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*The Musi Board as a didactic tool:
strengthening conceptual mastery
of greatest common factor and
least common multiple*

Sri Silvia Kusumawati^a, Puguh
Darmawan^{b*}

^aDepartment of Mathematics Education,
Universitas Negeri Malang, Malang,
Indonesia

^bDepartment of Mathematics Education,
Universitas Negeri Malang, Malang,
Indonesia,
puguh.darmawan.fmipa@um.ac.id

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The Musi Board as a didactic tool: strengthening conceptual mastery of greatest common factor and least common multiple

Sri Silvia Kusumawati^a, Puguh Darmawan^{b*}

^aDepartment of Mathematics Education, Universitas Negeri Malang, Malang, Indonesia

^bDepartment of Mathematics Education, Universitas Negeri Malang, Malang, Indonesia, puguh.darmawan.fmipa@um.ac.id

Correspondence: puguh.darmawan.fmipa@um.ac.id

Abstract

This study employed a qualitative case study approach to investigate the effectiveness of the Musi board in enhancing students' understanding of the abstract mathematical concepts of Greatest Common Divisor (GCD) and Least Common Multiple (LCM). These topics were often difficult for students due to their abstract nature and the limited use of concrete learning media. The participants were third-semester students from Offering E in the Mathematics Department at Universitas Negeri Malang. The learning process was conducted using the Problem-Based Learning (PBL) model, where the Musi board functioned as both a visual aid and a tool for collaborative problem solving. The teaching sequence followed five PBL stages: problem orientation, student organization, guided investigation, group presentation, and evaluation. Data collection included classroom observations, video recordings, student worksheets (LKPD), and written feedback from the course lecturer. The data were analyzed using Miles and Huberman's interactive model consisting of data reduction, data display, and conclusion drawing. The findings revealed that the Musi board helped students concretize abstract mathematical ideas, making it easier to grasp and apply GCD and LCM concepts in problem-solving contexts. It also encouraged active participation and collaborative learning. The implication of this research was that integrating simple, culturally relevant, and interactive media like the Musi board into mathematics instruction could significantly improve conceptual understanding. Teachers were encouraged to incorporate such tools into their practice to make abstract content more accessible and engaging for students.

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1. Introduction

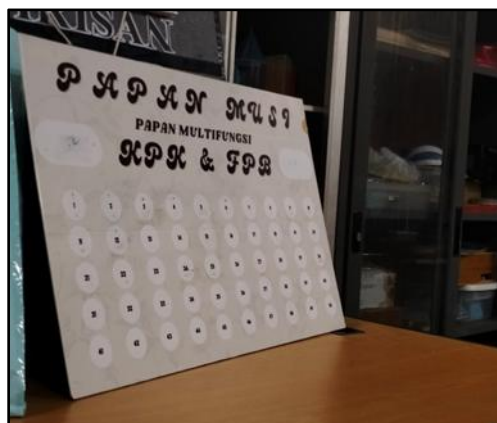
It is not a new phenomenon that mathematics is a compulsory subject at every level of education (Efwan et al., 2024; Rodríguez-Nieto et al., 2025; Runisah et al., 2022). This is because mathematics plays a significant role in daily life, thus creating an urgency for it to be thoroughly learned (Algani, 2022; Apriliani et al., 2024; Yavuz, 2018). In recent years, numerous studies and innovations have been conducted to improve the quality of mathematics instruction to achieve the desired learning outcomes (Savelsbergh et al., 2016). However, various problems and difficulties that arise during the learning process continue to affect the quality of mathematics education in Indonesia, which remains relatively low (Muqtafia et al., 2022). One of the contributing factors is the abstract and complex nature of mathematical concepts.

One of these abstract concepts is the topic of GCF and LCM, which students typically encounter in elementary and lower secondary school). In mathematics, GCF is defined as the largest positive

integer that can divide two or more integers evenly (Muthmainnah, 2024), while LCM is the smallest positive integer that is a common multiple of two or more integers, or can be evenly divided by them (Sintika et al., 2021). In classroom practice, students often face difficulties in distinguishing and determining the results of GCF and LCM (Nurhasanah et al., 2022). According to Unaenah et al. (2020), students tend to experience misconceptions on these topics due to computational errors rooted in a lack of conceptual understanding. Topics such as GCF and LCM require deep understanding and appropriate application (Unaenah et al., 2021). Therefore, teachers must ensure that students grasp the concepts thoroughly to minimize learning difficulties.

Figure 1

Musi Board



To help students understand mathematical concepts, they must be provided with a sequence of logical and tangible learning activities (Permatasari et al., 2021). One such concrete approach is the integration of instructional media into the learning process (Hariyanto et al., 2020). Instructional media can support teachers in transforming abstract concepts like GCF and LCM into more concrete forms that are easier for students to comprehend. Nurhasanah et al. (2022) argue that students' lack of understanding of GCF and LCM is due to the absence of instructional media to support the learning process. This finding aligns with the study by Nurlaila & Mahmudah (2023), which suggests that students struggle to grasp the material because teachers do not use media to monitor students' learning progress. The limited use of media restricts student understanding to a surface level. Therefore, it is essential for teachers to select and utilize appropriate instructional media to support the teaching of GCF and LCM and reduce learning difficulties.

According to Nurhasanah et al. (2022), the Musi Board (a multifunctional board) can be utilized by teachers to mitigate the challenges in teaching GCF and LCM. As shown in Figure 1, the Musi Board is a modified board containing numbers from 1 to 50. These numbers are arranged sequentially and can be adjusted based on the problems being solved. The Musi Board helps students in identifying factors, multiples, common factors, and common multiples. This tool assists students in visualizing concepts, thereby facilitating comprehension (Herawati et al., 2023). Thus, the Musi Board serves as an alternative instructional medium that teachers can use when teaching GCF and LCM.

In practice, the researcher encountered challenges in using the Musi Board for teaching GCF and LCM. The common method taught in schools involves using factor trees or prime factorization. To this day, many teachers still rely on the factor tree method as it is perceived to be the easiest. Even university students continue to rely heavily on this method, despite its limitations—particularly inapplicability when dealing with two or more prime numbers. Initially, the researcher assumed that the Musi Board could be used to clarify the factor tree method, but in reality, the method involves exponentiation, which creates ambiguity when applied to the Musi Board. Solving GCF and LCM using the Musi Board requires a clear understanding of the concepts of factors and multiples. Therefore, the researcher concluded that the Musi Board can provide comprehensive conceptual understanding of GCF and LCM during the learning process.

Throughout the learning process, the researcher aimed for students to gain a complete understanding of GCF and LCM in order to avoid misconceptions and errors in determining the results. The Musi Board, as a concrete medium, allows students to discover and construct their understanding

as an outcome of the learning experience. It also enables them to better grasp the concept of multiples and factors of numbers, reinforcing multiplication and division operations. The interactive experience with the medium boost's motivation, leading students to become more focused and enthusiastic, ultimately enhancing their understanding of GCF and LCM.

Every instructional medium has its own advantages and limitations. According to Mufidah & Amir (2021) in Nurlaila & Mahmudah (2023), the Musi Board offers visualization of GCF and LCM concepts and demonstrates their connection to mathematical operations such as multiplication, division, addition, and subtraction. Additionally, the Musi Board serves as an interactive medium that engages students directly. Interactive learning encourages students to take an active role in the classroom, thereby increasing motivation. This is supported by Ramdhanian et al. (2022), who found that the Musi Board effectively enhances student enthusiasm and focus during GCF and LCM lessons.

However, the Musi Board has its limitations, such as the restricted range of numbers. The board used by the researcher only includes numbers up to 50, limiting its use to problems involving smaller numbers. Moreover, the numbers on the board are fixed and cannot be adjusted to suit various problem types. When using a self-made version of the Musi Board, the material tends to be less durable and prone to damage. Thus, the Musi Board should be used optimally to extend its lifespan.

Based on the above discussion, this paper was developed to highlight the importance of GCF and LCM instruction for mathematics teachers and prospective educators. First, the researcher presents evidence of the Musi Board's significant role in supporting teachers in delivering GCF and LCM content. Second, this paper illustrates the difficulties students face in understanding GCF and LCM without the aid of the Musi Board. Third, the paper outlines the strengths and weaknesses of the Musi Board, allowing teachers and prospective teachers to design more effective instruction. Fourth, it serves as a reminder that the core concepts of GCF and LCM are rooted in factors and multiples, and that teachers must provide accurate conceptual explanations. There are many instructional materials that can be developed and used depending on the context, budget, and specific learning needs (Muzkiati et al., 2023). In conclusion, this paper presents the positive impact and urgency of improving GCF and LCM learning by fostering teachers' and prospective teachers' awareness of the importance of instructional media.

Based on the findings from the learning practice using the Musi board in teaching GCF and LCM concepts, several important issues emerged that warrant further investigation. These issues focus on the effectiveness of the Musi board as a learning medium, its impact on student understanding and engagement, as well as practical challenges encountered during its implementation. Therefore, the following research problems are formulated to guide the study:

- a) How does the Musi board assist students in understanding the abstract concepts of Greatest Common Factor (GCF) and Least Common Multiple (LCM)?
- b) How effective is the use of the Musi board in helping students differentiate between the problem-solving processes for GCF and LCM?
- c) What challenges arise during the use of the Musi board in the learning process, and how do these challenges affect student interaction and motivation?

2. Method

2.1 Approach and Type of Research

The approach taken by the researcher is a qualitative approach with a case study type of research. A qualitative approach focuses on gaining an in-depth understanding of the research subjects' perspective on a phenomenon, which can be described in the form of words or non-numerical data. The case study discussed involves students' understanding of the concepts of GCD (Greatest Common Divisor) and LCM (Least Common Multiple). Additionally, this study investigates the phenomenon of using the Musi board as a learning medium and as a tool for solving problems. The aim of this research is to describe the effectiveness of the Musi board for GCD and LCM based on the participants' initial understanding of the GCD and LCM concepts.

2.2 Subjects and Procedure

The subjects of this study are third-semester students from Offering E of the Mathematics Department, Universitas Negeri Malang. The research was conducted through a teaching practice

using the PBL (Problem-Based Learning) model, employing the Musi board as a medium for delivering the concepts of GCD and LCM, and as a tool for solving GCD and LCM problems. In accordance with the PBL syntax, the study was carried out in five stages: problem orientation, organizing students, guiding group investigations, presenting results, and evaluating the problem-solving process.

In the problem orientation stage, the researcher presented a simple problem as a form of apperception to assess students' understanding of GCD and LCM, and provided an example of using the Musi board to find solutions to GCD and LCM problems. The next stage, organizing students, began with the researcher dividing the students into three groups and distributing student worksheets (LKPD) containing problems that needed to be solved. In the third stage, the researcher guided the group investigations by providing keywords to help determine how the problems could be solved using either GCD or LCM. Subsequently, each group presented their work on the LKPD, and the researcher asked a representative from each group to present their results using the Musi board. In the final stage, the researcher evaluated the problem-solving process using the Musi board as presented by each group.

2.3 Data Sources and Research Data

The data sources in this study are third-semester students from Offering E of the Mathematics Department at Universitas Negeri Malang and the course lecturer for Mathematics Learning Media, Dr. Puguh Darmawan, M.Pd. The instruments used for data collection were the LKPD and the Musi board. The research data included video recordings of the learning practice and notes from the course lecturer. The video recordings captured the learning process, including the interactions between the researcher and the students, the use of the media, and interactions between the researcher and the lecturer. Throughout the learning practice, the lecturer provided supervision and guidance, and at the end of the teaching practice, the researcher received written feedback from the lecturer as part of the evaluation.

2.4 Data Analysis Technique

The qualitative data analysis technique used was the interactive data analysis technique formulated by Miles and Huberman. Data analysis involved data collection, data reduction, data display, and conclusion drawing (Darmawan & Yusuf, 2022). Data were collected through teaching practice using the Musi board on GCD and LCM material. The researcher then carried out data reduction to select the necessary data and discard irrelevant data. Next, data display was done in the form of a narrative specifically focused on the research problems. The final step was drawing

3. Results and Discussion

3.1 Results

The researcher conducted the learning practice following the sequence of activities in the teaching module. The class began with routine activities such as greetings, prayers, and attendance. Next, the researcher provided an introduction to the concepts of GCF and LCM check students' understanding regarding common factors and multiples, as illustrated in Figure 2.

Figure 2

The researcher provides apperception

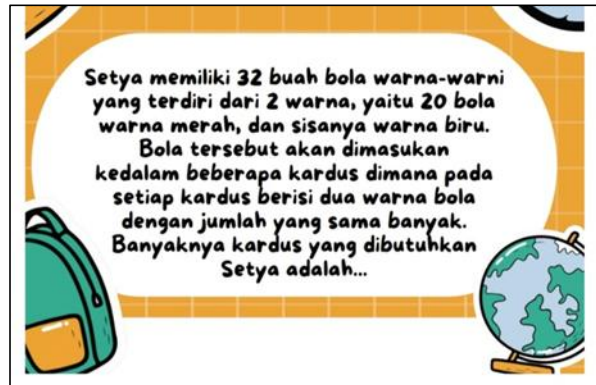


At this stage, it was found that students were familiar with solving GCF and LCM using the factor tree method. Then, the researcher presented a problem involving finding the GCF and LCM of

two prime numbers, which led to ambiguity when using the factor tree method. The researcher encouraged students to find solutions to this problem using the musi board. At this stage, it can be said that students successfully built an understanding of the concepts of factors and multiples in GCF and LCM material, as evidenced by their enthusiasm during the introduction using the musi board.

Figure 3

Student Worksheet Questions



The next stage involved organizing students into three groups, followed by guiding their group investigation. After distributing worksheets containing problems as shown in Figure 3, the researcher provided keywords to assist students in solving the worksheets. At this stage, students were able to recognize the relationship between the keywords and the problems in the worksheet. The students then proceeded to the result presentation stage. The researcher asked group representatives to present their work results by demonstrating the problem-solving process using the Musi board, as illustrated in Figure 4. At this stage, students were able to distinguish between the solution processes of GCF and LCM by independently applying the concepts of factors and multiples using the Musi board, thereby determining the common factors and multiples as the correct solution.

Figure 4

Musi board as illustrated



This indicates that the Musi board helped students overcome confusion in differentiating between GCF and LCM results. Thus, the Musi board assisted students in reaching conclusions about problem modeling using GCF and LCM, as illustrated in Figure 5.

Figure 5

Students give conclusions



Challenges and Obstacles in Using the Musi Board

During the implementation of learning activities using the Musi board as a teaching medium for the Greatest Common Factor (GCF) and Least Common Multiple (LCM) materials, this study identified several challenges and obstacles that impacted the smoothness and effectiveness of the teaching and learning process. While the use of the Musi board generally had a significant positive effect on student understanding and engagement, technical and practical difficulties arose throughout the learning activities. This section elaborates on these challenges based on observations, interactions, and reflections during the learning process.

a) Physical Constraints and Media Design Issues

One of the main challenges encountered was related to the physical design and materials of the Musi board. The board was not designed to be hung, attached, or stand independently during the learning sessions. As a result, either the researcher or students had to hold the Musi board manually while using it. This situation limited freedom of movement and interaction during learning activities, particularly during group presentations and classroom discussions. This limitation also potentially reduced the effectiveness of visualizing GCF and LCM concepts. Ideally, instructional media should be easy and comfortable to use without disrupting the flow of teaching. However, having to hold the Musi board manually diverted some of the students' and teacher's attention to managing the media's position instead of focusing on the lesson content. Furthermore, the materials used to create the Musi board were relatively thin and less sturdy, such as paper, thin cardboard, or styrofoam. These materials were prone to damage and not durable enough for frequent or long-term use. The limited durability of the media affected its practicality since teachers needed to handle it carefully and limit its usage frequency to avoid rapid deterioration.

b) Challenges in Media Provision and Development

Another obstacle related to the availability and development of the Musi board itself. The teaching media used in this study was made simply from easily available and inexpensive materials. Although this was advantageous economically and for ease of production, there were challenges in making the design attractive and functional. Previous studies have shown that Musi boards equipped with bright colors and appealing designs can better capture students' attention and motivation. However, the media in this study did not optimally incorporate such features. The lack of visual appeal posed a challenge in maintaining student enthusiasm during lessons, especially for students who tended to lose focus or become easily bored. Moreover, in terms of sustainable media development, teachers face the need to adapt and improve the Musi board design to suit students' needs and characteristics. This requires creativity, time, and additional resources that are not always available in daily practice. Therefore, challenges in media provision and development must be addressed to ensure the Musi board can be used effectively and efficiently over time.

c) Obstacles in Classroom Management and Interaction

During the learning practice using the Musi board, challenges also arose in classroom management and interaction dynamics among students and between the teacher and students. While interactive media such as the Musi board generally increased overall student engagement, it also demanded more careful and structured classroom management to ensure the learning process ran smoothly. One issue encountered was the difficulty in managing time and turns for using the Musi board during group discussions or presentations. Since the media was limited in number, groups had to

take turns using the Musi board, requiring precise time management to give all groups fair opportunities without disrupting the learning flow.

Additionally, the physical limitation of having to hold the board during use affected student interaction. On some occasions, students' focus was divided between following the lesson material and helping to hold or operate the Musi board. This could reduce the effectiveness of communication and collaboration within groups. Classroom management also needed to anticipate variations in students' abilities to understand the GCF and LCM concepts and to use the media effectively. Some students required more intensive guidance to maximize their use of the Musi board as a visual aid. Limited time and teacher resources sometimes hindered providing individualized support to all students adequately.

d) Technical Limitations and Media Functionality

Besides physical obstacles, technical limitations related to the Musi board's functions were also present. The media was static and simple, lacking support for more dynamic teaching methods such as interactive simulations or multimedia that can provide immediate feedback to students. Being made from simple materials, the Musi board could not display animations or sounds that might enrich the learning experience. Consequently, learning with the Musi board heavily relied on the teacher's explanations and guidance, making the media's effectiveness closely tied to the teacher's instructional skills. This limitation posed challenges for students with kinesthetic or visual learning styles who benefit from varied instructional media to grasp concepts fully. Without media variety, some students might find it difficult to maintain focus or deepen their understanding.

3.2 Discussion

The learning practice using the Musi board media for GCF and LCM has both strengths and weaknesses that need to be elaborated. One of the strengths of using the Musi board media in this learning practice is that it provides a concrete representation of the abstract concepts of GCF and LCM, thus making it easier for students to grasp these concepts. This aligns with the purpose of using instructional media as a means to deliver information from the teacher to the students (Yonanda et al., 2021). The Musi board supported the researcher in creating interactive learning. It helped students to visualize and physically engage with the concepts of GCF and LCM, which were previously only presented in textbooks or through teacher lectures. This finding is in line with Nurhasanah et al. (2022), who found that when working on tasks using the Musi board, students who were usually disengaged in class became enthusiastic and eager to take turns using the board.

The increased enthusiasm and motivation among students during the GCF and LCM lessons using the musu board had a positive impact on their learning outcomes. This approach helped students complete the worksheets accurately and determine the correct results. This finding is supported by recent studies, such as Ramdhanian et al. (2022), which reported improvements in mathematics learning outcomes using the Musi board for GCF and LCM materials. Similar findings were reported by Fitriah et al. (2023), who found that the musu board enhanced student achievement in GCF and LCM topics. Additionally, Siregar & Hasanah (2023) confirmed the Musi board's effectiveness in improving student learning outcomes in GCF and LCM topics. During the learning practice, there was also increased interaction between the researcher and the students, creating a more enthusiastic and warmer classroom atmosphere. Media can enhance learning activities and improve the quality of learning (Suliani, 2020). This is consistent with the view that media facilitating teacher-student interaction leads to more effective and efficient learning (Maharani et al., 2023).

However, a drawback encountered during the use of the Musi board was that the researcher did not ensure that the board could be hung, attached, or stood upright to facilitate learning. This limitation meant that either the researcher or the students had to hold the board during its use, which restricted movement. According to Ramdhanian et al. (2022), the Musi board can be made using colorful paper to attract students' attention. This aligns with Fitri et al. (2023), who developed GCF and LCM media using easily obtainable and economical materials, making them suitable for independent teacher development. This implies that the Musi board was made from less sturdy materials such as paper, thin board, or even styrofoam.

4. Conclusion

The Musi board serves as an informational tool that provides visualizations of the abstract concepts of GCF and LCM. Its use in the learning process helps teachers create interactive lessons. The Musi board can be modified to meet classroom needs in ways that attract student attention and enthusiasm. As a result, students become more focused and motivated, leading to stronger conceptual understanding. Therefore, based on the research, it is concluded that the Musi board is an effective instructional medium to support student understanding of GCF and LCM topics.

Implications

This study implies that integrating visual and interactive media like the Musi board into mathematics teaching can significantly enhance student engagement and comprehension, especially for abstract concepts. Teachers should consider incorporating such media to create dynamic learning environments that foster deeper understanding and motivation among students. Additionally, the adaptability of the Musi board suggests that instructional tools can and should be customized to better suit diverse classroom contexts and learner needs.

Recommendations

Future implementation of the Musi board should focus on improving its physical design for greater durability and ease of use, such as making it freestanding or mountable. Teachers are encouraged to creatively modify and adapt the board's features to maintain student interest and facilitate active participation. It is also recommended that teacher training includes effective strategies for integrating such instructional media and managing interactive classroom activities. Furthermore, combining the Musi board with digital or other multimedia resources could further enrich the learning experience.

Limitations

The study's findings are limited by the specific context in which the Musi board was used, including the particular student group and setting. The physical design and material quality of the Musi board may have constrained its full potential, and results could vary with different versions or implementations. Moreover, the effectiveness of the Musi board relies heavily on the teacher's facilitation skills, which may affect the generalizability of the findings. Further research is needed to explore the board's applicability across varied subjects, student populations, and learning environments.

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