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Development of Fraction Domino Card Media: Validity and Practicality for Fourth-Grade Mathematics Learning

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Abstract
The prevalent use of monotonous learning media in elementary mathematics, particularly for difficult topics like fractions, often leads to low student engagement and suboptimal understanding. Game-based learning media, such as domino cards, offer a potential solution by transforming abstract concepts into interactive activities. This study aimed to develop and evaluate the validity and practicality of domino card media for teaching fractions to fourth-grade students. The research followed the Research and Development (R&D) method using the Borg and Gall model. The product underwent a systematic process including expert validation (linguist, media specialist, material expert) and attractiveness testing through individual, small-group, and field trials. The results demonstrated that the domino card media was highly valid, with validation scores of 95% (linguistic), 80% (media), and 85% (material), and highly attractive to students, with trial scores of 96.6% (individual), 94.5% (small group), and 95.7% (field). These findings indicate that the developed media is a valid, practical, and engaging tool for fraction instruction. While this study establishes a strong foundation for its use, the findings warrant further investigation through a quasi-experimental design to empirically verify its impact on student learning outcomes.

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INTRODUCTION

Mathematics serves as a foundational discipline essential for developing logical reasoning and problem-solving skills, which are critical for academic and everyday life (National Council of Teachers of Mathematics [NCTM], 2014). In elementary education, proficiency in basic mathematical concepts, particularly in arithmetic such as fractions, is a strong predictor of future academic achievement (Siegler et al., 2010; Usmonov, 2024). However, mathematics instruction at this level frequently encounters pedagogical challenges, often stemming from the

reliance on conventional teaching methods. Studies indicate that teachers predominantly use textbooks, resulting in monotonous instruction that fails to engage students and leads to inadequate comprehension of abstract concepts (Afifah & Fitrianawati, 2021; Ajizah et al., 2023). This issue is especially pronounced in the topic of fractions, which is widely recognized as a cognitively demanding area for young learners (Siegler et al., 2010).

The integration of engaging in instructional media is considered a viable strategy to mitigate these challenges. As emphasized by Hamalik (as cited in Aziz, 2018), appropriately designed media can mediate abstract concepts into more tangible forms, thereby facilitating meaningful learning. This approach aligns with the developmental characteristics of elementary students, who are more effectively engaged through interactive and play-based activities (Pyle et al., 2017). Consequently, the development of innovative learning tools that are both pedagogically sound and visually appealing is imperative.

Among various interactive learning tools, game-based media such as domino cards have demonstrated potential in enhancing educational experiences. The structure of domino games, which involves matching and pattern recognition, offers a natural mechanism for teaching fractions by enabling students to connect visual representations such as parts of a whole with their corresponding symbolic notations (Hadiyani & Salam, 2024). Previous research has documented the positive effects of domino card media on student motivation and learning outcomes across different subjects (Lumbansiantar et al., 2020; Muthoharoh & Cholifah, 2020; Assina et al., 2021). Nonetheless, there remains a scarcity of studies focusing on the systematic development and validation of fraction-specific domino media for elementary education, particularly those incorporating rigorous evaluation of both validity and attractiveness without yet extending to effectiveness testing.

This study aims to address this gap by developing domino card media specifically designed for fraction instruction among fourth-grade students at Madrasah Ibtidaiyah (MI). The novelty of this research is threefold. First, the media is carefully aligned with fractional competencies, integrating questions, answers, and content directly into gameplay to promote active conceptual engagement rather than rote memorization. Second, the development process adheres to the systematic Borg and Gall (1983) R&D model and includes validation by experts in linguistics, instructional media, and mathematics education, thereby ensuring technical, linguistic, and pedagogical quality. Third, the design is iteratively refined based on student feedback from multiple testing phases, ensuring alignment with learners' needs and preferences.

Preliminary observations at MI Islamiyah Kedungmegarih underscored the urgency of this endeavor. An analysis of learning outcomes indicated that 61% of fourth-grade students (n = 27) scored below the minimum passing grade of 75, with class averages ranging between 65

and 71. These results highlight a critical need for innovative instructional tools to support mathematical understanding.

It is important to note that while this study focuses on assessing the validity and attractiveness of the developed media, it does not evaluate its effectiveness in improving learning outcomes through experimental measures such as pre-test/post-test comparisons. Thus, the research is intentionally limited to establishing the media's feasibility and appeal, setting the stage for subsequent empirical investigation into its instructional efficacy. The primary objective of this study is to produce a valid and attractive domino card media for fraction learning, thereby providing a foundation for future research on its educational impact.

METHOD

This study employed a Research and Development (R&D) approach with the primary objective of developing a feasible educational product and evaluating its validity and practicality (Gall et al., 2007). The development process was guided by the procedural model established by Borg and Gall (1983), which provides a framework of ten systematic stages. The present research was conducted through the first nine stages: (1) research and information collecting, (2) planning, (3) developing a preliminary form of the product, (4) preliminary field testing, (5) main product revision, (6) main field testing, (7) operational product revision, (8) operational field testing, and (9) final product revision. The tenth stage, dissemination and implementation, was beyond the scope of this study.

A preliminary study was conducted at the research site, involving classroom observations and interviews with the fourth-grade teacher. This analysis confirmed that the primary challenges in teaching fractions were the lack of varied instructional media and low student engagement. Based on this analysis, the initial prototype of the fraction domino card media was designed.

The research was conducted at MI Islamiyah Kedungmegarih, Lamongan Regency, over a nine-month period from October 2022 to June 2023. The participants for the product trials were the entire population of fourth-grade students (N=27), selected via total sampling. These students were involved in successive stages of attractiveness testing: the preliminary field test (individual trial, n=3), the main field test (small group trial, n=9), and the operational field test (field trial, n=27).

Data were collected using structured questionnaires to gather quantitative and qualitative feedback. The validity of the media prototype was evaluated by a panel of three expert validators:

1. A linguist (holding an M.Pd. in Indonesian Language) assessed the clarity, correctness, and age-appropriateness of the language.
2. A media specialist (holding an M.Pd. in Educational Technology) evaluated graphic design, usability, durability, and overall technical quality.
3. A subject-matter expert (holding an M.Si. in Mathematics Education) assessed the accuracy, depth, and curriculum alignment of the fraction content.

Each validator used a questionnaire employing a 4-point Likert scale (from 1=Very Poor to 4=Very Good) to provide quantitative scores. They also provided qualitative comments and suggestions for improvement, which formed the basis for product revisions prior to student trials.

The media's attractiveness was measured using a student questionnaire administered during each trial phase (individual, small group, field). It is critical to note that the research design was focused on establishing validity and attractiveness; it did not include a pre-test/post-test or quasi-experimental component to measure the media's impact on learning outcomes. Therefore, this study makes no claims regarding effectiveness, which remains a necessary focus for future research.

The quantitative data from the validation and attractiveness questionnaires were analyzed using descriptive statistics. The average scores from each validator and student trial group were converted into percentages. The resulting percentages were interpreted using the predetermined criteria outlined in Tables 1 and 2. The product was deemed feasible for educational use if it achieved a minimum score in the "Valid" category from expert validators and "Interesting" or above from student trials.

Table 1. *Criteria for Validation Assessment*

No	Percentage (%)	Criteria
1	80-100	Very Valid (Can be used without revision)
2	60-79	Valid (Can be used with minor revisions)
3	40-59	Less Valid (Not recommended for use without major revision)
4	0-39	Invalid (Cannot be used)

Table 2. Criteria for Attractiveness Assessment

No	Average Percentage	Criteria
1	80 – 100	Very Interesting
2	66 – 79	Interesting
3	56 – 65	Quite Interesting
4	46 – 55	Not Interesting
5	≤ 45	Very Uninteresting

RESULT AND DISCUSSION

This study successfully developed domino card learning media for fraction topics through the Borg and Gall (1983) development model, implemented through the ninth stage. The product was rigorously evaluated, with results demonstrating high validity based on expert assessment and high attractiveness based on student trials.

Product Validity

The validity of the domino card media was assessed by three experts. The quantitative results are presented in Table 3.

Table 3. *Recapitulation of Expert Validation Results*

No	Validator	Average Score	Criteria
1	Linguist	95%	Very valid
2	Media Specialist	80%	Very valid
3	Material Expert	85%	Very valid

The data in Table 3 indicates that the media achieved a "Very Valid" categorization across all assessed dimensions. Qualitatively, the validators provided constructive feedback crucial for refinement. The media expert suggested

improvements for graphic consistency, card size for group visibility, and material durability. The material and language validators offered minor suggestions for clarifying instructions and fraction representations. This qualitative input, integrated into the final revision prior to student trials, underscores the iterative nature of quality media development (Branch, 2009).

Product Attractiveness

The media's attractiveness was measured through three trial phases. The results are summarized in Table 4.

Table 4. *Recapitulation of Student Attractiveness Test Results*

No	Trial Phase	Average Score	Criteria
1	Individual Trial	96.6%	Very Interesting
2	Small Group Trial	94.5%	Very Interesting
3	Field Trial	95.7%	Very Interesting

The consistently high scores across all phases, each exceeding 94%, demonstrate that the media is highly appealing to the target audience. Qualitative feedback from students indicated that the game-based format was enjoyable and reduced anxiety associated with learning fractions. Suggestions for adding more card variations were noted for future development, reflecting a desire for extended play and learning opportunities.

Discussion

Validity and Quality of the Domino Card Media

The high validity scores confirm that the domino card media meets rigorous quality standards. The material expert's score (85%) signifies that the fraction content is accurate and well-aligned with curriculum objectives, a cornerstone of effective instructional design (Dick et al., 2014). Similarly, the linguist's score (95%) ensures the language used is clear and appropriate for the grade level, facilitating comprehension.

The slightly lower, though still "Very Valid," score from the media expert (80%) provides valuable insight into the practical aspects of educational product design. The feedback on card size and durability resonates with findings from other development studies, which highlight that usability and practical constraints are common focal points for improvement during validation (Purnama, 2021). This multi-faceted validation process is a strength of the study, as it moves beyond a single quantitative score to provide a comprehensive roadmap for creating a product that is both pedagogically sound and practically viable (Plomp & Nieveen, 2013).

When compared to similar research, the validation results are strong. For instance, Wulandari et al. (2021) reported a higher media validation score (96%) but a lower material score (77%) for domino card media. The comparatively high material validity score in this study (85%) suggests a successful emphasis on content accuracy. The inclusion of qualitative feedback enriches the validation data, emphasizing that expert critique is indispensable for moving a product from being theoretically valid to being practically optimal (Richey & Klein, 2014).

Attractiveness and Student Engagement

The exceptional attractiveness scores provide compelling evidence for the effectiveness of the game-based learning approach. These findings align with cognitive and motivational theories, which suggest that game-like environments can reduce cognitive load, increase engagement, and create a positive emotional climate conducive to learning (Plass et al., 2015). The domino mechanic, which requires matching visual and symbolic fraction representations, effectively operationalizes the concept of concreteness fading, helping students bridge concrete experiences with abstract mathematical ideas (Fyfe et al., 2014).

This result corroborates previous findings on game-based media. The work of Muthoharoh and Cholifah (2020), which demonstrated increased motivation through domino cards, is strongly supported. The high level of engagement observed in this study reinforces the argument that well-designed educational games are powerful tools for fostering positive attitudes towards challenging subjects like mathematics, potentially mitigating maths anxiety (Ramirez et al., 2018).

Limitations and Implications for Future Research

Acknowledging the limitations of this study is crucial for a balanced interpretation. The most significant limitation is the absence of an empirical measure of the media's effectiveness on learning outcomes. While the media is highly valid and attractive, its impact on students' conceptual understanding or problem-solving skills in fractions remains an open question. This limitation is inherent in research design, which focused on establishing feasibility as a necessary first step.

This constraint clearly delineates the scope of the present study and directs future research. The essential next step is to implement a quasi-experimental design with pre-test and post-test measures to rigorously evaluate the media's pedagogical efficacy. Furthermore, the study was conducted in a single school, which may affect the generalizability of the findings. Future studies should test the media in more diverse educational contexts to strengthen external validity.

In conclusion, the systematic development and evaluation process has yielded a domino card media product that is both highly valid and highly attractive. It represents a promising tool for enhancing engagement in fraction learning. However, this study establishes its feasibility, not its efficacy. The compelling results related to validity and attractiveness provide a strong foundation and clear justification for the future experimental research required to validate its impact on student achievement.

CONCLUSION

This study was conducted to develop and evaluate the feasibility of domino card-based learning media for fraction instruction in the fourth grade. The findings, derived from a systematic research and development process, lead to two primary conclusions that directly fulfill the research objectives.

First, the domino card media has been established as a highly valid instructional tool. This conclusion is

substantiated by the quantitative assessments from expert validators, which yielded scores of 95% (linguist), 80% (media specialist), and 85% (material expert), all categorized as "Very Valid." This multi-dimensional validation confirms that the product is linguistically appropriate, technically sound, and pedagogically aligned with the curriculum. Furthermore, the integration of qualitative feedback during the revision process ensured that the final product is not only theoretically valid but also practical and refined for classroom application.

Second, the media proved to be highly attractive to students. The data from all trial phases—individual (96.6%), small group (94.5%), and field trials (95.7%)—provided consistent and robust evidence that the game-based format is highly engaging. This exceptional level of attractiveness demonstrates the media's strong potential to foster a positive and interactive learning atmosphere, thereby increasing student motivation and participation in learning fractions, a topic often perceived as challenging.

In summary, this study successfully achieved its goal of producing a feasible and promising learning media product. The domino cards developed are valid, attractive, and suitable for use in fraction learning based on their design qualities and appeal.

However, it is imperative to reiterate the fundamental limitation of this research: its scope was confined to assessing validity and attractiveness. The study did not investigate the media's effectiveness in improving learning outcomes. Therefore, while the product is suitable for implementation, claims regarding its efficacy in enhancing conceptual understanding or academic achievement cannot be made. The essential and logical next step is to conduct further research utilizing a quasi-experimental design with pre-test and post-test measures to empirically validate the impact of this media on student learning outcomes.

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