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# Design of Interactive Media for World of Mathematics using MDLC Method

Bernadhed[1], Haryoko[2*], Dhimas Adi Satria [3], Nadea Cipta Laksmita[4], Rifki Arifianto [5]

**Abstract**

Adopting recent technological approaches can leverage learning activities in schools, specifically by using interactive learning media. However, the use of interactive media is still rarely implemented in primary schools that deliver educational material using cooperative learning methods, lectures, and simple videos. It may cause students to quickly become bored and struggle to understand the material on whole numbers and measurement. In this study, we adopted the MDLC method for creating the interactive media application. Data collection was conducted through direct interviews with teachers. The results of the feasibility aspect testing indicate that the developed interactive learning media received a score of 89.00%, categorizing it as very feasible, and the results of the material comprehension aspect testing show a Likert scale result of 81.5789474%, categorizing it as very well understood.

***Keywords:***
Mathematics, Measurement, Interactive Media, MDLC Method



## 1. Introduction

Mathematics has long been considered a core subject in education, but many students still struggle to understand its fundamental concepts. Conventional teaching methods that rely on books and verbal explanations often fail to stimulate student interest, especially in younger learners. For instance, research indicates that interactive digital games developed with the MDLC method can significantly improve comprehension of basic mathematical concepts such as whole numbers, showing that multimedia elements enhance both understanding and motivation [1]. This highlights the need for innovative learning tools that present mathematics in a more engaging format.

Traditional mathematics textbooks provide structured content but lack interactivity, making it difficult for learners to visualize and apply abstract ideas in real-world contexts. Although textbooks such as the ESPS Mathematics series are widely used in elementary schools, they cannot fully address different learning styles or levels of digital literacy among students [2]. As a result, many children remain passive learners, unable to connect mathematical theory with practical problem-solving, pointing to the urgency of integrating interactive digital media into the learning process.

The use of interactive storytelling and games in education has shown potential in increasing engagement and retention. For example, the application of MDLC in designing a folklore-based game successfully captured learners' attention and improved comprehension of cultural narratives [3]. Translating this approach into mathematics

**Corresponding Author:** Haryoko (haryoko@amikom.ac.id)
1 Bernadhed, University of Amikom Yogyakarta, bernadtagger@amikom.ac.id
2 Haryoko, University of Amikom Yogyakarta, haryoko@amikom.ac.id
3 Dhimas Adi Satria, University of Amikom Yogyakarta, dhimas@amikom.ac.id
4 Nadea Cipta Laksmita, University of Amikom Yogyakarta, nadealaksmita@amikom.ac.id
5 Rifki Arifianto, University of Amikom Yogyakarta, rifki.a@students.amikom.ac.id

education suggests that embedding interactive and narrative-driven elements could help overcome students' perception of mathematics as a rigid and difficult subject, making the learning experience more enjoyable and accessible.

Mobile-based learning solutions are increasingly popular due to their accessibility and flexibility, particularly for elementary-level mathematics. A study on mobile learning media demonstrated significant improvement in mathematical performance, showing that interactive features supported students' ability to practice anytime and anywhere [4]. However, the lack of systematic development processes in some applications often leads to usability problems, limited content coverage, and insufficient alignment with curricular needs. This underscores the importance of structured methods like MDLC in designing effective mathematics learning tools.

Interdisciplinary learning applications that combine mathematics with other subjects, such as English, have also shown promise in enhancing both cognitive skills and digital engagement among children [5]. Nevertheless, these applications often struggle to maintain focus on mathematics as the core subject, as students may become more interested in the secondary content. This suggests that mathematics-focused interactive media must balance engagement with subject-specific learning objectives to maximize educational outcomes.

Various development models have been used in educational technology, such as ADDIE and MDLC. While ADDIE emphasizes iterative evaluation, MDLC offers a more systematic process for multimedia learning, ensuring that content, design, and interactivity are developed cohesively. Studies on game-based mathematics learning using structured methodologies have shown improvements in both achievement and enthusiasm [6]. This makes MDLC particularly suitable for creating mathematics media that blends educational value with interactive features.

The success of digital learning media also depends on user acceptance and usability. Research on interactive mathematics applications using MDLC demonstrated that user acceptance testing is critical to ensuring learners find the application intuitive and helpful [7]. Without adequate attention to usability, even content-rich applications risk being abandoned by students. Therefore, usability testing should be considered a crucial stage in the MDLC approach for mathematics education. Finally, MDLC has been applied successfully across diverse educational contexts, from science education [9] to augmented reality-based exploration [10], confirming its adaptability and robustness. It's structured phases, which include concept, design, material collecting, assembly, testing, and distribution, to ensure that learning applications are not only functional but also engaging and pedagogically effective. By applying MDLC to mathematics, developers can address persistent challenges in comprehension and engagement, offering students an interactive platform that transforms mathematics into a more accessible and enjoyable subject.

## 2. Related Works

Yanto et al. developed a two-dimensional educational game aimed at improving students' understanding of whole numbers using the MDLC method. Their study demonstrated that multimedia-based game design can enhance learning motivation and comprehension by presenting abstract concepts in an interactive form. The results indicated a marked increase in students' engagement, with over 80% of participants showing improved test results after using the application compared to conventional methods [1]. This suggests that MDLC-based interactive media is effective for strengthening mathematical fundamentals.

Adhalia and Sy evaluated the use of the Erlangga Straight Point Series (ESPS) textbook for grade 2 elementary students, which provided structured lessons but limited interactivity.

Their findings revealed that while students could follow the material, many had difficulties grasping complex mathematical ideas due to the static nature of the learning media. Teachers reported that nearly 40% of students required repeated explanation of certain topics, underscoring the limitations of book-based learning compared to digital alternatives [2]. This demonstrates the need for supplementary digital media to improve understanding.

Kusuma and Santika explored the use of MDLC in designing an educational game based on the folklore *Timun Mas*. The study found that integrating interactive multimedia with storytelling could significantly improve student comprehension of cultural material. Approximately 85% of learners expressed greater interest in the subject matter, and retention scores increased by more than 20% compared to traditional teaching [3]. Their results support the view that MDLC can enhance engagement in educational contexts, which can be adapted effectively for mathematics learning.

Rurut et al. designed a mobile-based learning media for elementary mathematics and found that students' performance increased when interactive elements were integrated into the platform. The research revealed a 75% improvement in learning outcomes among users compared to non-users, particularly in problem-solving skills. Additionally, teachers noted reduced classroom fatigue as students became more enthusiastic about practicing mathematics through mobile devices [4]. This demonstrates the potential of mobile interactive media as an effective mathematics learning tool.

Pratama and Rijati created an educational game that combined mathematics and English for elementary school students. Their findings indicated that integrating two disciplines within a game environment fostered multitasking skills and encouraged collaborative learning. The application achieved a 90% satisfaction rate among participants, with students showing higher confidence in both language and mathematics exercises [5]. This dual-subject approach, however, revealed a challenge: maintaining focus on mathematics as the primary subject, which reinforces the importance of subject-specific applications like the one proposed in this study.

Fauzan et al. implemented a game-based mathematics learning system using the ADDIE method. Their results showed a measurable improvement in student achievement, with an average score increase of 18% between pre-test and post-test results. Additionally, the structured design ensured that instructional objectives were met efficiently [6]. However, their reliance on ADDIE demonstrated less emphasis on multimedia design aspects compared to MDLC, suggesting that the latter could provide more engaging and visually appealing solutions for mathematics media.

Agusti and Alfian developed interactive media for mathematics formulas using MDLC combined with User Acceptance Testing (UAT). Their evaluation revealed that more than 85% of students found the application easy to use, and 82% agreed it improved their understanding of mathematical formulas [7]. The study underscores the importance of usability testing in multimedia-based mathematics education, as poor interface design could hinder rather than support learning, even with strong content.

Maharani applied MDLC in designing an Android-based learning media for science (IPA) at the junior high school level. The study showed that MDLC's structured phases with concept, design, material collection, assembly, testing, and distribution. More than 88% of students reported improved understanding of science concepts, while teachers praised the clarity of the media's interactive features [9]. The success of MDLC in science education supports its adaptation for mathematics, where abstract concepts similarly require visualization and interactivity for better comprehension.

Ami's study presented a game-based interactive mathematics media developed via the MDLC method. The resulting app successfully captured student attention and helped them understand mathematical concepts more effectively, as echoed by positive reception during early testing stages [11]. Similarly, AR-based learning media designed for elementary school students using MDLC demonstrated high usability, with the Bangun Ruang application achieving scores of 86% (ease of use), 88% (efficiency), 90% (effectiveness), and 87% (satisfaction) in SUS evaluations [12]. These successes underscore MDLC's strength in shaping student engagement and media quality in mathematics learning contexts.

Other interactive media implementations support this trend. Applying MDLC to develop an AR-based learning tool for solid geometry led to excellent user evaluations across multiple usability metrics, reinforcing its applicability in spatial mathematics education [12]. Moreover, Purwanti et al. utilized MDLC to create a multimedia learning system (not specifically focused on mathematics). The study's outcomes confirmed robust functionality, usability, and design consistency, proving the approach's effectiveness in interactive learning across subjects [13]. These results validate that MDLC ensures coherent design, comprehensive development, and reliable media performance, which are critical for mathematics education.

Beyond mathematics, interactive MDLC-driven tools in other disciplines demonstrate the method's versatility and effectiveness. Wahyuni's integration of R&D and MDLC for web-based learning media yielded full functionality in testing, with 100% of features working as intended [14]. Additionally, the development of a Rubik's Cube tutorial using MDLC revealed that learners' behavioral intentions (interest levels) were significantly influenced by factors like Performance Expectancy and Effort Expectancy, while Learning Value and Hedonic Motivation played varying roles [15]. These findings highlight that user engagement and perceived usefulness are fundamental to the success of interactive learning media, with insights directly translatable to math-focused applications developed using MDLC.

# 3. Proposed Method

The MDLC (Multimedia Development Life Cycle) method has six stages, including concept, Design, material collection, assembly, testing, and distribution. The concept stage involves data collection through interviews and literature studies. The design stage includes UML (Unified Modeling Language) design and UI (user interface) design. The material collection stage involves creating assets such as animated images, background sounds, and other materials needed to create interactive media applications. This study adopted the MDLC Method, with the most important mathematical formulation, which should capture the systematic and sequential nature of the MDLC process. In this study, we model MDLC as a discrete sequential optimization process, where each stage must be completed before moving forward, and the quality of the final product is a function of all stages.

**Mathematical Formulation of MDLC**

Let the MDLC process consist of six sequential stages, including Concept (C), Design (D), Material Collecting (M), Assembly (A), Testing (T), and Distribution (R)

We define the development process as a sequence of transformations:

$$P_{final} = f_R(f_T(f_A(f_M(f_D(f_C(P_0)))))) \quad (1)$$

where:

- $P_0$ = initial project idea,
- $f_X$ = transformation function at stage $X$,
- $P_{final}$ = completed interactive learning media.

**Quality Function of MDLC**

The success of the final media can be expressed as:

$$Q = \prod_{i=1}^{6} q_i \tag{2}$$

where:

- $Q$ = overall quality score,
- $q_i \in [0,1]$ = normalized success rate of each MDLC stage.

If any stage fails (e.g., $q_i = 0$), then $Q = 0$, meaning the media cannot be effectively delivered. This reflects the dependency structure of MDLC: each stage is critical.

**Efficiency of Development**
We can also define efficiency as:

$$E = \frac{O}{\sum_{i=1}^{6} T_i} \tag{3}$$

where:

- $E$ = development efficiency,
- $O$ = measurable outcome (e.g., student learning improvement, engagement score),
- $T_i$ = time spent on stage $i$.

This gives a ratio of learning outcomes gained relative to total development time. The sequential function $P_{final}$ shows MDLC is a pipeline: no later stage can be executed before the earlier one. The quality product function $Q$ highlights that overall success depends on each stage working properly. The efficiency metric $E$provides a way to quantify how well the MDLC process translates development effort into learning impact.

# 4. Experimental Setup

**1. Dataset**

In data collection, the author used literature studies and interviews. Interviews were conducted directly with the principal and a teacher at SDN Caturtunggal 3, located in Depok, Sleman, Yogyakarta. n the assembly stage, all asset materials are implemented, and animation effects are applied to the images, which are accompanied by background sounds. In the assembly stage, coding is also performed on each button, asset, and interface so that the application can be used. Once all coding is complete, the application can be built. This is followed by the testing phase, which includes black-box testing, beta testing, and usability evaluation. This testing phase is conducted before distributing the application to users. If the testing results show no bugs or errors and align with the intended objectives, the application is then distributed to the research subjects.

**2. Design**

The following are the results of the Design of the interactive media application Dunia Matematika (DUMA). Fig.1 depicts the menu display of the DUMA application.


Fig. 1 Menu Display of DUMA application

Fig. 1 shows the select material scene, which contains three buttons to navigate the "Select Whole Numbers Subtopic" scene; the Measurement button (with icon and label) to navigate to the measurement scene; and the Back button to return to the select menu scene. The application title also features animated movement. It also shows the select whole numbers subtopic scene, which contains six buttons and the application title. The six buttons are: Counting Numbers, Place Value, Addition, Subtraction, Comparing and Ordering Numbers (each with an icon and a label). Each button navigates to its respective material scene. The Back button returns to the select material scene. The application title also features animated movement. Then, it shows the selected measurement subtopic scene, which contains five buttons and the application title. The five buttons are: Time Measurement, Length Measurement, Weight Measurement, Area and Volume Measurement (each with an icon and a label). Each button navigates to its respective material scene. The Back button returns to the select material scene. The application title also features animated movement. Fig.2 depicts a scene game of the DUMA application.


Fig. 2 Scene Game of DUMA application

Fig. 2 shows the game scene, where the player character walks through obstacles to reach various stations containing math questions, as shown in Figure 10. The interface includes four control buttons: Left Navigation (move left), Right Navigation (move right), Up Navigation (jump), and Pause (pause the game). It also shows the pause menu with three buttons: Continue (resume game), Menu (navigate to select menu scene), and Restart (restart the game). Two UI elements are displayed in the top right corner: the score counter and the number of answered questions. If the player falls into water, a "Game Over" pop-up will appear that contains two buttons: Play Again (restart game) and Menu (navigate to select menu scene). If the player encounters unanswered questions, they cannot reach the finish station and must return to find and answer the remaining questions.

## 5. Results and Analysis

**1) Questionnaire**

A questionnaire was used to measure the interactive learning media application. It was tested directly by teachers to assess its feasibility and by students to assess their understanding of the material presented in the application. Teacher responses were prepared by researchers and analyzed using a Likert scale. The following are the instrument assessment criteria, as seen in Table 1.

Table 1. Research Scale

| No | Information | Score |
|---|---|---|
| 1. | Very Good | 5 |
| 2. | Good | 4 |
| 3. | Quite Good | 3 |
| 4. | Not Good | 2 |
| 5. | Very Bad | 1 |

Each assessment result is calculated using the formula T (number of respondents) multiplied by Pn (number of choices on the Likert scale). Next, find the value (Y) obtained by multiplying the highest score on the Likert scale by the number of respondents. Then, determine the score interpretation criteria and calculate the index formula (%). The following is the Formula for determining the score interpretation criteria.

Interval Formula= $\frac{100}{\text{number pf scores (likert scale)}}$

Therefore, = $\frac{100}{5}$= 20.

The above values represent the intervals from the lowest to the highest, 0% to 100%. The results of the score interpretation criteria are shown in Table 2.

**Table 2.** Score Interpretation Criteria

| No | Score | Criteria |
|---|---|---|
| 1. | 81% - 100% | Very Adequate/Understood (SS) |
| 2. | 61% - 80% | Adequate/Understood (S) |
| 3. | 41% - 60% | Fairly Adequate/Understood (CS) |
| 4. | 21% - 40% | Not Adequate/Understood (TS) |
| 5. | 0% - 20% | Very Not Adequate/Understood (STS) |

**2) Application Feasibility Aspect Questionnaire**

The following are the results obtained from the feasibility test of the interactive media application of the world of mathematics (DUMA) by two teachers of SDN Caturtunggal 3. The total score and percentage of feasibility can be seen in Table 3.

**Table 3.** Application Eligibility Percentage Results

| No | Questions | SS | S | CS | TS | STS |
|---|---|---|---|---|---|---|
| 1 | The application is easy to operate | 2 | | | | |
| 2 | The application really helps students understand the material. | 1 | 1 | | | |
| 3 | The content of the material in the application is very clear | 1 | 1 | | | |
| 4 | Presentation of examples of how to calculate easily to understand | 1 | 1 | | | |
| 5 | The questions presented in the game are in accordance with the material. | 1 | 1 | | | |
| 6 | The display design that is implemented is good | 2 | | | | |
| 7 | The application can help teachers deliver material | 1 | 1 | | | |
| 8 | The image applied to the application is very clear | 1 | | 1 | | |
| 9 | An effective application used for learning at school and at home | | 1 | 1 | | |
| 10 | The games implemented in the application motivate students to continue learning. | 1 | 1 | | | |
| Amount | | 11 | 7 | 2 | 0 | 0 |
| Total Score | | 55 | 28 | 6 | 0 | 0 |
| Total All Score | | 89 | | | | |
| Percentage (%) | | 89.00% | | | | |

The total score is obtained by multiplying the total score for each question by the Likert scale value. The scale value can be seen in the research scale table. The interpretation result is obtained by multiplying the highest score (Y) on the Likert scale by the number of questions prepared, so 5 * 10 = 50. The desired score is the highest score multiplied by two respondents, so Y = 50 * 2 = 100. If the total score is 89, then the respondent's interpretation of the data using the index% Formula is as follows:

Index% formula $= \frac{\text{Total Score}}{\text{Y}} * 100\% = \frac{89}{100} * 100\% = 89\%$

= 89.00%

The calculation results from the questionnaires filled in by two teachers at SDN Caturtunggal 3 yielded a percentage value of 89.00%. So it can be concluded that the value based on the feasibility criteria table falls into the very feasible criteria, and this interactive learning media application is very suitable to be used as a learning medium for mathematics for class 2 of SDN Caturtunggal 3.

**3) Questionnaire on Understanding of Material Aspects**

This questionnaire was used to assess whether the interactive media concept could provide students with a response and understanding of the material presented. Therefore, the researchers collected data from 19 students in grade 2 of SDN Caturtunggal 3. The data collected consisted of answers to questions in the game presented. The questionnaire results can be seen in Table 4.

**Table 4.** Percentage Results of Student Understanding

| No | Correct Answer | Correct Number of Students |
|---|---|---|
| 1 | C. 202 | 17 |
| 2 | B. 80 | 19 |
| 3 | D. 580 | 18 |
| 4 | A. 128, 135, 204, 246, 378 | 18 |
| 5 | C. 5 | 18 |
| 6 | A. 175 + 243 = 418 | 11 |
| 7 | C. 442 | 16 |
| 8 | C. 325, 20, & 105 | 10 |
| 9 | D. 475 – 230 – 124 = 121 | 13 |
| 10 | D. 303 | 17 |
| 11 | A. 06.00 | 18 |
| 12 | B. 16.35 | 9 |
| 13 | A. 1 jam 15 minutes | 12 |
| 14 | D. 08.45 | 8 |
| 15 | C. 5 Nail | 19 |
| 16 | B. 7 cm | 18 |
| 17 | C. 8 glasses | 19 |
| 18 | B. Higher | 14 |
| 19 | C. 100 | 17 |
| 20 | A. Apple | 19 |
| Amount | | 310 |

From the results of the questions above, the researcher calculated the percentage of correct answers based on the total score. The number of correct answers given by students at SDN Caturtunggal 3 for all questions was 310. The total score for all answers declared correct in each question was 380. Therefore, the percentage of questions answered correctly is:

Index % formula $= \frac{\text{Total Score}}{\text{Total Overall Score}} * 100\%$

$= \frac{310}{380} * 100\% = 81.5789474\%$ = 81.5789474%

The average comprehension aspect of the material was 81.5789474%, which is classified as very understanding.

# 6. Conclusion

The study developed learning media using the MDLC method as interactive learning media DUMA to support mathematics learning for second-grade students. The MDLC approach, consisting of six sequential stages to ensures a structured development process and to increase both engaging and pedagogically capablities. The application focuses on whole numbers and measurement, areas that are fundamental to early mathematics education, and presents them in an accessible and interactive manner suitable for young learners.

According to the experimental results, the feasibility test can yield a Likert scale score of 89.00%, placing the application in the "very feasible" category. This result highlights that the application meets pedagogical requirements and can be integrated effectively into classroom instruction. Moreover, the evaluation of student understanding shows that 19 second-grade students achieved a comprehension score of 81.58% on the Likert scale, categorizing their performance as "very understanding." These findings confirm that the DUMA application not only enhances students' learning experience but also significantly improves their grasp of mathematical concepts.

Future work can focus on expanding the scope of the application to cover additional mathematical topics beyond whole numbers and measurement, incorporating adaptive features that respond to individual student progress, and integrating gamification elements to further increase engagement. Additionally, larger-scale testing across diverse schools and student populations will be conducted to validate the generalizability of the results and ensure that the application can be adopted widely as a digital learning innovation.

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