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DEVELOPMENT OF MANIPULATIVE NUMBER CARD MEDIA IN MATHEMATICS LEARNING AT MADRASAH IBTIDAIYAH MUHAMMADIYAH TRANGSANG SUKOHARJO

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Abstract

This study is motivated by the limited research on the development of manipulative number card media in elementary mathematics education, despite its strong potential to enhance students' conceptual understanding. The research aims to analyze the effectiveness of manipulative number card media in improving third-grade students' comprehension of simple fractions and to describe the process of its development. Utilizing a Research and Development (R&D) approach based on the ADDIE model, the study involved 64 third-grade students at MI Muhammadiyah Trangsan Sukoharjo, selected through purposive sampling. Data were gathered through observations, interviews, questionnaires, and achievement tests, and analyzed using quantitative descriptive methods. The results demonstrate high feasibility ratings for the developed media, with scores of 97% from media experts, 100% from material experts, 93.75% from teachers, and 96.81% from students. The average post-test score was 95.04, indicating excellent student performance. These outcomes support the learning theories of Piaget and Bruner, emphasizing the critical role of concrete manipulative media in facilitating students' understanding of abstract mathematical concepts. The study concludes that manipulative number card media is an effective tool for mathematics instruction and highlights the potential for future research to expand its application to other mathematical topics.
Keywords: Manipulative Media; Number Cards; Mathematics Learning; Elementary Education; Media Development

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INTRODUCTION

Primary education plays a strategic role in shaping students' character, cognitive abilities, and social skills. Mathematics is one of the core subjects taught at the elementary school level (Syam, 2020; Utami & Ningsih, 2025). At this stage, mathematics learning is essential in fostering students' logical, critical, and creative thinking skills (Nur et al., 2021; Purwaningrum, 2016). However, field observations indicate that many students still struggle to understand basic mathematical concepts, particularly in the topic of simple fractions. These difficulties are often caused by monotonous teaching methods and the lack of interactive learning media (Indrapangastuti et al., n.d.; Wildaniati, 2015). Moreover, students' low interest in learning mathematics poses another challenge for teachers. Learning that relies solely on textbooks or verbal explanations tends to make students passive and unmotivated (Sapriyah, 2019). This aligns with initial findings at MI Muhammadiyah Trangsan Sukoharjo, where mathematics learning was limited in media variation, resulting in suboptimal student participation. In fact, engaging learning media can help transform abstract concepts into more concrete understanding (Wahidin, 2025).

At the national level, the issue of low mathematical comprehension in elementary schools is not confined to a single region but represents a broader challenge in Indonesia. The PISA (Programme for International Student Assessment) results show that Indonesian students' mathematical literacy remains below the international average (Damanik & Handayani, 2023; Habibi & Suparman, 2020; OECD, 2019). This finding highlights the urgent need for innovative learning strategies that can enhance both students' motivation and their understanding of mathematics from an early stage.

In light of this condition, the researcher argues that developing innovative learning media is a strategic solution to improve the quality of mathematics learning in elementary schools. Referring to constructivist theory, students build knowledge through active interaction with objects and their learning environment (Abdiyah, 2021; Herdiana, 2024; Iswara, 2025). Therefore, media that enables students to directly manipulate the concepts being studied is believed to significantly improve comprehension.

The use of manipulative media, such as number cards, aligns with experiential learning approaches. This medium allows students to learn while playing, thereby reducing the perception that mathematics is a difficult and intimidating subject (Farhana et al., 2022). Thus, this research aims to develop manipulative number card media that is not only

visually appealing but also effective in helping students grasp the concept of simple fractions.

Previous studies have demonstrated the effectiveness of manipulative media in mathematics learning. Pratiwi et al. (2013) found that the use of number cards significantly improved the cognitive abilities of early childhood learners. Similarly, Jannah (2024) confirmed that number card media is both feasible and practical for use in grade II of madrasah ibtidaiyah. However, most prior studies have focused on younger learners or lower grade levels, with limited exploration of its application to simple fractions in grade III. Furthermore, earlier studies tended to evaluate only the feasibility or practicality of the media without thoroughly examining its impact on learning motivation and conceptual understanding. This creates a research gap to be addressed in the present study, namely the development and simultaneous testing of manipulative number card media to enhance students' comprehension of simple fractions.

The novelty of this research lies in the development of manipulative number card media specifically designed for grade III simple fractions, incorporating visually engaging designs created with Canva and illustrations relevant to students' daily lives. This design aims to foster students' active engagement, consistent with Mayer (2009) multimedia learning principle, which emphasizes the integration of text, images, and symbols to strengthen understanding. Additionally, this study adopts the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) as suggested by Sugiyono (2013). This model provides a systematic framework for producing learning media that is valid, practical, and effective. Such an approach allows the media to be assessed from multiple perspectives, including validation by subject matter experts, media experts, teachers, and students' responses.

Theoretically, this research is grounded in Bruner's learning theory, which emphasizes learning through three stages: enactive (learning by doing), iconic (learning through images), and symbolic (learning through symbols). Manipulative number card media facilitates all three stages, thereby supporting students' transition from concrete to abstract mathematical understanding.

Based on the discussion above, this study focuses on developing, assessing the feasibility, and testing the effectiveness of manipulative number card media in mathematics learning on simple fractions for grade III students at MI Muhammadiyah Trangsan

Sukoharjo. The development is not only intended to improve instructional quality but also to create an enjoyable and interactive learning environment. Specifically, this study aims to: (1) describe the development process of manipulative number card media using the ADDIE model; (2) evaluate the feasibility of the media based on expert validation and user responses; and (3) test the effectiveness of the media in improving students' understanding of simple fractions and their learning motivation in the 2024/2025 academic year.

METHODS

The research employed is a research and development (R&D) study using the ADDIE development model (Analysis – Design – Development – Implementation – Evaluation). According to Sugiyono (2013), this model is applied to create a specific product that can be used and to determine the effectiveness of that product. The researcher developed manipulative number card media for mathematics learning in the third grade of MI Muhammadiyah Trangsan, Gatak District, Sukoharjo Regency, from February 19 to April 29, 2025, involving a total of 64 students. These students were divided into three learning groups: Class 3A with 22 students, Class 3B with 21 students, and Class 3C with 21 students. This study employed a quantitative descriptive method, which is a type of research used to investigate populations or samples through surveys or questionnaires (Sugiyono, 2017).

The development research using manipulative number card media followed the ADDIE model as described below:

Analysis Stage: This phase aims to identify instructional needs, particularly the difficulties faced by third-grade students at MI Muhammadiyah Trangsan in understanding the topic of simple fractions. The researcher conducted observations and interviews to evaluate the effectiveness of the current teaching and the importance of using media that support the learning process.

Design Stage: At this stage, the researcher began designing the manipulative number card media. The media design was aligned with Core Competencies (Kompetensi Inti), Basic Competencies (Kompetensi Dasar), indicators, and learning objectives. The selected material focused on simple fractions, presented in the form of engaging and easy-to-understand educational cards.

Development Stage: The media that had been designed was then turned into a tangible product. This product was prepared for trial and implementation in the learning process.

Implementation Stage: This phase involved validating the media through assessments by a subject matter expert, media expert, and user (teacher). Evaluation was conducted using questionnaires to gather feedback on the quality of the media, which served as the basis for revision and refinement.

Evaluation Stage: Evaluation was carried out to assess the feasibility and effectiveness of the media based on the validation results and the responses from both students and teachers. If deemed feasible, the media can be used as an alternative instructional tool for teaching simple fractions in third-grade classrooms at MI Muhammadiyah Trangsan.

The outcomes of this development were assessed and validated by several experts. The validation of the developed media was carried out using the following formula (Sa'adah & Wahyu, 2022:97) :

$$P = \frac{\text{Total score of respondent's answers for one item}}{\text{Ideal score for one item}} \; x \; 100\ \%$$

The results of validation data from media experts, material expert validation, users (teachers) will be grouped into five categories Very Feasible, Feasible, Feasible Enough, Less Feasible, which are listed in table 1 below:

Table 1. Feasibility Score Percentage Categories (Riduwan & Aldon, 2015)

No.	Percentage	Category
1	81%–100%	Highly Feasible
2	61%–80%	Feasible
3	41%–60%	Fairly Feasible
4	21%–40%	Less Feasible
5	0%–20%	Not Feasible

Next, the average score of students' worksheet results was calculated using the following formula:

$$\bar{x} = \frac{\text{Total of all data score}}{\text{Number of data points}}$$

The results of the student worksheets are converted to the categories in table 2 below:

Table 2. Worksheet Evaluation Categories (Riduwan & Aldon, 2015)

No.	Percentage	Category
1.	81–100	Excellent
2.	61–80	Good
3.	41–60	Fair
4.	21–40	Poor
5.	0–20	Very Poor

RESULTS

The development of manipulative number card media for the topic of fractions in Grade 3 at MI Muhammadiyah Trangsan was carried out using the R&D approach with the ADDIE model, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation. Based on interviews, teachers reported that prior to using this media, students had difficulty understanding fractions due to their abstract nature. Students were confused when distinguishing between fractions such as one-half and one-fourth because they lacked visual representations. After the introduction of number card media, learning became more enjoyable and students showed greater engagement. They were enthusiastic about learning through play and were able to understand the material more quickly by matching images with fraction symbols. Teachers also noted that the media fostered an interactive learning environment and was suitable for students of varying abilities. Interview data analysis using the Miles and Huberman model indicated that teachers responded positively and supported the use of this media in mathematics instruction.

Next, the researcher designed the manipulative number card media based on teacher input and the characteristics of third-grade students. The media was designed using Canva, paying attention to principles of readability, visual appeal, and content alignment with the curriculum. The card size was adjusted to suit lower elementary students, made large enough to be clearly visible to the entire class and easily explained by the teacher. The cards were printed on A3-sized paper (21 cm x 42 cm).

The visual design of the media used the "Chewy" font to make the text visually appealing and easy for students to read. The content included the introduction of numbers and fraction symbols to help students grasp abstract numerical concepts. The number cards were designed in accordance with Core Competencies (Kompetensi Inti), Basic

Competencies (Kompetensi Dasar), and learning indicators. Images and symbols were made attractive and contextual to support students' visual understanding of the material. Here is Figure 1 Number card design.

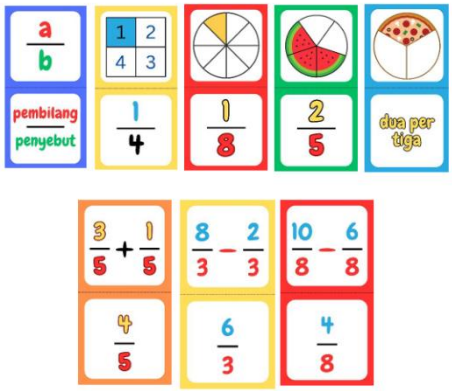

Figure 1. Number Card Design

Following the development this phase (Figure 1), the fourth stage, media validation, was conducted by expert validators, including a media expert, a subject matter expert, and the end user (teacher). Each validator provided feedback and suggestions for improvements, which were used to revise the media as needed. The validation process is described as follows:

Media Expert Assessment

Table 3. Results of Media Expert Validation

No.	Component Indicator	Question No.	Score
1	Alignment with learning objectives	1	5
		2	5
		3	5
		4	5
2	Language and writing clarity	5	5
		6	5
3	Media appearance	7	5
		8	5
		9	5
4	Media usability	10	5
		11	4
		12	4
		13	5
		14	5
		15	5
Total Score			73
Percentage			97%

In Table 3, the score obtained from the media expert validator, 73, was formed in a percentage of 97%, indicating in the calculation of the media expert validator that the learning media is very feasible and does not need revision.

Subject Matter Expert Assessment

Table 4. Results of Subject Matter Expert Validation

No.	Component Indicator	Question No.	Score
1	Alignment with Core and Basic Competencies	1	5
2	Content breadth	2	5
		3	5
3	Content clarity	4	5
		5	5
		6	5
3	Relevance to real-life context	7	5
4	Quality of content delivery	8	5
5	Appropriateness of visuals and terminology	9	5
6	Clarity and organization of content	10	5
Total Score			75
Percentage			100%

As shown in the table 4 above, the subject matter expert assigned a total score of 75, equivalent to 100%. This indicates that the instructional media is classified as "Highly Feasible" and does not require any revisions.

Following the validation and revision stages conducted by both material and media experts, the manipulative number card media was declared highly feasible for use in the learning process. The media trial was conducted on April 29, 2025, at MI Muhammadiyah Trangsan Sukoharjo and involved all 64 third-grade students. During the trial, the researcher began by introducing themselves, followed by an explanation of whole numbers and simple fractions as an introduction. The researcher then introduced and demonstrated the use of the developed manipulative number card media. To gain insight into the teacher's perspective regarding the media, the researcher distributed a questionnaire containing several statements evaluating the media's feasibility and effectiveness in

supporting mathematics learning. The responses were then analyzed to assess the extent to which the media met the criteria as an interactive and educational learning tool.

Teacher Responses

The manipulative number card media received highly positive feedback from the third-grade teacher at MI Muhammadiyah Trangsan Sukoharjo. Based on a questionnaire containing 16 items, the teacher provided a total score of 75 out of a maximum score of 80.

No.	Component Indicator	Question No.	Score
1	Alignment with Core Competencies, Basic Competencies, and Learning Objectives	1	5
		2	4
2	Clarity of Content	3	4
		4	5
		5	5
3	Relevance to Real-Life Context	6	5
4	Media Selection Criteria	7	3
5	Readability of Text, Letters, and Numbers	8	5
6	Accuracy of Color, Image, and Media Size	9–10	5
		10	5
7	Attractive Design	11	5
8	Clear Usage Instructions	12	5
9	Ease and Effectiveness of Use	13	4
		14	5
10	Enhancing Student Motivation	15	5
		16	5
Total Score			75
Percentage			93,75%

Table 5. Teacher Response Results

Thus, based on Table 5, a percentage of 93.75% was obtained, which is included in the "Very Feasible" category. Teachers stated that this media facilitates the learning process, is in accordance with basic competencies, is interesting for students, and is effective in delivering simple fraction material. Teachers also assessed that this media supports a communicative and fun learning process.

Student Responses

All 64 students provided feedback through a Likert-scale questionnaire containing 10 statements. The total score obtained was 3,098 out of a maximum of 3,200, resulting in a percentage of **96.81%**, which falls under the **"Excellent"** category. Students reported

that the number card media was attractive, easy to understand, fun, and helpful in understanding fraction material more quickly. Moreover, the media increased student enthusiasm and participation in the learning process.

Data on student performance was collected through a test administered after the use of the manipulative number card media. The test was taken by all 64 third-grade students at MI Muhammadiyah Trangsan and aimed to measure their understanding of simple fractions. Based on the calculations, the total score of all students was 6,083. The average score was calculated as follows:

$$\bar{x} = 6{,}083 / 64 = 95.04$$

The average test score of 95.04 falls within the range of 81–100, thus classified as **"Excellent."** This result indicates that students were able to answer the questions well after using the manipulative number card media. The findings suggest that the developed media was effective in improving students' understanding and can serve as an engaging and meaningful alternative instructional tool.

DISCUSSION

The Effectiveness of Manipulative Number Card Media in Enhancing Students' Understanding

The results of this study indicate that the use of manipulative number card media significantly improves students' understanding of fractions. This is evidenced by the average student test score of 95.04 (categorized as excellent) and a student questionnaire score of 96.81% (categorized as highly positive). These findings demonstrate that the media is effective in helping students grasp abstract concepts related to basic fractions.

According to Piaget's theory, elementary school students are in the concrete operational stage, during which they can better comprehend abstract concepts when supported by tangible or visual aids (Santrock, 2011). Manipulative media such as number cards serve as a bridge between the real world and abstract mathematical ideas that are otherwise difficult to explain verbally. This study is also in line with Bruner's (1974) perspective, which states that meaningful learning occurs through three stages of representation: enactive (using concrete objects), iconic (through images or illustrations), and symbolic (using numbers or symbols). Number card media integrates all three stages,

allowing students to visualize images, physically manipulate objects, and recognize fraction symbols simultaneously.

The media's effectiveness is also reflected in students' high enthusiasm during the learning process. They enjoyed learning, actively matched pictures with fractions, and were motivated to complete the tasks. According to Ryan and Deci's (2020) Self-Determination Theory, intrinsic motivation increases when learners feel autonomous, competent, and actively engaged. This intrinsic motivation contributes to significantly improved learning outcomes.

The Development of Manipulative Number Card Media and Its Impact on Students' Understanding

The media was developed using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Each stage was carefully carried out by considering students' characteristics and the instructional needs of lower-grade classrooms. For example, the use of the "Chewy" font, A3-sized cards, and contextual illustrations were designed to ensure readability and appeal to young learners.

The validation process resulted in a score of 97% from media experts and 100% from subject matter experts, indicating that the media is highly feasible for use without the need for major revisions. Teachers also awarded a score of 93.75%, highlighting that the media is not only suitable but also aligned with Basic Competencies (Kompetensi Dasar), visually engaging, easy to use, and successful in increasing student participation. This development approach is consistent with instructional design principles proposed by Heinich et al. (2002), which emphasize that effective instructional media must integrate content, visual design, usability, and clarity in concept delivery.

Additionally, this study is supported by findings from Dewi et al. (2024), Farhana et al. (2022), and Rahmatih et al. (2024), which suggest that manipulative media can accelerate students' understanding and enhance learning outcomes in mathematics. Direct visualization and manipulation allow students to construct their own understanding through active learning experiences.

Research Implications

The results of this study have several important implications in the context of learning mathematics in elementary schools. First, the development of number card

manipulative media proved to be able to improve the understanding of simple fraction concepts and motivate students to be more active in the learning process. This shows that teachers can utilize educational game-based media to overcome student difficulties in abstract material. Second, this research supports the implementation of Curriculum 2013 which emphasizes interactive and student-centered learning, so this media can be used as a reference for teachers in developing similar learning innovations. Third, practically, this research contributes to providing media that is easily accessible and can be replicated by other teachers using simple graphic design applications, such as Canva, thus expanding opportunities for technology utilization in learning media development.

Research Limitations

This research still has some limitations that need to be considered. First, the media trial was only conducted on a limited scope, namely third grade students of MI Muhammadiyah Trangsan Sukoharjo, so the results of this study cannot be generalized to other schools with different characteristics. Second, the research only measured the effectiveness of the media on simple fractions, so it is not yet known to what extent this number card media can be applied to other mathematics materials. Thirdly, the limited time of the research caused the trial to be conducted only once, so it has not illustrated the long-term effect on student learning outcomes. Thus, further research is needed to expand the implementation of this media in more diverse contexts, materials and populations.

CONCLUSION

This study aimed to develop, assess the feasibility, and evaluate the effectiveness of manipulative number card media in teaching simple fractions to grade III students at MI Muhammadiyah Trangsan Sukoharjo. The results confirmed that the development of the media using the ADDIE model successfully produced a valid, practical, and effective learning tool. Validation results from subject matter experts, media experts, and practitioners indicated that the media met high standards of content relevance, design quality, and instructional usability. Furthermore, student responses showed positive engagement, indicating that the media enhanced their learning motivation and participation. Most importantly, the implementation of the number card media led to a measurable improvement in students' understanding of simple fraction concepts, supporting the initial hypothesis and addressing the research objectives comprehensively.

In terms of its contribution to knowledge, this research provides three significant inputs: (1) the creation of an instructional media prototype tailored to the cognitive characteristics of grade III students, grounded in Bruner's enactive-iconic-symbolic learning stages; (2) empirical validation of manipulative media effectiveness within the underexplored context of simple fraction learning at the elementary level; and (3) a methodological contribution through the systematic application of the ADDIE model, offering a replicable framework for similar educational development studies. These findings enrich the body of literature on media-assisted mathematics learning in madrasah ibtidaiyah and support the broader discourse on integrating constructivist and experiential learning approaches in early mathematics education.

For future research, several recommendations are proposed. First, a longitudinal study could be conducted to examine the long-term impact of using manipulative number card media on students' mathematical reasoning and retention. Second, expanding the sample to include different regions and school types would enhance the generalizability of the findings. Third, future studies may explore integrating digital elements into the media, such as QR codes or augmented reality features, to increase interactivity and align with current trends in digital learning innovation. By addressing these avenues, subsequent research can further refine and extend the utility of manipulative media in diverse educational settings.

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