

Development of a digital LKPD on relations and functions to enhance mathematical conceptual understanding

Atika Suri^{1)*}, Mardiah Syofiana²⁾, Kashardi³⁾

¹⁾²⁾³⁾ Program Studi Pendidikan Matematika, Universitas Muhammadiyah Bengkulu, Indonesia

*atikasuri2828@gmail.com

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Abstract

Conceptual understanding can be achieved through digital teaching materials, which can make teaching and learning activities more efficient and imaginative. Therefore, this study aims to develop a digital LKPD on relations and functions to enhance students' mathematical conceptual understanding and to determine its validity and practicality. This research is a Research and Development (R&D) study using the ADDIE development model. The study's subjects were students in class VIII C at SMPN 1 Kabawetan. The research instruments consisted of validation sheets, assessed by material and media experts, and student response questionnaires. The results showed that the developed digital LKPD received a valid category from material experts (average score of 0,75) and a highly valid category from media experts (average score of 0,81). Meanwhile, a limited trial produced an average result of 80%, indicating a practical category. Thus, the developed digital LKPD is feasible and practical for use in school mathematics instruction.

Keywords: Conceptual Understanding; Digital LKPD; Mathematics.

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INTRODUCTION

Mathematics is closely related to everyday life and is often found in various fields and activities that we engage in. Since mathematics will always be needed in many aspects of life, its development never stops along with the changes of time (Siagian, 2017). Unlike other academic disciplines, mathematics uses the language of symbols and numbers and explores abstract ideas that are sometimes difficult to understand (Putra & Mashuri, 2016). Therefore, learning mathematics is important because it helps people deal with various problems encountered in everyday life. Therefore, learning mathematics is important because it helps people address the problems encountered in everyday life. Mathematics is a subject taught at all levels of education. In the learning process, students need to possess conceptual understanding skills as a fundamental ability (F. P. Lestari & Ristontowi, 2021). Understanding mathematical concepts is also essential as a foundation for achieving higher levels of thinking

(Hudiria et al., 2022; L. Lestari & Surya, 2017). Individuals are required to comprehend problem concepts in an organized mind map form, as this is necessary for drawing conclusions or discussing solutions (Arsip et al., 2018). Therefore, students need to have this ability.

Conceptual understanding can be enhanced by using teaching materials that foster a more effective, innovative learning process and help students comprehend mathematical ideas more easily (Nufus & Sakti, 2021). One of the teaching materials that can be used during the learning process is the LKPD. With technological advancement, LKPD is no longer limited to physical form but can also be presented digitally, allowing students to access learning materials flexibly anywhere through devices such as computers, laptops, or smartphones (Hanum & Amini, 2023; Wiranata & Sujana, 2021). Moreover, Digital LKPD can include various components such as videos, illustrations, texts, and practice questions with automatic assessment features (Deya et al., 2022).

Based on interviews with a mathematics teacher and several students at SMPN 1 Kabawetan, it was found that both teachers and students are still accustomed to using printed LKPD. This indicates that the utilization of technology in mathematics learning has not been fully optimized. This finding is also supported by research results (Suryaningsih & Nurlita, 2021), which show that, in general, the teaching resources used are still traditional, such as printed books and worksheets. This condition reveals that learning resources, teaching aids, and instructional media that support a modern and interactive learning process are still inadequate (Asma et al., 2020). Therefore, it is necessary to develop more engaging and interactive teaching materials or learning media to support an effective and enjoyable learning process, such as digital LKPD, which can be adapted to meet specific learning goals and needs (Hidayah et al., 2021; Zahara et al., 2021). In this context, the LKPD developed contains material on relations and functions.

Relations and functions are fundamental concepts that help students understand the connections between elements in mathematics and support their problem-solving abilities (Aqfi et al., 2023). In addition, the topic of relations and functions serves as an essential prerequisite for understanding more advanced topics, such as linear functions and quadratic functions (Rahmi & Yulianti, 2022). This shows that students are required to have conceptual understanding skills and be able to restate a statement using their own understanding.

Based on the explanation above, a digital LKPD is needed to facilitate students' ability to understand mathematical concepts. The use of a digital LKPD provides opportunities for creating a more engaging and interactive learning process. The topic of relations and functions

was chosen because it is a fundamental and essential concept that requires students to have a strong conceptual understanding in order to solve mathematical problems accurately.

METHODS

This study employed the Research and Development (R&D) method using the ADDIE development model approach, which consists of five main stages: Analysis, Design, Development, Implementation, and Evaluation. The study involved 25 eighth-grade students (class VIIIC) from SMPN 1 Kabawetan as the research subjects. Kindly direct your attention to the Figure 1.

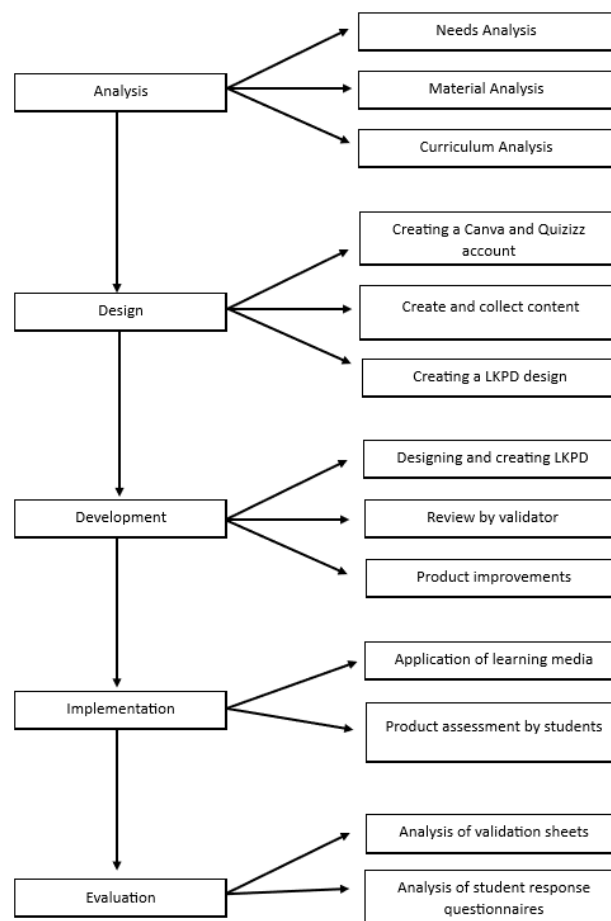


Figure 1. Research Design

The instruments used consisted of validation sheets from subject-matter experts and media experts, as well as a student response questionnaire. Data collection techniques included interviews, validity testing, and practicality testing.

RESULTS AND DISCUSSION

This study examines the level of validity and practicality of the digital LKPD on relations and functions in facilitating students' mathematical conceptual understanding. Before designing the digital LKPD, the initial step was to gather various relevant sources from several learning materials, such as textbooks, student worksheets, and online references, to serve as a basis for designing the digital LKPD. The development of the digital LKPD using the ADDIE model resulted in a learning product that went through five stages, namely:

Analysis Stage

The analysis stage was conducted at SMP Negeri 1 Kabawetan, which included the following components:

a. Needs Analysis

The results of interviews and classroom observations in Grade VIII at SMPN 1 Kabawetan showed that learning was still teacher-centered, relying solely on textbooks, with minimal use of technology due to teachers' limited knowledge of software that could be used for instruction and the lack of facilities such as computers and projectors. This condition made students passive and easily bored. Therefore, an innovation in the form of a digital LKPD is needed one that is engaging, easily accessible via links or QR codes, and can be used independently outside school hours through mobile phones so that limited school facilities do not become an obstacle.

b. Material Analysis

The Grade VIII Mathematics curriculum covers various topics, but the topic of Relations and Functions was chosen for the development of the digital LKPD because it is still taught mainly through lectures, making students less independent and causing difficulties in understanding, operating, and distinguishing between relations and functions, especially in word problems. In fact, this topic serves as a prerequisite for subsequent materials such as linear and quadratic functions. The digital LKPD is designed to help students understand the material through interactive animations and videos that can enhance motivation and learning outcomes.

c. Curriculum Analysis

SMPN 1 Kabawetan applies the Merdeka Curriculum. A curriculum review for Grade VIII Mathematics was conducted as a guideline in developing the digital LKPD to ensure its relevance to learning objectives and students' needs, particularly in facilitating conceptual understanding skills. This aligns with the view of (Fernandes, 2019) the

curriculum needs to be continuously updated to remain aligned with the developments of the times, and is supported by (Arsip et al., 2018), who emphasize the importance of adapting the curriculum to technological advancements.

Design Stage

This stage produced a learning medium in the form of a digital LKPD developed using Canva and Quizizz as the main media. The LKPD was designed for one learning session with an attractive layout to encourage and motivate students in the learning process. The problems presented in this digital LKPD refer to the indicators of students' mathematical conceptual understanding as outlined by (Nurindah & Hidayati, 2022), as they are most suitable for achieving the learning objectives of the *Relations and Functions* topic. Table 1 summarizes the digital LKPD planning:

Table 1. Presents The Digital LKPD Planning

No	Indicator	Digital LKPD Planning
1	Restating a concept	Present two different problems and provide a conclusion box so that students can restate their understanding of the topic of relations and functions in their own words.
2	Presenting a concept in various forms of mathematical representation	Present a problem whose answer can be represented in various forms of mathematical representation, such as a set of ordered pairs and an arrow diagram.
3	Applying a concept or algorithm in problem-solving	Present problems in the form of Cartesian diagrams or word problems so that students can analyze and apply the concepts they have previously learned.

The initial design of the LKPD can be seen in the figure below:

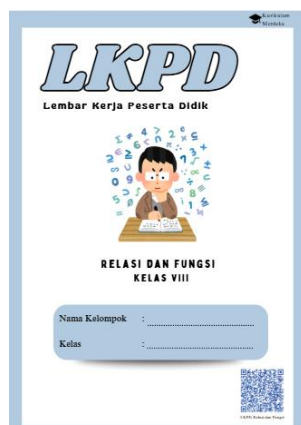


Figure 2. Initial Design of The LKPD Cover

In the initial design of the LKPD cover, the cover includes the LKPD identity, consisting of the title, a QR code for accessing the digital LKPD, the education level, and the class.

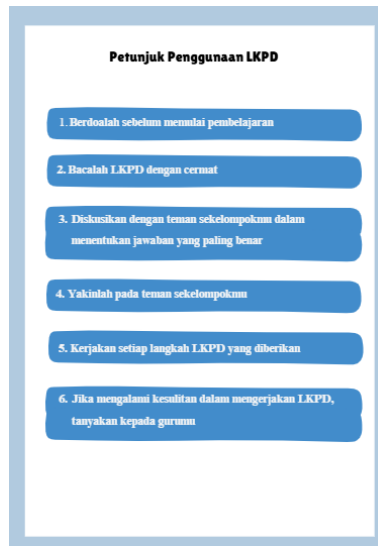


Figure 3. Instructions For Using The LKPD

This page contains instructions for using the LKPD, enabling students to follow the learning process more clearly and independently.

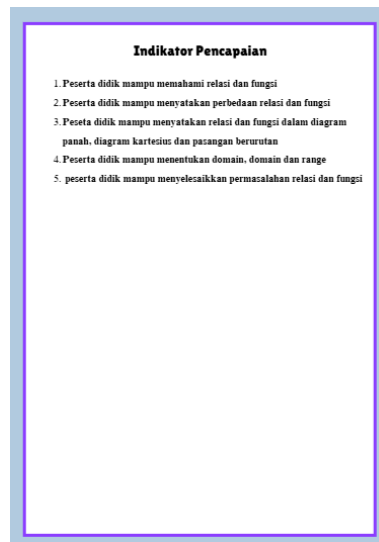


Figure 4. Achievement Indicators

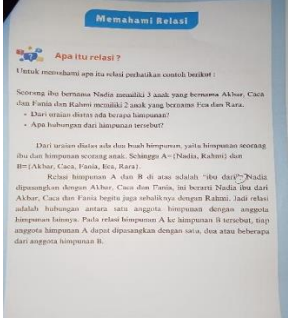
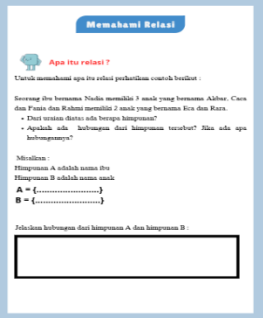
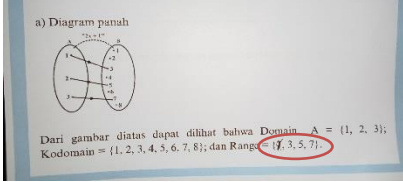
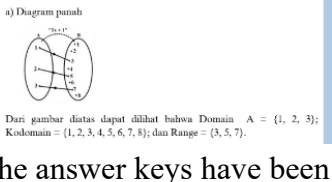
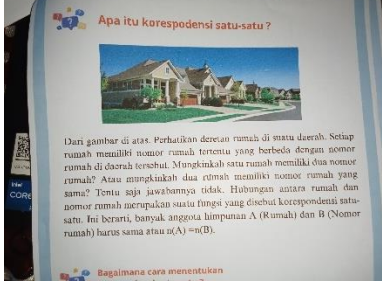

On the achievement indicators page, the competencies that students are expected to achieve after completing the LKPD are listed.

Development Stage

After the initial design of the digital student worksheet was completed, the next stage was validation by material experts and media experts, consisting of three validators. Validator 1 was

a Mathematics Education lecturer from Universitas Muhammadiyah Bengkulu, Validator 2 was a Mathematics Education lecturer from UIN Fatmawati Soekarno Bengkulu, and Validator 3 was a mathematics teacher from SMP Negeri 1 Kabawetan. This validation stage was conducted to obtain a valid LKPD. Any parts of the LKPD that were not yet valid were revised based on the suggestions and feedback provided by the validators until the desired results were achieved. Table 2 is the result of validation by material experts:



Table 2. Material Expert Validation Results

Before Revision	After Revision
	
<p>Validator 2 stated that the questions should not directly lead to the answers, but should require students to think</p>	<p>The questions have been revised in accordance with the suggestions</p>
	
<p>Validator 1 advised paying attention to the answer keys provided for the questions</p>	<p>The answer keys have been corrected</p>
	
<p>Validator 2 stated that the questions should not directly lead to the answers</p>	<p>The questions have been revised based on the validator's suggestions</p>

The results of the media expert validation showed that the validator suggested adding animations to the digital LKPD to make it more engaging and to increase students' learning

interest. This suggestion was used to revise the digital LKPD by incorporating animations into the developed product. Table 3 is the result of validation by media experts:

Table 3. Media Expert Validation Results

Before Revision	After Revision
 <p>Validator 3 suggested adding computer animations. Before the revision, the learning video was less engaging and appeared very plain</p>	 <p>After receiving suggestions from the validator, computer animations were added.</p>

The digital LKPD that has been revised based on the validators' suggestions and feedback is deemed suitable to be used as a research instrument and can then be tested on students. The results can see in Table 4.

Table 4. Validator Assessment Results

No	Appraiser	Average	Criteria
1	Material expert	0.75	Valid
2	Media expert	0.81	Very valid

Based on the validators' assessment results, the developed digital LKPD was declared feasible for trial implementation.

Implementation Stage

A trial was conducted with class VIIIC students of SMPN 1 Kabawetan. Each student is asked to bring a mobile phone and complete the digital worksheet through the provided link or by scanning the QR code on the cover page. After completing the digital LKPD, the students were asked to fill out a questionnaire which was then analyzed to determine its practicality. The results can see in Table 5.

Table 5. Presenting the percentage of questionnaire results

Practitioner	Percentage	Criteria
Students	80%	Practical

Based on the results of the limited trial, it can be seen that the digital LKPD falls into the practical category. The digital LKPD received positive responses from students and was able to facilitate their conceptual understanding of the topic of relations and functions.

Evaluation Stage

Evaluation was conducted at each stage of the process. After completing the analysis, the researchers developed a learning medium in the form of a digital LKPD on relations and functions to support students' mathematical conceptual understanding. The digital LKPD was designed using Canva and Quizizz. Subsequently, the media were revised in accordance with the validators' guidance and feedback.

Based on the overall process, the results of Development of a digital LKPD on Relations and Functions to Enhance Mathematical Conceptual Understanding were declared valid based on data obtained from the validation conducted by material and media experts. Furthermore, the digital LKPD received positive responses from students, as evidenced by the results of the student response questionnaire, which indicated the product's practicality. In addition, a study by (Said et al., 2023) also showed that the developed LKPD was valid and feasible for implementation.

However, several challenges were encountered, such as selecting the appropriate application for developing the LKPD, limited device availability, and unstable internet connectivity. These factors need to be taken into consideration in future LKPD development. Overall, the results of this study confirm that digital LKPD are a relevant learning medium and can effectively support students' conceptual understanding of mathematics in the digital age.

CONCLUSION

The research results indicate that the five stages of the ADDIE development model serve as the foundation for the development of the digital LKPD. Quizizz and Canva were the applications used in the product development. The digital LKPD was validated by experts to determine the product's validity. The developed digital LKPD obtained an average score of 0.75 from material experts, categorized as valid, and 0.81 from media experts, categorized as highly valid. The analysis of the student response questionnaire results in the limited trial showed an average score of 80%, which falls into the practical category.

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