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Effectiveness of the Make a Match Model Based on Flashcard Media to Improve Students' Learning Outcomes on Fractions

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ABSTRACT

The low results Study mathematics material fractions in elementary school are caused by the abstract nature of the material and patterns, teaching isolated, teacher-centered. This study aims to test effectiveness application of the make-a-match model assisted by flashcard media to improve results Study mathematics material fractions compared with the Problem Based Learning (PBL) model. This type of research is a quantitative experiment with a quasi-experimental design with a non-equivalent control group design. Instrument data collection in the form of test results Study mathematics objective, 26 items, question choice double, which was tested as a pretest and posttest (Cronbach's alpha of 0.703). The data analysis technique uses statistical tests, descriptive and inferential, which include prerequisite tests and hypothesis testing using an independent-samples t-test and paired-samples t-test. The pretest results showed that the initial abilities of the two groups were relatively balanced with an average of 58.16 for the experimental class and 53.80 for the control class. After the intervention, the results showed a significant difference in learning outcomes between the two groups based on the independent samples t-test with a t value of 4.124, df = 58, and a p value < 0.001. The experimental class obtained a posttest average of 83.43, significantly higher than the control class (PBL), which obtained an average of 75.57. In addition, the Normalized Gain (N-Gain) test proved that the experimental class increased by 57.18% (moderate and more effective category), outperforming the control class, which only achieved 45.38% (moderate and quite effective category). Based on these results, it can be concluded that the application of the make-a-match model assisted by flashcard media is more effective in improving the mathematics learning outcomes in fractions compared to the use of the problem-based learning (PBL) model.

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Introduction

The low results Study mathematics on the material fractions be one of problem crucial issues that urgently need to be resolved at the elementary school level. Evaluation results periodically like The Program for International Student Assessment (PISA) confirms this that literacy numeracy Indonesian students in general consistent is below the global average due to weakness mastery concepts base (OECD, 2023). Phenomenon This macro was photographed in a way real in space class III, where the results Study mathematics students on the material fractions Not yet capable reach Criteria Achievement of the established Learning Objectives (KKTP) , with an average value of students who are stuck at 69 from the minimum target of 75. So far, the low achievements the caused by patterns learning conventional teacher - centered, minimal stimulation through instructional models active, and limitations visualization the material that makes climate class tend passive .

In a way specific, obstacles fundamental students in the material fractions rooted in adversity cognitive to conceptualize characteristic abstract from number fractions That alone. When faced with the task question fractions, reasoning and ability think level high (Higher Order Thinking Skills or HOTS) students often experience distortion Because Not yet able to make the transition logical from number intact to parts number (Samsudin et al., 2023). Students tend experience whole number bias , namely trend wrong consider fractions as two numbers separate spheres (numerator and denominator) rather than as one unity mark single (Fuchs, LS, Wang, AY, & Malone, 2021). Obstacle this cognitive is visible real when student faced with surgery comparison or comparing fractions have unequal denominators ; they often consider $\frac{1}{4}$ greater than $\frac{1}{2}$ just because the number 4 is greater than 2 (Braithwaite, DW, & Sprague, 2021). This pattern of error is reinforced by the fact that the learning process often ignored aspect recreational and visual, so that student difficulty linking meaning operation fractions and tends passive consequence limitations of the game media that are capable bridge understanding abstract they (Suciati, 2021).

Understanding this erroneous concept requires solution quick Because material fractions are the foundation basic (gateway topic) to learn construct more mathematics complex at a higher level high, such as algebra, percentages, and decimals (Siegler, 2024). Considering characteristics psychological child elementary school age Still is in phase operational dominant concrete based motor activities and experimentation direct (Geller & Alibali, 2023), then educator required to formulate a teaching model that is capable of manifest draft abstract fractions become concrete, participatory, and visual representation competitive-recreational. As effort build experience meaningful learning, Make a Match model offer alternative very representative methodological model. This model apply technique matchmaking pair card questions and answers within a certain time limit, so trigger interaction social, communication, and concentration Study student in a way intensive (Suprianto, 2024). Card-based active learning has been empirically proven to be able to initiate a learning space that challenges students' mathematical reasoning (Fegi Nopriani et al., 2025). To eliminate boredom and maximize understanding of basic fraction concepts, this model requires child-friendly supporting media, one of which is flashcards. As a visual instructional medium, flashcards function to present a representation of fraction values through a combination of colors, concrete image pieces, or mathematical notation that can focus students' cognitive attention (Afiyah & Sutriyani, 2024). The use of these picture cards is very effective in simplifying complex material, even when developed into a digital platform (Amalia, 2025).

Several previous studies have attempted to integrate active learning models and flashcards to improve the quality of fraction instruction. Research by Wahyuni & Damayani (2025) shows that the implementation of Make a Match can optimize mathematics learning

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
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outcomes gradually through classroom action. Furthermore, Sari (2025) also found that the combination of Make a Match and flashcards effectively increased student participation from the pre-cycle to the final cycle. However, the majority of previous studies examining the effectiveness of this combination have relied on Classroom Action Research (CAR) methods. The CAR approach has limitations in generalizing results due to its case-based focus on internal improvement within a single class without a control group to compare the method's reliability.

This is where the innovation and novelty of this research lies. Through this gap analysis, this study fills a gap in the literature by testing the effectiveness of integrating the Make a Match model with flashcards using a quantitative approach through a Quasi- Experimental Design. By involving both experimental and control groups, the empirical validity of this intervention's effect on mathematics learning outcomes can be measured more objectively without the bias of the action cycle. Based on the theoretical and methodological gaps, this study aims to significantly test the effectiveness of the implementation of the Make a Match model assisted by flashcard media to improve the learning outcomes of third-grade students on fractions. Specifically, this study is directed to measure the significance of differences in the achievement of mathematical concept understanding between groups of students who are taught using the Make a Match model assisted by flashcards and groups of students who use conventional models. The results of this study are expected to provide theoretical contributions to the development of mathematics teaching strategies for fractions in elementary schools, while providing practical solutions for educators in designing a dynamic, concrete, and adaptive classroom ecosystem for children's cognitive development.

Method

Types of research

This research is a research quantitatively using method experiment quasi - experimental design . The experimental design applied is Non-equivalent Control Group Design. Reasons for use this design is Because subject study be in a group classes that have been formed in a way naturally in schools, so it is not possible to carry out randomization subject individually (true experiment). Through this design, researchers testing two groups intact subject to control influence variables outside to results Study material fractions .

Population and Sample

The population in this study is all over student grade III elementary school . Taking sample apply technique cluster random sampling (area sampling), a procedures that guarantee that all over group / class own equal probability of being selected become group observation without bother structure classes that have been there is. Based on technique Of these, two classes were selected with representation quantity balanced and possessing subjects characteristics demographic homogeneous (age around 8–9 years with background behind socio-economic equivalent), namely group experiment consists of of 30 students , studied using the Make a Match model based flashcard . Meanwhile group control consists of of 30 students, studied using conventional models assisted by image media.

Instrument Study

Data collection in experiment This use instrument test results Study cognitive shaped objective choice double about material fractions simple. Reasons for use instrument test This is

For measure in a way objective and measurable level understanding draft as well as ability solution problem mathematical student before and after intervention. Before implemented , the instrument that was originally consists of of 32 grains question has tested try it moreover formerly For test its eligibility through validity and reliability tests.

Validity test grains question done use product moment correlation with level significance of 5% ($r_{table} = 0.3610$). Test results show that of 32 grains There were 26 questions tested question the rest declared valid because mark $r_{count} > 0.3610$, while 6 items question the rest stated invalid because mark $r_{count} < 0.3610$. Next, the reliability test use formula Cronbach's Alpha against 26 items question produce coefficient of 0.703. This figure show that instrument own level high reliability and consistency For used as tool measuring results Study. Here is an example of 6 points the question stated valid along with aspects measured based on test instruments in the field is as following :

Table 1. Aspects Cognitive and Examples Valid Question Items

No	Question Indicator	Example Valid Question Items
1.	Understanding draft base fractions through representation visual (fractions as part from the whole whole)	Whether picture the show draft fractions as parts from overall ? a. Yes, because the shaded part is part of a whole object. b. Yes, because all part shaded c. No, because shaded part more from One d. No, because circle No object intact
2.	Mastery of fraction component terminology (identifying the position and function of the "numerator" in fraction notation)	In fractions $\frac{3}{5}$The number 3 is called… a. Numerator b. Denominator c. Amount d. Difference
3.	Students can identify fractional number symbols from the visual images presented.	A watermelon is cut into 4 equal pieces. Mother gives 1 piece to Andi. Symbol fractions For piece Andi's watermelon is … $\frac{1}{2}$b. $\frac{1}{3}$c. $\frac{1}{4}$d.$\frac{4}{1}$
4.	Students can determine equivalent fractions based on visual illustrations.	Look at the two pictures The circles below ! The first circle is shaded in part, while the second circle is divided into 4 parts. To have the same value as the first circle, how many parts $\frac{1}{2}$of the second circle must be shaded? a. 1 part c. 3 parts b. 2 parts d. 4 parts
5.	Student can apply draft fractions For solve question story simple in life daily .	Budi has a divided chocolate into 8 parts The same big . If Budi eats 3 parts chocolate said , then remainder Budi's chocolate in form fractions is ... **a.** $\frac{3}{8}$b. $\frac{4}{8}$c. $\frac{5}{8}$d.$\frac{8}{5}$
6.	Student can compare big two values fractions with denominator different .	Where is it? from the statement below shows connection comparison correct fraction ? a. $\frac{1}{2} > \frac{1}{4}$ b. $\frac{1}{2} > \frac{1}{2}$ c. $\frac{1}{3} < \frac{1}{5}$ d. $\frac{1}{2} = \frac{1}{4}$

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i2.5259 Volume 6, No 2, April - June 2026, pp. 894 –906

Procedure Study

Study implemented as many as 4 meetings in each group with details procedure data collection with stage Pretest : Before intervention started, second group given test initial (pretest) using 26 items valid questions for mapping ability base students on the material fractions and ensure second group leave from point equal start. Stage Treatment with scenario class experiment implementing the Make a Match model based Flashcards . The learning syntax begins with the delivery of the objectives of the fraction material and motivation. The teacher presents basic information about the concept of simple fractions, then distributes flashcards (some containing visual images of fraction pieces and some containing numerical notation) $\frac{a}{b}$. Entering the core stage, students actively move to find matching pairs of cards within a certain time limit. After pairing, they discuss in groups to validate the accuracy of the answers, followed by a presentation of the results in front of the class for confirmation by the teacher, and ending with reinforcement and reflection (Sulistio & Haryanti, 2022). Scenario Class Control : Implementing a conventional teacher - centered model assisted by image media . stay on the board write. Activity started explanation draft fractions in a way classical, giving example question compare fractions on the board write, and end with workmanship exercise question in a way independent by students from book package without existence interaction active intergroup (Nurjannah et al., 2025).

Data analysis

Result data Study mathematics counted in a way quantitative through two approaches statistics (Sugiyono, 2021). Statistics descriptive used For serve data profile in the form of average value (mean), value maximum-minimum, standard deviation, and percentage completeness study student from score pretest and posttest . Statistics inferential used For test hypothesis research . Before testing the hypothesis, a prerequisite test is carried out analysis which includes the Normality Test (for know whether data distribution is normally distributed) and Homogeneity Test (for ensure second data variance group equal / homogeneous). Testing Testing Hypothesis consists of from the Paired Sample T-Test. Applied For see significance improvement results learning within each class (comparing pretest and posttest group That itself). Independent Sample T-Test applied to the scores Normalized gain (N-Gain Score) based on the formula (Hake, 1998). This N-Gain analysis used For measure effectiveness and magnitude significance improvement results Study material fractions student between groups using the Make a Match model based flashcard with conventional model group.

Research Findings

Study experiment This mock was carried out at Genuksari 02 State Elementary School by involving student class III as a subject research . Data collection was carried out through two stages measurement, namely a pretest to find out ability beginning students and posttest to find out results Study after given treatment. Capability data initial (pretest) obtained before second group given intervention learning. Ability results initial (student pretest) class experiments and classes control presented in Table 2.

Table 2. Class Pretest Results Experiments and Classes Control

No	Pretest Results	Amount Student	Average
1.	Class Experiment	30 students	58.16
2.	Class Control	30 students	53.80

Based on Table 2, it can be seen that the average initial ability of the experimental class was 58.16 and the control class was 53.80. Both classes had relatively balanced initial abilities and neither had yet reached the minimum completion criteria set by the school. After the entire series of four experimental meetings was completed, the researchers collected final data (posttest) to measure the results of the treatment applied to each class. Details of the comparison of final achievement scores between the experimental and control classes are presented in Table 3.

Table 3. Class Posttest Results Experiments and Classes Control

No	Posttest Results	Amount Student	Average
1.	Class Experiment	30 students	83.43
2.	Class Control	30 students	75.57

The final learning outcomes of students in the experimental class reached an average of 83.43, while those in the control class achieved an average of 75.57. This contrasting difference in academic performance stems from the implementation of all stages of the flashcard-based make-a-match learning syntax in the experimental class (Slavin, 2025). In the first phase, the implementation of the model in the experimental class was realized through a card matching scenario that combined physical-motor activities and numeracy reasoning. Students were faced with the challenge of mapping abstract concepts to concrete forms by matching question cards (containing visual shading representations of fruit fractions) with answer cards (containing fraction symbol notations $\frac{a}{b}$) within a strictly specified time limit. Empirical findings in the field showed that this competitive-recreational activity arrangement successfully activated students' emotional engagement and sharpened their memory retention when comparing fraction values.

If in comparison, this dynamic is comparable inversely related to class control using conventional models One direction (*teacher-centered*). In class control , students tend passive accept information from blackboard, experiencing boredom and difficulties visualize magnitude fractions worth due to the absence of instrument interactive visual manipulatives . This comparative fact confirms that intervention structured in class experiment in a way real capable cut obstacle cognitive student compared to pattern teaching traditional. The dynamic activities of students in the experimental class are visually documented in Figure 1.

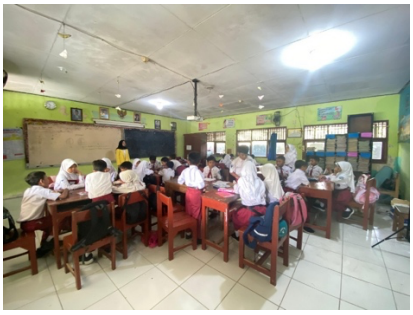

Figure 1. Activities of Grade III Students of SDN Genuksari 02 When Applying the Make a Match Learning Model Syntax

This model is effective because it is supported by the availability of adaptively designed visual instruments, such as flashcards. The specifications, physical form, and visual content of the paired flashcards used as a cognitive bridge for third-grade students in understanding the meaning of real fractions are shown in Figure 2.

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
https://doi.org/10.51574/kognitif.v6i2.5259 Volume 6, No 2, April - June 2026, pp. 894 –906

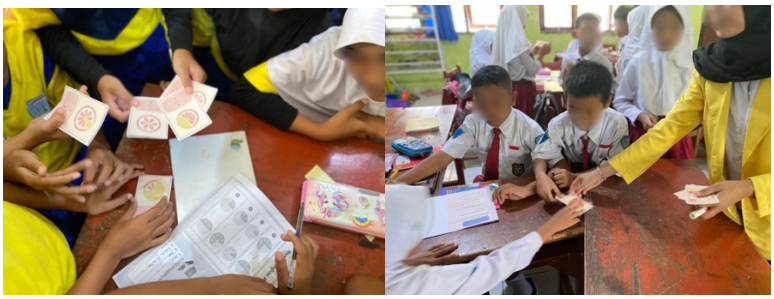

Figure 2. Visual Fruit -Based Flashcard Media for Fraction Material Simple Class III

Before conduct a hypothesis test For interesting conclusion , data results Study moreover formerly tested prerequisites , including normality tests and homogeneity tests . Normality tests use Shapiro-Wilk method . Data from normality test results presented in Table 4.

Table 4. Normality Test Results Class Experiments and Classes Control

Class	Shapiro Wilk Statistics Sig	Note
Pretest Experimental Class	935 0.065	Normal
Posttest	938 0.079	Normal
Pretest Control Class	939 0.088	Normal
Posttest	971 0.557	Normal

The data in Table 4 shows that all significance values (Sig.) of the pretest and posttest data in both classes are greater than 0.05. Thus, it can be concluded that the result data Study mathematics normally distributed. Next, a homogeneity test was carried out variance of the data whose results listed in Table 5.

Table 5. Results of the Homogeneity Test for the Experimental Class and the Control Class

	Lavene Statistics	Sig	Note
Pretest of experimental-control class	1,199	0.313	Homogeneous
Posttest of experimental-control class	1,198	0.314	Homogeneous

Based on Table 5, the value The significance (Sig.) of the homogeneity test for the pretest data was 0.313 and the posttest data was 0.314. Since the Sig. value is > 0.05, the variance of the data from both groups is declared homogeneous (the same). After the prerequisite test is fulfilled, the hypothesis test to see the difference in learning outcomes between the two groups is calculated using the Independent Samples T-Test. The results of the t-test are as follows: presented in Table 6.

Table 6. Results of the Independent Sample T-Test in Class Experiment and Control

Results	Mean	Sig (2-tailed)	Note
Experimental Class Posttest	83.43	<0.001	There is a difference in the average learning outcomes of students on the final test
Control Class Posttest	75.57		

The results of the Independent Samples T-Test in Table 6 show Sig. value (2-tailed) is < 0.001, which means smaller of 0.05. This proves that that there is difference results Study mathematics material significant fraction between students who are taught using the flashcard-

based Make a Match model with students who are being taught using conventional models . To see significance improvement results study in each group internally , done testing through Paired Sample T-Test.

Table 7. Results of the Paired Sample T-Test for Class Experiment and Control

Results	Mean	Sig (2-tailed)	Note
Experimental Class: Pretest Posttest	58.16 83.43	<0.001	There was an increase in the average student learning outcomes between the initial test and the final test.
Control Class: Pretest Posttest	53.80 75.57	0.002	

The data in Table 7 shows that Good class experiment and class control experience improvement results significant learning from pretest to posttest stage. To measure size quality improvement results Study in a way comparative, done calculation Normalized Gain (N-Gain) score.

Table 8. N Gain Test Results

Class	Mean N-gain (%)	Category	Information
Experiment	57.18	Currently	More Effective
Control	45.38	Currently	Enough Effective

Based on Table 8, the average N-Gain score for the experimental class reached 57.18%, while the control class only achieved 45.38%. Although both classes are in the "Moderate" improvement category based on the classification proposed (Hake, 1998), the percentage of improvement for the experimental class was much higher than that of the control class

Discussion

The main findings of this study prove that the implementation of the Make a Match model assisted by flashcard media provides a higher empirical contribution in optimizing the cognitive understanding of fraction material in elementary school students. The procedural success in the experimental class is rooted in the conditioning of a participatory teaching climate. The implementation of syntax begins with the delivery of conceptual apperception of fractions, followed by the organization of heterogeneous groups. The teacher distributes instrument in the form of divided flashcards on visual problem cards and cards notation number. At the core stage of searching couple, students move look for partners the matching card in range time measurable. Activity kinesthetic interactive This force concentration think child For match object picture abstract with formal mathematical symbols in a way instant . After each other in pairs, students required do confirmation, verification truth answer through discussion group small, and present it in front of class for validated by educators through giving strengthening.

Facts on the ground show that use visual image of a cut fruit colored on flashcards proven success reduce weakness typical child age basic, namely whole number bias (tendency consider numerator and denominator as number round separate). This flashcard media help conceptualize fractions as magnitude mark intact single value Continuous . Students' learning attention is maintained constantly because the reasoning process is packaged through fun and challenging activities. In addition, working on matching cards stimulates mathematical communication in third-grade students to actively discuss solving comparison operations of fractions with unlike denominators without the shadow of fear of being wrong or bored.

When compared with previous literature, the positive findings in this experimental class support and strengthen the theory of teaching based on external visual manipulation. These

Kognitif: Jurnal Riset HOTS Pendidikan Matematika
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research findings align with quantitative studies (Fauzi & Rahmawati, 2024). which explains that the use of matching cards is proven effective in minimizing conceptual bias and improving children's academic learning completion in basic mathematics. This targeted physical-kinesthetic conditioning tactic facilitates the transition of students' memory from concrete to abstract levels of thinking logically (Asadulloh, 2023). The growth of student interest and participation during the card matching scenario also strengthens the analysis (Wulandari & Ismiyanti, 2022) which states that engineering a recreational mathematics classroom climate is linear with the achievement of satisfactory cognitive scores. The successful translation of fruit image representations into formal number symbols in this study is supported by the finding that flashcard media in fraction material helps improve students' understanding of mathematical concepts (Putri et al., 2024).

In contrast, a contrasting comparison was found in the performance of the control class using the conventional model, with learning growth tending to be slow (average 75.57; N-Gain 45.38%). The teacher - centered, one-way teaching pattern without manipulative visual aids resulted in students in the control class being passive and prone to concentration distortion. The negative impact of this stagnant conventional classroom atmosphere is in line with criticism (Pratama, 2023) which confirmed that the oral expository method triggers systemic confusion in children when faced with fraction story problems. The limited concrete visualization in the control class caused students to make mistakes in comparing fractions with unlike denominators, a finding that reflects the results of the analysis (Widiastuti & Utami, 2024). regarding the high level of cognitive obstacles resulting from abstract teaching that is isolated from the child's real world. Without active exploration, students' critical reasoning struggles to develop optimally (Anwar & Setiawan, 2022).

Despite its strengths, the findings of this quasi-experimental study still have limitations and operational weaknesses. The fundamental weakness of the Make a Match model lies in the high level of classroom noise during the moving phase of searching for a matching card, which risks disrupting the learning focus of slow auditory learners (Andani et al., 2021). In addition, this intervention was limited by its short duration (4 meetings), so it was not yet possible to detect the stability of the consistency of students' learning outcomes in the long term. The quasi -experimental design with a Non-equivalent Control Group Design also implies that subject randomization was not carried out purely individually, so the potential for bias due to the subjects' innate characteristics (extraneous variables) between classes could not be absolutely controlled (Suyoto, 2015).

Despite these operational limitations, the novelty of this research lies in the comparative quantitative methodological approach used to test the intervention's reliability. The majority of previous publications on the Make a Match model using instructional cards are dominated by Classroom Action Research (CAR) methods, which focus on the internal improvement of a single classroom (Darrosa et al., 2026). The limitations of CAR make it difficult to generalize findings broadly due to the lack of a purely external control as an objective comparison instrument. This research successfully fills this gap in the literature (gap analysis) by providing validated quantitative data using a separate experimental control group. The theoretical novelty of this research is emphasized by positioning the visual match cards as not merely a recreational medium but also structurally designed as a cognitive stimulus to erode basic numeracy bias in children by providing a meaningful group discussion space (Amerinda, 2026). This experiment provides a new scientific contribution by empirically proving that the arrangement of physical-kinesthetic models combined with visual-tactile media is significantly able to optimize the learning outcomes of mathematics on fractions in elementary school students.

Conclusion

Based on the results of data analysis and discussion, it can be concluded that the implementation of the Make a Match cooperative learning model assisted by flashcard media is effective in improving mathematics learning outcomes in fractions. The combination of physical activities of finding card pairs with concrete visualization on flashcards has been proven to be able to eliminate boredom, spark active involvement, and make it easier for students to conceptualize mathematical material from abstract to concrete. The success of this intervention is strongly supported by empirical data where the average posttest score of the experimental class reached 83.43, significantly outperforming the control class which obtained an average of 75.57. The quality of learning outcomes in the experimental class was also proven to be much more optimal with a Normalized Gain (N-Gain) score of 57.18% which is included in the moderate category, while the control class only achieved an N-Gain score of 45.38%. Thus, the integration of this model and media has succeeded in addressing the problem of low numeracy learning outcomes through reducing cognitive barriers (whole number bias) and formulating students' understanding of fraction concepts effectively.

Despite recording superior results and supported by valid analytical data, this study still has several limitations and operational weaknesses that need to be underlined. First, the implementation of the Make a Match model triggers a fairly high increase in classroom noise levels during the phase of students' movements looking for card pairs, thus potentially disrupting the learning focus of students with slow auditory characteristics. Second, this teaching intervention is limited by a relatively short time scope, namely only 4 meetings, so it has not been able to detect the level of stability and consistency of students' cognitive learning outcomes in the long term (long-term retention effect). Third, the quasi -experimental design with a Non-equivalent Control Group Design does not apply pure individual subject randomization, so the potential for bias in the innate characteristics of subjects (extraneous variables) between classes cannot be absolutely controlled as in a true experimental design.

For third-grade teachers, it is recommended to adopt the Make a Match model with the aid of flashcards regularly for mathematics materials with a high level of abstraction. To overcome the weakness of high class noise during the matchmaking phase, teachers are recommended to develop clear game rules before the cards are distributed, implement strict time management at every step of the syntax, and utilize class assistants or colleagues to optimize group supervision during student movement. For further researchers, it is recommended to replicate this research using a true experimental design with a longer face-to-face duration (e.g. 8–12 meetings) to test the consistency of students' long-term memory retention, as well as expanding the scope of observation variables at the level of mathematical material or characteristics of different students' cognitive styles.

Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

Auhor Contributions

N.N.F. conceived the research idea presented, designed the flashcard media, and collected data in the field. The other two authors (T.M. and I.R.) actively participated in the development of theory, methodology, data organization and analysis, guidance, discussion of results, and approval of the final version of the work. All authors declare that the final version of this paper

has been read and approved. The total percentage of contributions to the conceptualization, preparation, and correction of this paper is as follows: N.N.F.: 40%, T.M.: 30%, and I.R.: 30%.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author [N.N.F.] upon reasonable request.

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