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DEVELOPMENT OF MUSI BOARD MEDIA (MULTI-FUNCTIONAL) WITH INDEX CARD MATCH LEARNING MODEL OF LCM GCD MATERIAL

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ABSTRACT

Learning about Least Common Multiple (LCM) and Greatest Common Divisor (GCD) in junior high school still faces challenges because students often struggle to understand the concepts of multiples and factors through conventional instruction. Previous studies have developed MUSI Board media, but its integration with a structured active learning model, such as Index Card Match, remains limited, particularly at the junior high school level. This study aimed to develop MUSI Board learning media integrated with the Index Card Match model for LCM and GCD material that is valid, practical, and effective. This research used the ADDIE development model, consisting of analysis, design, development, implementation, and evaluation. The subjects were 9 students in a limited trial and 20 students in a large-scale trial at public Junıor High School (SMPN) 17 Malang. Data were collected through expert validation sheets, student response questionnaires, and learning outcome tests. The results showed that the MUSI Board obtained validity scores of 96.4% from media experts, 93.75% from material experts, and 90.63% from practitioners, all categorized as very valid. The practicality scores were 97.57% in the limited trial and 92.18% in the large-scale trial, both categorized as very practical. The effectiveness score reached 93.5%, indicating that the media was very effective in supporting student learning outcomes. These findings imply that the MUSI Board integrated with Index Card Match can be used as an alternative active learning medium for number material in junior high school.

Keywords: Index Card Match, LCM & GCD, Learning Media, MUSI Board (Multifunction)

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INTRODUCTION

Education is a fundamental aspect of life for national development(Aeni & Astuti, 2021). Through education, humans can discover new things that can be developed and acquired to face existing challenges in accordance with the times (Maharani et al., 2023). Furthermore, education is a planned process to create a learning atmosphere and learning process so that students actively develop their potential (Rahmadani et al., 2025). Education can shape the future and will not be separated from each subject taken by each student, one of which is mathematics. Based on this, thorough preparation is required from a student to be able to understand mathematics (Husnindar & Hayati, 2021). Through learning Mathematics, students are trained to think logically and analytically (Akkas et al., 2025).

Mathematics is a crucial component of education, studied at all levels of education {Formatting Citation}. Mathematics is a discipline that plays a crucial role in developing logical, analytical, and systematic thinking skills (Taufik et al., 2025). Mathematics plays a crucial role in the Indonesian curriculum because it supports the development of logical, analytical, and systematic thinking skills (Khaalishah et al., 2025). Mathematics is a crucial subject because students' logical and analytical thinking skills are honed through mathematics learning (Ratnasari et al., 2025). One of the key topics in the independent curriculum for grade VII mathematics is the LCM (Least Common Multiple) and GCD (Greatest Common Factor). The independent learning curriculum emphasizes the importance of teachers as educators in creating a conducive learning environment and focusing on developing student competencies and characteristics (Pranyata, 2023).

The learning process consists of teachers as educators assisted by tools, media, and methods for students. The learning tools used by educators to help students understand concepts and help solve problems are learning media. The education and teaching process in schools becomes more effective when learning media is implemented (Prayogo et al., 2025). The teaching and learning process, especially mathematics learning, is a pattern of interaction that occurs between students and mathematics teachers in the classroom, so it requires a mathematics learning model with various approaches, strategies, methods, teaching materials, and learning techniques used in the teaching process.

In the ever-evolving world of education, the application of learning methods and media that utilize technology is very important (Pratiwi & Sulistyowati, 2024). One effort that can be made to help students is through the use of learning media that are appropriate to their characteristics and needs (Aisyah & Anwar, 2026). Learning materials are an important component in the learning process because they function as a reference for educators and students in achieving learning objectives (Ratnasari et al., 2025). One of the teaching materials that educators can use in the learning process is learning media. Learning media is very important to attract students' attention in the learning process (Neha, et at., 2023). Learning media is a tool to make it easier for educators to convey material and make it easier for students to understand the material (Wardani & Setyadi, 2020). In line with research by Hartanti et al., 2020, learning media is a learning communication tool that can improve the quality of learning.

Media is a communication tool that serves as a source of messages to the target audience, acting as an intermediary to convey messages or learning information, thus achieving learning success (Qomariyah et al., 2021). Essentially, media is a specific intermediary, specifically a communication tool, used to convey information from one source to the recipient. When learning materials are structured in such a way using engaging media, integrated with appropriate learning methods, it will engage students in a pleasant learning environment. This can foster a strong desire in students to continue learning (Yonanda et al., 2021).

Based on the results of the researcher's observations while at SMP Negeri 17 Malang, specifically class VII G, with a total of 32 students who have completed the LCM and GCD material. There are 20 students whose scores are still below the KKM, and 12 students whose scores are complete in solving problems in the LCM and GCD material. Based on this, many students still do not meet the KKM (Kriteria Ketuntasan Minimal or minimum mastery criterion) score, which is the minimum passing grade set by an educational institution to determine student competency in a specific subject. It serves as a benchmark for academic achievement, where students who fail to reach this threshold are typically required to undergo remedial programs to ensure they meet the learning objectives. This is because many students admit to not understanding the material previously at the elementary school level. In addition, at public Junior High School (SMPN) 17 Malang, especially in class VII G, there are no mathematics learning media that can help students in the teaching and learning process. Due to the lack of teaching materials owned by students, it results in a lack of student understanding

of the material presented by educators. This is supported by research by Tendri (2021) that the environment, namely learning resources, methods, and environmental support, is one of the things that can influence student learning outcomes. Furthermore, current mathematics learning tends to be less flexible, less applicable, and less contextual (Utami et al., 2022). Learning outcomes are achieved through purposeful and mutually supportive collaboration, while teachers motivate students, ensure a conducive environment, guide discussions, recognize efforts, and provide confirmation at the end (Sihombing & Simanjorang, 2025). However, the mathematics learning process is expected to be effective in producing optimal results (Nur et al., 2021).

Efforts to overcome the problems that occur at SMPN 17 Malang require learning media that are interesting, easy to understand, fun, concise, and clear. Based on these problems, the author wants to develop learning media that can help students during learning. The learning media that will be developed is the MUSI Board (multifunction) learning media on the LCM and GCD material. The MUSI Board (multifunction) learning media were developed in accordance with the LCM and GCD material, presented in the form of learning media, and aim to facilitate students and make them more active during learning. The MUSI Board (Multifunction) is one of the learning media used as a medium for learning mathematics. The function of this MUSI board (multifunction) is to help determine the factors of the greatest common factor and find out the multiples of the smallest number (Siregar & Hasanah, 2023).

The index card match learning model is a mathematics learning model or game that involves the use of index cards. This is in line with Andika's research, which argues that card-based learning games are a suitable medium and can be applied in mathematics learning (Faris et al., 2024). The appropriate method is to use index cards to create flashcards. Flashcards are cards that usually contain brief information, such as questions and answers (Muflihah, 2021). This is supported by the fact that learning with the help of cards can be used to teach mathematical concepts to children in an interactive and fun way (Pratiwi & Sulistyowati, 2024). The index card match model is also used in learning to determine student learning outcomes.

Based on previous research, many researchers have tried to develop similar teaching materials with the aim of making it easier for students to solve problems (Ramdhania et al., 2022). The results of Ramdhania et al's research prove that the MUSI Board (multifunctional) learning media is proven to be efficient in making students more enthusiastic and focused in following the learning of LCM and GCD materials, because they can group with friends in a smaller scope than before and can absorb the material more focused. The novelty of the researcher's research with previous research is the existence of an index card match learning model, which, in previous research, only focused on teaching materials, and the research subjects were elementary school children who still used the 2013 curriculum. The purpose of the research to be carried out is to "Produce MUSI Board media (multifunctional) with an index card match learning model on LCM and GCD materials that are valid, practical, and effective".

Various previous studies have developed MUSI Board learning media for the subject of LCM and GCD, especially at the elementary school level, using an ADDIE-based development approach (Ramdhania et al., 2022; Rahmadani, S, 2025; Rintana et al., 2025). However, these studies generally focused on the effectiveness of the media as a visual aid without systematically integrating specific cooperative learning models into the design of the media. Furthermore, most previous studies were conducted at the elementary school level. In contrast, the cognitive characteristics and learning needs of junior high school students differ significantly, particularly in the demands of more abstract numerical reasoning in the LCM and GCD material.

On the other hand, the Index Card Match learning model has been widely used to enhance learning activities and interactions. However, no research has been found that explicitly integrates this model into the operational design of the MUSI Board media as a systematic

learning tool. Thus, there is still a research gap in the integration of concrete media innovations based on number boards with structured cooperative learning models to improve learning engagement and learning outcomes for junior high school students. The novelty of this research lies in: Integrating the MUSI Board media design with the syntax of the Index Card Match learning model systematically in learning scenarios; Implementation at the junior high school level in the context of the Independent Curriculum that emphasizes learning activities and independence; and Product evaluation that assesses not only validity and practicality, but also effectiveness based on improved learning outcomes through pretests and posttests. Thus, this research does not simply replicate the development of the MUSI Board media but offers a new implementation model that combines concrete media and active learning strategies as a unified pedagogical innovation in the LCM and GCD material at the junior high school level.

METHOD

This research is a type of development research oriented towards product development. The resulting product is a learning media "MUSI Board (multifunction)" on the LCM and GCD material. The development model used by the researcher is ADDIE (Analysis, Design, Development, Implementation, and Evaluation). The development of the MUSI Board followed the ADDIE model through five operational stages. During the Analysis phase, the researcher conducted observations and interviews at public Junior High School (SMPN) 17 Malang, identifying that 20 out of 32 students failed to meet the minimum passing grade (KKM) due to disengagement with LCM and GCD materials. In the Design stage, the researcher created a blueprint for a multifunctional board using plywood and styrofoam, featuring numbers 1–100 and integrated with the Index Card Match model. During Development, the physical product was constructed and validated by material, media, and learning experts. In the Implementation phase, the media were tested through limited trials in class VIIF and extensive trials in class VIIG, where students used the board to solve problems and provided feedback via questionnaires. Finally, the Evaluation stage confirmed the product's success.

The product specifications to be developed are in the form of a MUSI (multifunction) board containing the LCM and GCD material for grade VII of junior high school. The development of the MUSI (Multifunction) board using plywood and styrofoam board attached with colorful paper in the form of squares with numbers 1 to 100 written on them, which are used to find solutions to LCM and GCD problems. The types of data used in this study include qualitative and quantitative data. Qualitative data are in the form of criticism and suggestions from three validators, namely media expert validators, material experts, and learning experts. This data was obtained during the product validation process and used as a guideline for making improvements or revisions to the MUSI (multifunction) Board media product on LCM and GCD materials. Quantitative data are in the form of assessment scores from validators and student responses. The data used as a determinant of the quality of the product developed meets the minimum valid classification based on the table of valid, practical, and effective categorization criteria.

The data collection method in this study was a questionnaire and test questions. The questionnaire in this study was used to analyze the feasibility of developing the MUSI Board (multifunctional) learning media. The assessment in the questionnaire was through a Likert scale with four categories, namely score (4) Very Good/Strongly Agree (SB/SS), score (3) Good/Agree (B/S), score (2) Less/Less Agree (K/KS), and score (1) Very Less/Very Less Agree (SK/SKS). The test questions in this study aimed to measure the level of effectiveness of using the MUSI Board (multifunctional) in learning based on the process carried out by students in solving problems. The test questions were in the form of written tests in the form of LCM and GCD questions. Students will be given two types of tests, namely pretest and

posttest. The pretest aims to measure student outcomes before using the MUSI Board (Multifunctional) media. At the same time, the posttest aims to measure student outcomes after using the MUSI Board (multifunctional) media.

The data were analyzed using qualitative and quantitative descriptive methods aimed at interpreting the data in depth and presenting the results in numerical form and descriptions that illustrate the research findings, consisting of feasibility, practicality, and effectiveness analysis. The data feasibility analysis, obtained from the assessment validation sheet from material experts, media experts, and learning experts, used the following formula:

$$p = \frac{\sum x}{N} x100\%$$

Description:
P = Percentage score
ΣX = Total score obtained
N = Maximum score

To determine product validity, see Table 1 for the assessment criteria as follows.

Table 1. Product Validation Criteria

Percentage (%)	Criteria
$80 < P \leq 100$	Very Valid
$60 < P \leq 80$	Valid
$40 < P \leq 60$	Quite Valid
$20 < P \leq 40$	Less Valid
$P \leq 20$	Not Valid

The analysis of the practicality of the media, obtained from the questionnaire responses of teacher and student users, was analyzed to determine the practicality of the MUSI Board (multifunction) learning media using the formula calculation:

$$p = \frac{\sum x}{N} x100\%$$

To determine the practicality of the product, you can see the assessment criteria in Table 2 as follows.

Table 2. Product Practicality Criteria

Percentage (%)	Criteria
$80 < P \leq 100$	Very practical
$60 < P \leq 80$	Practical
$40 < P \leq 60$	Quite practical
$20 < P \leq 40$	Not practical
$P \leq 20$	Not practical

Analysis of media effectiveness, obtained from student learning outcome tests, was analyzed to determine the effectiveness of the MUSI Board (multifunction) using the formula calculation:

$$nilai = \frac{jumlah\ skor\ yang\ diperoleh}{total\ skor\ maksimal} x100$$

.

After knowing the student's test score, students will be declared to have completed the test if they obtain a score of ≥ 75.

The percentage of students who completed the test is calculated using the following formula:

$$nilai = \frac{banyak\ peserta\ didik\ yang\ tuntas\ dalam\ tes}{banyak\ peserta\ didik\ yang\ mengikuti\ tes} x100$$

.

After obtaining the percentage of students who completed the test, to determine the effectiveness of the product, this can be seen based on the assessment criteria in Table 3 as follows.

Table 3. Media Effectiveness Criteria

Percentage (%)	Criteria
$80 < P \leq 100$	Very Effective
$60 < P \leq 80$	Effective
$40 < P \leq 60$	Moderately Effective
$20 < P \leq 40$	Less Effective
$P \leq 20$	Ineffective

RESULT

The development of the MUSI Board (multifunctional) learning media for the LCM and GCD materials was carried out using the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model according to (Slamet, 2022). The stages of developing this learning media are described more clearly. The Analysis Stage (Analysis), which considers two aspects: problem analysis and curriculum analysis. The problem analysis included observations and unstructured interviews with mathematics class teachers. These activities indicated that students had difficulty understanding the LCM and GCD materials. This was due to the pandemic, which had made learning less effective, hindering their understanding of the materials, and teachers' ineffectiveness in delivering the lessons. The results of the student needs analysis indicated that students needed engaging and enjoyable media during the learning process to facilitate their understanding of the LCM and GCD materials. The curriculum analysis was conducted to determine the curriculum used at public Junior High School (SMPN) 17 Malang. Based on the curriculum analysis, it was found that SMPN 17 Malang uses the Merdeka curriculum. Furthermore, this curriculum analysis also aimed to determine the materials that would be used as guidelines in designing learning media. Design Stage (Design), the product design stage in the form of a MUSI Board (multifunction) learning media on the material of LCM and GCD. The MUSI Board (multifunction) learning media contains the back of the media containing the basic material using plywood, and the front is made of styrofoam with colored paper attached with written numbers from 1 to 100. Development stage, the development stage of making the MUSI Board (Multifunction) learning media at LCM and GCD. The results of the development of the MUSI Board (Multifunction) learning media design are as follows.

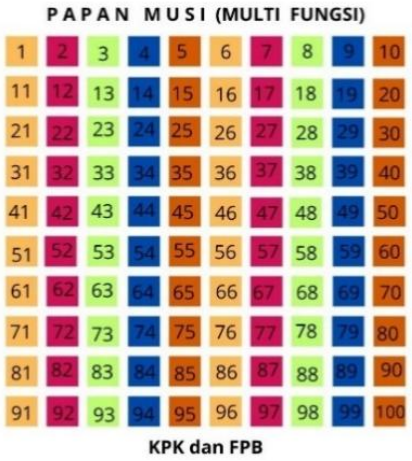

Figure 1. Front End of Media

Implementation Stage (Implementation), The MUSI Board (multifunction) learning media was tested in two stages, namely, limited field trials and extensive field trials. In the field, limited to class VIIF, which was taken by 9 students, and continued with extensive field trials in class VIIG, as many as 20 students at SMPN 17 Malang. During the implementation of operating the MUSI Board (multifunction) learning media, students were asked to complete 1 question for 1 student. The test questions were used to measure the effectiveness of the learning media. After completing the test questions, students were asked to assess the learning media by filling out a student response questionnaire. The questionnaire was used to measure the practicality of the learning media as follows.

Table 4. Assessment of Student Response Questionnaire in Limited Field Test

No	Students	Content	Practicality	Learning	Material	Average Score	Category
1.	EZF	8	8	3	12	96,87%	very practical
2.	FBPP	8	7	3	12	93,75%	very practical
3.	HEN	8	7	4	12	96,87%	very practical
4.	MAS	8	8	4	12	100%	very practical
5.	MAIA	8	8	4	12	100%	very practical
6.	NRA	8	8	4	12	100%	very practical
7.	PAPW	8	8	4	12	100%	very practical
8.	RAAS	8	7	3	12	93,75%	very practical
9.	WPT	8	8	3	12	96,87%	very practical
Average Total						97,57%	very practical

Table 5. Recapitulation of Student Response Questionnaire in the Extensive Field Test

No	Students	Content	Practicality	Learning	Material	Average Score	Category
1.	AYAQ	8	8	3	12	96,87%	very practical
2.	ARM	8	7	3	12	93,75%	very practical
3.	ADH	8	7	4	12	96,87%	very practical
4.	AER	8	8	4	12	100%	very practical
5.	DAJ	8	8	4	12	100%	very practical
6.	EK	8	8	4	12	100%	very practical
7.	ENID	8	8	4	12	100%	very practical
8.	FER	8	7	3	12	93,75%	very practical
9.	FP	8	8	3	12	96,87%	very practical
10	IS	8	8	4	12	100%	very practical
11.	MYPP	8	8	4	12	100%	very practical
12	MRAQ	8	8	3	12	96,87%	very practical
13	MIR	8	6	4	12	93,75%	very practical
14	R	8	7	4	12	96,87%	very practical
15	RF	8	7	4	12	96,87%	very practical
16	SBQ	8	8	3	12	96,87%	very practical
17	SSAH	8	6	3	12	90,6%	very practical
18	SCDP	8	8	4	12	100%	very practical
19	TPA	8	7	4	12	96,87%	very practical
20	ZM	8	6	4	12	93,75%	very practical
Average Total						92,18%	very practical

Evaluation Stage (Evaluation), the final stage of this development stage, which aims to evaluate the MUSI Board (multifunction) learning media on the LCM and GCD materials. The evaluation stage is based on the results of the validation test in the form of comments, criticisms, and suggestions, as well as the results of the user response questionnaire that have been obtained from the implementation stage. The evaluation stage aims as a form of improvement of the developed learning media. Based on the implementation results from 2 different classes, namely the limited trial class and the large-scale trial class, it was found that the MUSI board (multifunction) media was "very practical" to use during the learning process.

DISCUSSION

Development and Relevance of the MUSI Board to Students' Needs

The development of concrete instructional media such as the MUSI Board is a direct response to students' learning needs, especially in inherently abstract topics, such as Least Common Multiple (LCM) and Greatest Common Factor (GCF). These mathematical concepts often present cognitive challenges for learners because they require students to identify numerical patterns and relationships beyond procedural memorization. Research shows that concrete instructional media significantly enhance conceptual understanding and student motivation in mathematics by providing tangible and interactive learning experiences, as opposed to traditional lecture-based teaching (Rozy et al., 2025). This aligns with experiential learning frameworks that emphasize *learning by doing*, where physical manipulatives help bridge the gap between concrete and abstract cognitive representations. Concrete media serve as effective scaffolding tools that allow students to visualize factors and multiples directly. For example, the MUSI Board's design — such as displaying numbers 1–100 visibly and using manipulatives — helps students recognize patterns in factors and multiples intuitively. This visual engagement supports deeper comprehension, thereby reducing misconceptions that arise when learners only engage with symbolic or text–based explanations (Putri et al., 2025).

Moreover, research on educational board games indicates that board-based learning activities in mathematics promote higher levels of student engagement and interaction, ultimately improving mathematical reasoning and problem-solving skills (Anindita & Pratama, 2024). Similarly, studies have found that game-like learning environments and concrete learning aids contribute to more meaningful and enjoyable mathematics learning experiences, which can in turn lower math anxiety and increase persistence (Muqoddaroh et al., 2024).

Learning frameworks in the 21st-century curriculum emphasize student-centered activities that foster critical thinking and active participation. These educational priorities support the use of manipulatives and interactive media to engage learners meaningfully. Therefore, the MUSI Board not only addresses existing gaps in students' understanding of LCM and GCF but also aligns with modern pedagogical demands for active, student-driven learning environments.

Validity and Practicality of the MUSI Board in Classroom Implementation

Assessing both **validity and practicality** is crucial in instructional media development to ensure that a tool accurately represents learning concepts and can be feasibly used by teachers and students in real classroom settings. Validity reflects how well the media supports educational goals and concept accuracy, while practicality evaluates usability during teaching-and learning activities (Solakhudin et al., 2024).

Research on mathematics learning media frequently uses expert validation and user responses to gauge these aspects. For instance, studies developing interactive geometry applications reported strong validity and practicality scores, indicating that the media were appropriate for student use and aligned with curriculum goals (Solakhudin et al., 2024). Similarly, Cahyono et al. (2024) found that manipulative media enhanced student engagement

and understanding of abstract concepts in mathematics, primarily because students could interact directly with the materials, which helped bridge theory and practice.

Practicality measures often involve questionnaires for students and teachers. Nasution (2023) reported that domino-card media were not only valid in representing multiplication concepts but also highly practical, being easy for students to manipulate and apply in problem-solving tasks. Another development study on ethnomathematics media using smartphone applications found both validity and high practicality scores, supporting its use in diverse classrooms (Ananda & Nofriyandi, 2022).

Mobile learning media developed with Smart App Creator also demonstrated strong validity and practicality, with positive expert ratings and student/teacher usability scores, reinforcing that technology-enhanced media can be both accurate and easy to implement (Adiastuty et al., 2024). Furthermore, research on interactive multimedia developed with Adobe Flash showed that rigorous validation and usability assessments are essential steps in establishing practicality for classroom use.

Taken together, these studies support that instructional media developed with systematic design models (like ADDIE), validated by experts, and tested with actual users can achieve high criteria for both validity and practicality. This evidence underpins the claim that the MUSI Board is not only pedagogically sound but also feasible to use in varied secondary school contexts, enhancing the teaching and learning of mathematical concepts.

Effectiveness of the MUSI Board in Improving Students' LCM and GCF Learning Outcomes

Evaluating the effectiveness of instructional media is essential to determine whether the media not only facilitate learning activities but also lead to measurable improvements in student achievement. In mathematics education research, effectiveness is often gauged through pre- and post-tests, student performance gains, and statistical analyses showing significant learning improvements (Karim et al., 2022). This framework supports the interpretation of findings from the MUSI Board intervention, where students demonstrated significant gains in understanding Least Common Multiple (LCM) and Greatest Common Factor (GCF) concepts after engaging with the media.

Numerous studies confirm that concrete manipulatives and interactive learning tools can significantly improve student mathematics outcomes. For example, research on manipulatives in number theory instruction showed that students who used manipulatives achieved higher post-test scores and greater conceptual understanding compared to traditional instruction groups (Clements & Sarama, 2021). Similarly, a quasi-experimental study by Tyas et al. (2023) reported that students exposed to concrete learning media in factor and multiple topics outperformed peers in both conceptual and procedural tasks, suggesting enhanced meaningful learning.

In the present study, student learning outcomes improved significantly following the MUSI Board intervention, indicating that the media facilitated deeper conceptual engagement. This aligns with findings from Nurhayati et al. (2024), who reported that students taught with media-enriched lessons demonstrated significantly higher achievement scores than the control group. Likewise, interactive games and board-based learning media have been shown to improve both accuracy and speed in solving mathematics problems, which reinforces the effectiveness of engaging manipulatives (Rahmawati & Hidayat, 2023).

Furthermore, research on blended learning environments with interactive visual tools suggests that such media not only support cognitive gains but also increase metacognitive awareness, allowing students to self-assess understanding and correct errors (Wijaya et al., 2022). In sum, these empirical findings support the conclusion that the MUSI Board is an

effective instructional tool for enhancing student achievement in LCM and GCF topics, as evidenced by substantial improvements in test scores and learning performance.

Implications, Limitations, and Future Recommendations

The results of this study carry several important implications for mathematics education practice, theory, and future research. First, the strong validity, practicality, and effectiveness of the MUSI Board suggest that concrete and interactive media can enhance conceptual understanding of abstract mathematical topics, such as Least Common Multiple (LCM) and Greatest Common Factor (GCF). This supports past findings that manipulatives and tactile tools facilitate deeper cognitive engagement and reduce abstract misunderstanding (Suprapto & Sulastri, 2024). Furthermore, integrating media with active learning strategies, such as the Index Card Match technique, aligns with contemporary pedagogical emphases on student-centered learning, collaboration, and constructivist approaches (Nurdin et al., 2023).

The positive outcomes also imply that mathematics educators should consider media tools not merely as "visual aids" but as core components of lesson design that shape students' learning processes and outcomes. Effective media use requires teacher facilitation, classroom management strategies, and alignment with curriculum goals (Kusumah et al., 2022). Teachers who understand the affordances of manipulatives are better positioned to design tasks that foster student discourse and reasoning.

However, this study has limitations that warrant caution in generalizing the results. The research was conducted in a single school context with a limited number of participants, which may restrict external validity. Other demographic factors — such as teacher experience, class size, and student prior achievement — were not deeply analyzed and may influence media effectiveness (Rosyidah et al., 2022). Furthermore, the study focused primarily on short-term outcomes; long-term retention and transfer of learning were not assessed, which remains critical in mathematics achievement research (Hidayat & Fatimah, 2023).

Future research is recommended to address these limitations by expanding implementation across different school types, grade levels, and cultural settings. Additionally, the development of digital or hybrid MUSI Board versions could explore the role of educational technology in scaling access while maintaining interactivity (Wahyuni et al., 2023). Longitudinal studies that track learning retention over time would provide richer insights into the sustained impacts of manipulatives in mathematics education.

CONCLUSION AND SUGGESTIONS

This study concludes that the development of the MUSI Board (Multifunction) learning media for seventh-grade students has resulted in a valid, practical, and effective learning medium for teaching the Least Common Multiple (LCM) and Greatest Common Divisor (GCD). The validation results indicate that the media meets the required criteria in terms of content, instructional design, and usability. Student responses during both limited and broader trials also demonstrate that the media is practical and easy to use in the learning process. Furthermore, the implementation findings indicate that the MUSI Board can effectively support students' learning of LCM and GCD concepts. These findings suggest that the multifunctional design of the MUSI Board can provide students with a concrete and engaging learning experience while supporting the delivery of mathematical concepts at the junior high school level.

For further development, future research could adapt the multifunctional design of the MUSI Board to other mathematical topics, such as prime factorization and integer operations, to examine its versatility across different learning contexts. Since the current media is a physical tool, subsequent studies could also explore the development of digital or interactive versions to complement technology-based learning environments. Further research is

recommended to examine the sustainability of students' learning outcomes over a longer period and to involve students from more diverse backgrounds and educational settings. Such studies could provide broader evidence regarding the applicability and effectiveness of the MUSI Board as a mathematics learning medium.

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