheets. In the action stage, the Make a Match learning model was implemented in classroom activities, whereby students actively engaged in matching pairs of number cards that represented mathematical problems and their corresponding solutions. The observation stage involved systematic documentation of student participation, interaction, collaboration, and performance, using structured observation sheets as well as field notes. Finally, the reflection stage was conducted collaboratively to evaluate the strengths and weaknesses of the cycle, leading to modifications and refinements in the subsequent cycle.

This research design was chosen because it enables a systematic and iterative process of improving pedagogy, combining quantitative evidence of learning outcomes with qualitative insights into classroom dynamics. The integration of these two dimensions provides a comprehensive understanding

of how the Make a Match model with number cards impacts mathematics learning among pre-service teachers.

B. Participants

The participants of this study consisted of 28 undergraduate students enrolled in the Mathematics Education course within the Department of Primary School Teacher Education, Universitas Doktor Nugroho Magetan, during the 2025 academic year. The sampling technique used was purposive sampling, as all students in the class were directly involved in the learning intervention and therefore represented a complete and relevant population for the classroom action research.

The demographic characteristics of the participants showed that 21 students (75%) were female, and 7 students (25%) were male, with an average age of 19 years. All students had previously taken introductory mathematics courses, which provided a relatively homogeneous academic background and ensured that variations in learning outcomes were attributable primarily to the instructional intervention rather than prior differences in mathematical knowledge. The selection of undergraduate students in teacher education was particularly significant, as these pre-service teachers are expected not only to enhance their own mathematical proficiency but also to develop pedagogical competencies that will later be applied in primary school classrooms.

C. Data Analysis Techniques

Data analysis in this study involved both quantitative and qualitative approaches, allowing for a robust and multidimensional evaluation of the effectiveness of the intervention.

1. Quantitative Analysis

The quantitative data were obtained from students' formative test scores administered at the end of each cycle. Descriptive statistics were employed to analyse improvements in students' mathematics learning outcomes, focusing on the mean score and the percentage of mastery learning. The mean score was calculated using the following formula:

$$\bar{X} = \frac{\sum X}{N}$$

where:
X = average student score,
$\sum X$ = total score of all students,
N = number of students.
The percentage of mastery learning was computed as:

$$P = \frac{n}{N} \times 100\%$$

where:
P = percentage of students achieving mastery,
n = number of students whose scores met or exceeded the minimum mastery criterion (≥ 75),
N = total number of students.

Learning improvement was considered satisfactory if the mastery percentage showed an upward trend across cycles and if at least 85% of students achieved mastery by the end of Cycle II.

2. Qualitative Analysis

The qualitative data consisted of observation sheets, field notes, and reflection documents. These data sources provided insights into students' engagement, collaboration, motivation, and classroom interactions. The analysis was conducted using a descriptive qualitative approach, in which data were categorized into three levels of engagement: low, moderate, and high. This classification allowed the researcher to capture changes in classroom behavior and learning dynamics that complemented the quantitative evidence of improved test performance.

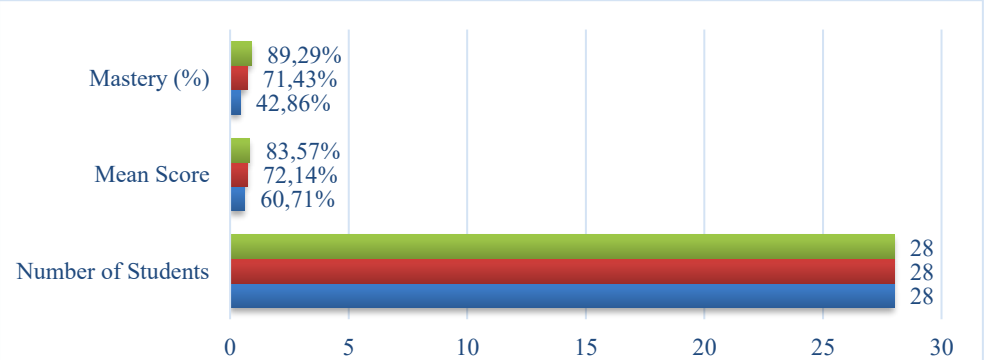
The triangulation of quantitative and qualitative data enhanced the validity of the study, as it provided a more comprehensive evaluation of the intervention's effectiveness. While quantitative data revealed the extent of improvement in academic outcomes, qualitative data offered deeper insights into the processes underlying these improvements, including the role of motivation, collaboration, and classroom atmosphere in shaping learning results.

Results and Discussion

This classroom action research was conducted at Universitas Doktor Nugroho Magetan, Department of Primary School Teacher Education, in the Mathematics Education course. The participants consisted of 28 undergraduate students enrolled in the second semester. The study aimed to investigate the extent to which the implementation of the Make a Match learning model using number cards could improve students' mathematics learning outcomes and engagement in classroom activities. The intervention was carried out in two cycles, with each cycle including the stages of planning, action, observation, and reflection.

A. Improvement in Students' Learning Outcomes

The learning outcomes were measured through formative assessments conducted at the end of each cycle. Figure 2 presents the results of students' mathematics learning performance across the pre-cycle, Cycle I, and Cycle II.



	Number of Students	Mean Score	Mastery (%)
Cycle II	28	83,57%	89,29%
Cycle I	28	72,14%	71,43%
Pre-Cycle	28	60,71%	42,86%

Figure 2. Improvement of Students' Mathematics Learning Outcomes

As illustrated in Figure 2, there was a clear upward trend in students' performance. The average score increased from 60.71 in the pre-cycle to 72.14 in Cycle I, and further to 83.57 in Cycle II. Likewise, the percentage of students who achieved the minimum mastery criteria rose substantially, from 42.86% in the pre-cycle to 71.43% in Cycle I, and finally to 89.29% in Cycle II. These results indicate a significant shift in students' achievement levels, with mastery criteria improving from the "low" category to "moderate" and eventually to the "high" category.

B. Observation of Learning Process and Student Engagement

Observation data complemented the quantitative findings by highlighting notable improvements in classroom participation and student enthusiasm. During the pre-cycle, students' engagement in learning was relatively low, as they were accustomed to conventional, lecture-based approaches. In Cycle I, the implementation of the Make a Match model encouraged greater participation, although a portion of students remained hesitant when engaging with the card-matching activity due to its novelty.

By Cycle II, students demonstrated a marked improvement in both individual and group engagement. Nearly all students actively participated in matching number cards, shared their reasoning in front of peers, and engaged in collaborative discussions to solve mathematical problems. The structured competitive element inherent in the Make a Match strategy fostered a more dynamic and interactive classroom environment, motivating students to think critically and work collaboratively.

C. Discussion and Interpretation of Findings

The reflection phase confirmed that iterative adjustments were central to the improvement process. In Cycle I, classroom management challenges such as unclear instructions and unequal group participation slightly limited the effectiveness of the intervention. These issues were addressed in Cycle II by refining task instructions, allocating time more efficiently, and ensuring balanced group dynamics. As a result, Cycle II demonstrated both higher levels of academic achievement and stronger student participation compared to the previous cycle [3], [4], [8].

Furthermore, the use of number cards as a concrete visual aid helped reduce the abstractness of mathematical concepts, thereby supporting students in achieving deeper conceptual understanding. The activity also created a more engaging and enjoyable learning atmosphere, which reduced students' anxiety toward mathematics and increased their willingness to participate actively [6], [10], [11].

Overall, the combination of quantitative data and qualitative observation strongly supports the conclusion that the Make a Match learning model with number cards effectively improves students' mathematics learning outcomes. The steady progression across the two cycles reflects the importance of continuous reflection and refinement inherent in classroom action research, making this strategy a valuable approach for mathematics education in primary teacher training programs.

Conclusion

This classroom action research demonstrated that the implementation of the Make a Match learning model supported by number cards was effective in improving mathematics learning outcomes among undergraduate students in the Department of Primary School Teacher Education at Universitas Doktor Nugroho Magetan. The findings revealed a consistent and significant increase in students' mean scores and mastery percentages across the research cycles, moving from the low category in the pre-cycle to the high category in Cycle II. In addition to measurable academic improvements, qualitative observations indicated that the model fostered greater student engagement, enhanced collaborative learning, and created a more enjoyable and interactive classroom environment. The iterative process of planning, action, observation, and reflection was found to be essential in refining the instructional strategy, ensuring better classroom management, and maximizing student participation. The integration of number cards provided a concrete and visual medium that reduced the abstractness of mathematical concepts, thereby supporting deeper comprehension and reducing learning anxiety. Overall, the study concludes that the Make a Match learning model with number cards is a pedagogically sound and effective approach for improving mathematics learning outcomes in teacher education contexts. It not only enhances students' academic performance but also promotes the development of critical learning skills such as collaboration, communication, and problem-solving. These findings suggest that the model holds strong potential for broader application in mathematics classrooms at both higher education and primary school levels, provided that the implementation is accompanied by systematic reflection and adaptation to specific classroom needs.

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Author Contributions

E.F: conceptualization; methodology; formal analysis; resources; data curation; writing - original draft; writing - review & editing. S.N: methodology; software; investigation; supervision; project administration; writing - original draft; writing - review & editing.

Availability of data and materials

All data is available from the authors.

Competing interests

The authors declare no competing interest.

Additional information

No additional information from the authors.

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