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Teaching Strategy: Adaptive Mathematics Learning with Liveworksheets Platform

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ABSTRACT

Technology is a supporting asset for the implementation of the teaching and learning process in educational institutions, and its application can be studied through research. This study uses a qualitative descriptive method with the aim of identifying the application of adaptive learning in mathematics learning with the help of Artificial Intelligence (AI) in the digitalization of mathematics education course. The research was developed using the design thinking method (empathize, define, ideate, prototype, and test), resulting in a product consisting of teaching tools (media, assessments, and student worksheet) independently created by students of class B1 Mathematics Education at IKIP Siliwangi. The instruments used were validation sheets included in form applications and polls on the WhatsApp application. The validation and poll results were analyzed using real-time techniques with Apache Spark. The teaching tools in this study were validated by practitioners and tested on a group of students. Based on the practitioner's validation and evaluations results, and student tests, the AI-assisted teaching tools for the digitalization of mathematics education course were deemed suitable for use and beneficial in the teaching and learning process.

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A. INTRODUCTION

Nowadays, the condition of the education system is under scrutiny by society, as it plays a crucial role in shaping the character, morals, and mindset of a nation. Bungawati (2022) explained that with education, individuals acquire the competencies and skills necessary for a better quality of life, which can be achieved through training and teaching processes. Juwana, Mustafa (2024) explained that teaching is an interactive process between educators and students aimed at transferring knowledge, skills, and attitudes. This process involves various strategies to achieve the established learning objectives. Teaching is not just about delivering material; it also involves guidance, motivation, and evaluation to ensure that students understand and can apply what they have learned (Fakhruddin et al., 2024; Saboleva, 2022), explained that several important aspects of teaching include; Teaching Planning (Determining learning objectives, instructional materials, methods, and evaluation tools), Teaching Implementation (Conducting the teaching and learning process using the planned methods), Learning Evaluation: (Assessing student learning outcomes through various forms of evaluation, such as tests, assignments, observations, or portfolio assessments), Feedback

(Providing students with feedback on their learning outcomes so they can understand their strengths and weaknesses and improve their deficiencies), and Use of Technology (Incorporating technology in teaching to enhance effectiveness and student engagement). Sariningsih et al. (2023) explained that effective teaching does not only rely on the academic abilities of the educator but also on interpersonal skills, creativity, and the ability to understand the individual needs of students. This is especially true for teaching mathematics.

Mathematics is relevant to everyday life. In fact, mathematical knowledge is often used in transactions and other activities. However, mathematics is still viewed as an unappealing subject by many people due to the fear of not being able to solve math problems Souza et al. (2024) explained that mathematics question items given to students need to be identified and tailored so that the items can be effectively understood and accepted by the students. Zulkardi et al. (2018) stated that Mathematics lessons pose a challenge and are not easily mastered; they require the mathematical abilities that each student possesses, especially understanding concepts and prerequisite material related to everyday life (Zulkardi & Putri, 2006). Linda, & Sugandi (2023) stated that the difficulties students' experiences arise from their own paradigm, believing that mathematics is difficult because it involves numbers. In reality, mathematics is deeply connected to human life (Hendriana et al., 2019). Damastuti et al. (2023) explained that mathematics is an important and useful subject for students. To address students' fears of mathematics, educators and prospective educators use strategies such as adaptive learning to minimize these fears.

Adaptive learning is an educational approach that uses technology and data to tailor content, pace, and teaching methods to the individual needs, abilities, and preferences of each student. Sari et al. (2020) stated that adaptive mathematics learning is an approach tailored to the individual learning needs of each student, allowing them to gain a better understanding of mathematical concepts. According to Fahrudin (2021), the goal is to create a more personalized, effective, and efficient learning experience. Dsharmawati (2023) stated that some key characteristics of adaptive learning include: Content/Material Adjustment, Use of Data and Analytics, Real-Time Feedback, Personalized Learning Experience, Technology Integration (Utilizing digital platforms, software, or applications). Examples of adaptive learning applications include student worksheet equipped with adaptive algorithms, e-learning platforms like live worksheets, and educational software designed to adjust teaching based on user data analysis.

With the advancement of the digital era, almost all learning activities are facilitated by the use of ICT (Information and Communication Technology). Therefore, to enhance efficiency, adaptive learning is also integrated with AI (Artificial Intelligence) platforms such as live worksheets. Mohamadou Y., Halidou, A., & Kapen, (2020) stated that AI is a field of computer science focused on creating systems and machines capable of performing tasks that typically require human intelligence. It encompasses a range of technologies and techniques that enable computers to learn from data, recognize patterns, make decisions, and interact with humans or their environment intelligently. According to Khowarizmi (2023) some key concepts in AI include; (1) Machine Learning, (2) Deep Learning, (3) Natural Language Processing, NLP, (4) Computer Vision, (5) Expert Systems, (6) Robotic, and (7) (Artificial General Intelligence, AGI). The benefits of AI include; (1) Task Automation, (2) Data Analysis, (3) Decision Making, and (4)

User Interaction (Mohamed et al., 2022). Liveworksheets is an online platform that allows teachers and students to create and use interactive worksheets. With Liveworksheets, worksheets in PDF format or statistical documents can be transformed into interactive exercises, such as: Drag and drop, Multiple choice, Short answer, Listening and writing, and Matching answers. Students can work on assignments directly on the platform, and the system will automatically grade their answers. Liveworksheets is often used in distance learning or blended learning to create more engaging and interactive exercises. Thus, this research takes the title Teaching Strategy: Adaptive Mathematics Learning with Liveworksheets Platform.

B. METHODS

The method used in this research is the design thinking method. According to Pitarto, Y. I., & Setiyawati, (2023) it is a method or approach for solving problems creatively and practically with a focus on the user. It helps understand the needs, challenges, and expectations of users, and creates solutions that fit the context and constraints. Design thinking also involves an interactive process, where ideas and prototypes are refined based on user feedback. Pitarto et al. (2023) stated that there are five stages in the process of design thinking, which are Empathize, Define, Ideate, Prototype, and Test. As in the following chart, as shown in Figure 1.

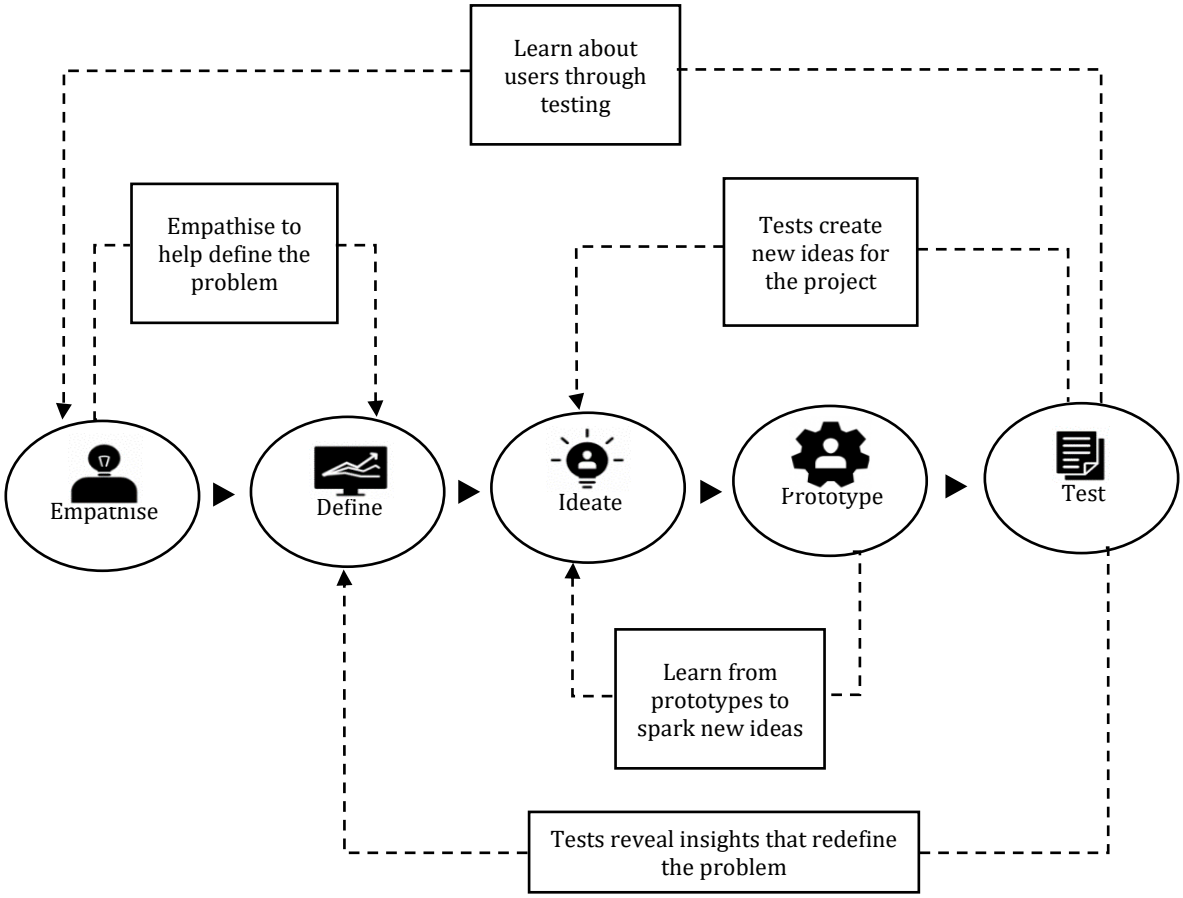

Figure 1. Research Design Stages

The chart above explains that the 4-D stages start from; (1) Empathize: This stage aims to gain an empathetic understanding of the problem to be solved by observing, interacting with, and empathizing with users to understand their experiences and motivations. To carry out this

empathy stage, an interview can be conducted with one of the teaching practitioners, namely a mathematics education lecturer who taught the ICT application course in mathematics learning in the previous class, with the background that the lecturer has expertise in operating various digital-based platforms or applications to support interactive learningTo conduct this empathize phase, interviews with several teaching practitioners can be carried out, (2) Define: This stage aims to analyze and synthesize the information collected during the empathize phase, identifying the core issues faced by users in a user-centered manner. In this stage, the findings from the interviews are defined using an existing business model canvas, (3) Ideate: This stage aims to generate a range of ideas and solutions for the defined problem, thinking broadly and creatively. This stage is characterized by business model canvas to be and services blueprint, (4) Prototype: This stage aims to create a prototype or a simple model of the chosen solution. The prototype can be a sketch or a simulation that can be tested and evaluated by educators, and (5) Test: This stage aims to test and evaluate the prototype that has been created, obtaining feedback from educators on the effectiveness, feasibility, and acceptance of the proposed solution. It also involves revising and refining the prototype based on this feedback. This stage is marked by interviews with prospective educators, evaluation of solution design using test instruments for students and non-tests for practitioners. The test consists of 9 questions according to the types of questions on the liveworksheet, including Short Answer type, Multiple Choice, Checkbox, Dropdown Menu, join with Arrows, Drag and Drop, Audio Recording, Listening Exercises, and Speaking Exercises. While for the non-test instrument as an evaluation in the form of an open questionnaire according to 6 indicators to see the validity of the liveworkseet application used, namely the attractiveness of the design and appearance, the ease of users in understanding the material and operating the student worksheets, the accuracy of the presentation of the material, the suitability of the teaching material, the sequence of the teaching material, and the accuracy of the language used, and Design constraint assessment using validation results and polls are analyzed using real-time techniques with Apache Spark, meaning that data collected from validation and polls is analyzed instantly (immediately), without having to wait for the entire process to complete. For example, when students fill out a poll, the results are immediately visible and analyzed at that very moment. Additionally, Apache Spark, a highly efficient big data computing platform, is used to process and analyze large volumes of data, including real-time data. Spark can process data quickly, even from multiple sources simultaneously, making it ideal for real-time analysis.

C. RESULT AND DISCUSSION

1. Empathize

The first stage is the analysis stage. In this stage, the researchers analyze the needs within the course of digitalization of mathematics learning. This course is conducted both online and offline at IKIP Siliwangi. Based on the researchers' findings, several issues were identified during online classes: some students engaged in activities unrelated to learning, students showed a lack of response during Q&A sessions, and after completing a questionnaire, it was indicated that additional teaching materials are necessary to help students better understand the material, learn independently, and be motivated to explore new topics. In accordance with Sihotang, R. E. M., Zulkardi, Aisyah, (2021) in online learning, students also find it difficult to

operate the student worksheet used and require contextual presentation of material content. The teaching materials created are closely related to current technological and informational developments, including Artificial Intelligence, and interviews are also conducted.

At this stage, the designer conducts research to collect user problems, namely by conducting interviews. In conducting the interview process, the designer has compiled several questions addressed to five Elementary School students who are in grades 4-6 as respondents to obtain interview results that are in accordance with expectations. This is done so that the interview results can remain focused on user needs. The questions asked by the designer to users can be seen in Table I.

Table 1. Interview Questions

No.	Question
1	What is your name?
2	What do you think about learning mathematics?
3	Why do you dislike mathematics?
4	How often do you study mathematics?
5	Do you have a phone or laptop?
6	Have you ever used technology-assisted media or teaching aids when studying mathematics?
7	What applications or software have you ever used for learning mathematics?
8	What are your suggestions and criticisms of mathematics in today's digital era?

2. Define

In this stage, the core problems that need to be addressed are identified and defined. This involves filtering the information gathered during the empathy phase to determine the main issues that need to be resolved. This is a crucial part of the Design Thinking process because it helps in identifying and understanding the various components important to educators. Prahmana et al. (2020) stated that for educators or prospective educators to achieve more general results regarding the effects of effective teaching and learning of mathematical modeling, it is essential to focus on cognitive aspects and incorporate key elements into the learning process. At this stage, all information obtained from the empathize stage is collected, analyzed, then synthesized to determine the core problems to be identified. This define stage will be very helpful in solving existing problems, because the problem has been determined. The following core problems obtained are presented in Table 2.

Table 2. Core Problem Analysis Results

Analysis of the effectiveness of mathematics learning	Literature Analysis	Student Characteristics Analysis	Peer Interview	Core problem
Many paradigms state that mathematics is difficult and students try to understand and be able to solve mathematical problems.	The materials related to the design of this student worksheet are liveworksheets. From the analysis that has been done, it is known that liveworksheets are used as website	• Students easily forget the concepts they have learned if they are not involved in the process of building conceptual understanding such as finding steps to solve a problem. The	So far, the mathematics lecture process refers to several textbooks and uses the lecture method. Students rely heavily on the lecturer's explanation in understanding the material. This means	Lack of use of student worksheet to improve student learning independence

Analysis of the effectiveness of mathematics learning	Literature Analysis	Student Characteristics Analysis	Peer Interview	Core problem
	applications to be used as student worksheet.	learning resources used so far have not been able to actively involve students. • Students have difficulty learning independently with limited learning resources. • Students who listen and respond and can solve questions related to the material given by the lecturer are students with high academic abilities.	that students are not yet able to learn independently. Therefore, a practical student worksheetis needed from the lecturer with a certain development method so that it can facilitate students to learn independently. Thus, students do not need too much help from lecturers in lectures.	

3. Ideate

In this stage, the researchers design the product based on the needs analysis of the digitalization of mathematics learning course conducted online. The teaching materials will be developed using liveworksheets. These AI tools will be used to create educational resources related to the digitalization of mathematics learning. This stage involves generating various ideas and potential solutions by developing an student worksheet, teaching materials, and assessments, including quizzes and exercises, using liveworksheets liveworksheets. The design solutions that have been determined by the designer based on user problems have been summarized in the form of a sitemap which can be seen in Figure 2.

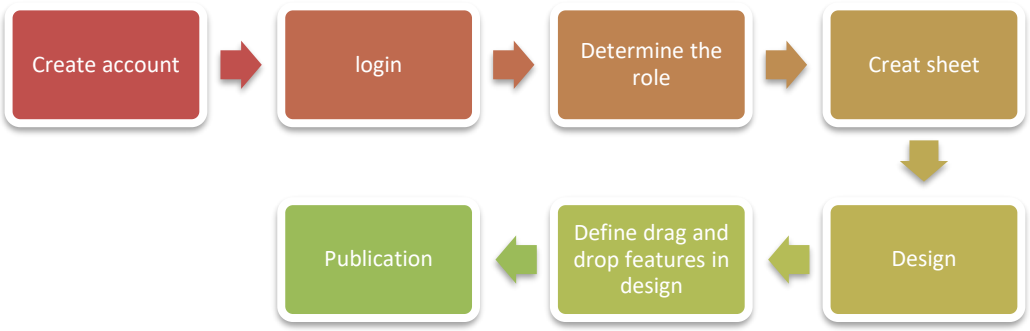

Figure 2. Research Design Stages

4. Prototype

At this stage, the development of AI-based teaching materials will be carried out using applications such as liveworksheet. The liveworksheet application offers independent lessons in mathematics, science, and humanities from kindergarten to college. The following is a view of the liveworksheet interface.

a. Create account

Create an account to start creating a product, the account contains the developer's data and identity as listed in each column. If the account has been created, log in with the account created, as shown in Figure 3.

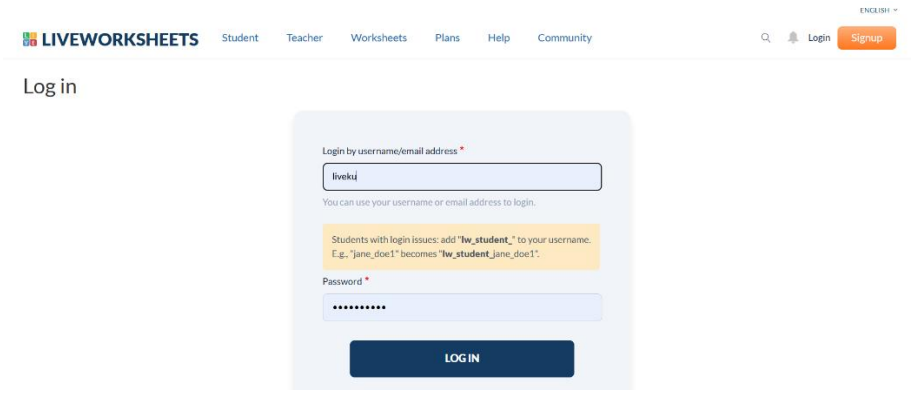

Figure 3. Create account

b. Creat sheet

On the dashboard, select the My Worksheet menu and select Create, then click My Worksheets to determine the page that will be used for product design, as shown in Figure 4.

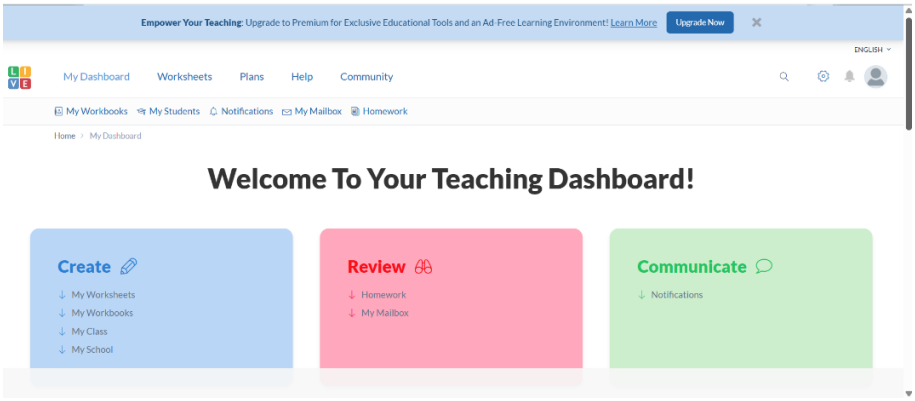

Figure 4. Creat sheet

c. Define drag and drop features in design

Drag and drop to map the available features on the available student worksheet design. There are 17 features that can be selected according to their function, as shown in Figure 5.

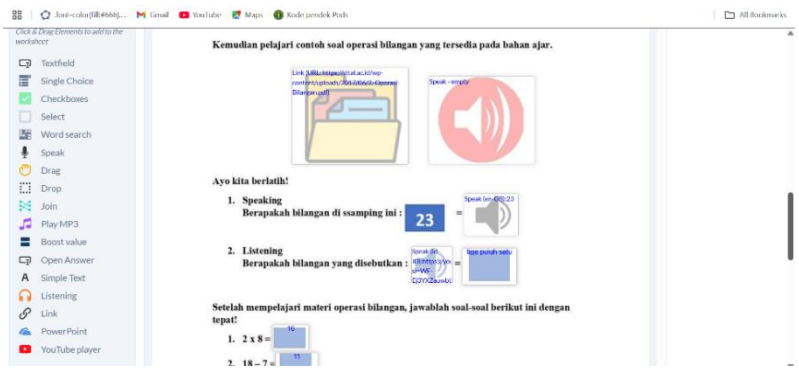

Figure 5. Define drag and drop features in design

d. Publication

After the product in the form of a student worksheet can be arranged properly on the liveworksheet, the next step is that the product that is created can be published to students in the form of a URL or can be further created into a barcode according to needs in order to beautify the appearance, as shown in Figure 6.

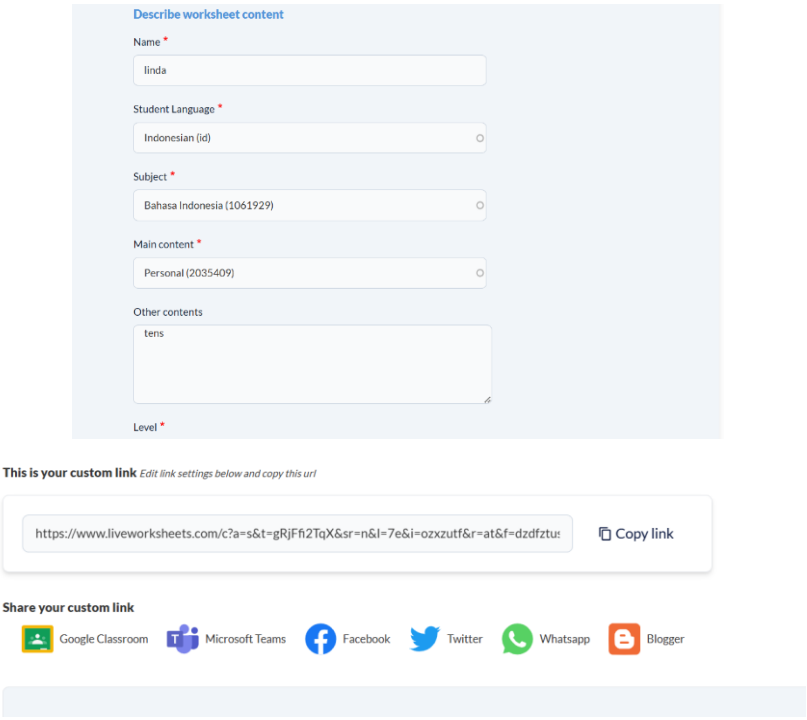

Figure 6. Publication

5. Test

In the Test/Evaluation stage, the prototype was tested with users to gather feedback and refine the design based on that feedback. This application was tested with 32 students from the B1 2022 class of the Mathematics Education program at IKIP Siliwangi. All menus could be thoroughly explored and their functions understood. After the teaching materials were completed, the researchers conducted validation with practitioners and students. To determine the average expert assessment score, the following formula is used:

$$p = \frac{S}{N} \times 100\%$$

With the notation that S is the total score obtained, N is the maximum score possible, and P is the percentage obtained. The assessment results were be converted using the criteria in the following table (Hidayat & Linda, 2023), as shown in Table 3.

Table 3. Assessment Criteria

Score	Criteria
$81 \leq score \leq 100$	Excellent
$61 \leq score \leq 80$	Good
$41 \leq score \leq 60$	Fair
$21 \leq score \leq 40$	Poor
$0 \leq score \leq 20$	Very Poor

The following are the assessment results conducted by teaching practitioners:

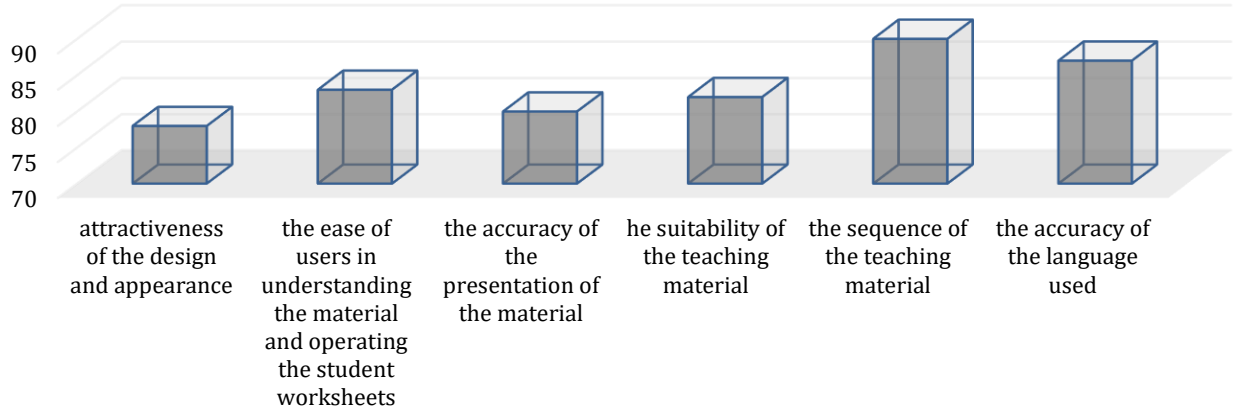

Figure 7. Results of Trials Conducted by Practitioners

Figure 7 the student worksheets with the help of liveworksheets are validated by teaching practitioners to analyze several related indicators such as the attractiveness of the design and appearance with an average of 78%, the ease of users in understanding the material and operating the student worksheets with an average of 83%, the accuracy of the presentation of the material with an average of 80%, the suitability of the teaching material with an average of 82%, the sequence of the teaching material with an average of 90%, and the accuracy of the language used with an average of 87%. This means that the results of the trial state that the indicators of the sequence of teaching materials are greater and better than other indicators, so that they are in the excellent category.

Based on the assessment from practitioners, the AI-based mathematics teaching materials developed received an average rating of *Good*. The practitioners evaluated the materials as follows: Appearance: scored 78, categorized as *Good*, Ease of Use: scored 85, categorized as

Excellent, Presentation of Materials: scored 80, categorized as *Good*, Relevance of Teaching Materials: scored 79, categorized as *Good*, Coherence of Materials: scored 80, categorized as *Good*, Appropriateness of Language Used: scored 82, categorized as *Excellent*, Accuracy of Pronunciation in Audio: scored 78, categorized as *Good*, Appropriateness of Language Choice: scored 79, categorized as *Good*. Based on the suggestions from practitioners, improvements are needed in the choice of display colors, the coherence of materials to be converted into audio, and the selection of language and type of audio used. After receiving feedback from practitioners, revisions were made and then implemented with a student study group. Next, a trial was conducted with the students. This trial showed that the AI-assisted teaching materials could be used effectively, with findings as shown in Table 4.

Table 4. Test Results on Students

Students Group	N	x and %	Test Score	Category
K1	3	x	76,67	Excellent
		%	85,19%	
K2	3	x	76,67	Excellent
		%	85,19%	
K3	3	x	78	Excellent
		%	86,67%	
K4	3	x	67	Good
		%	74,44%	
K5	3	x	60	Good
		%	73,33%	
K6	3	x	70,67	Good
		%	78,52%	
Total average			71,50	Fair
% Total			80,57%	
Category			High	

From the table above, it is revealed that the results of the trial of the student worksheets for students formed from 6 student study groups with each group consisting of 3 students, so that the total is 18 students. After the product was validated, it was tested on students by students filling out the available worksheets and answering the questions on the worksheets. It was found that 3 groups obtained a very good category, 3 groups a good category with a high average. This shows that in the trial, students were able to solve problems and understand the material presented on the student worksheets, the teacher was able to carry out learning activities well, so that students no longer felt any difficulty in working on the mathematical problems presented, with high interpretation of student test results, meaning that worksheets with liveworksheets were effective and suitable for use in learning.

Overall, the interpretation of the use of student worksheets with liveworksheets falls into the Good and high categories, which are characterized by the enthusiasm and activeness of students in using and studying the material presented through the liveworksheets worksheets. This is in line with Rahadiantino et al. (2022) which found that the development of teaching materials using Artificial Intelligence can support the learning process and facilitate interaction between lecturers and students. The application of AI-based learning is expected to produce better educational outcomes.

D. CONCLUSION AND SUGGESTIONS

Based on the development results of AI-based teaching materials, it can be concluded that these materials can be effectively used and utilized in mathematics digitalization courses. The teaching tools, including student worksheet and assessment media, were developed based on the design thinking model. Both practitioners and students rated the AI teaching materials with an average rating of Good, according to indicators such as appearance, ease of use, presentation of materials, relevance of teaching materials, coherence of content, and appropriateness of language used. Based on validation results and assessments from practitioners and students, trial runs with student groups, and subsequent evaluations of the developed teaching materials, the AI-based teaching tools for the digitalization of mathematics learning are deemed suitable for use in lectures. For future research, it is suggested that AI-based teaching materials be developed for other courses by integrating existing AI tools with more varied AI tools such as liveworksheets, tailored to the characteristics and cognitive levels of students.

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