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Development of e-LKM for Elementary School Mathematics Learning as an Open-Ended Problem-Based Teaching Material using MiKIR Approach

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ABSTRACT

The goal of this research is the e-LKM for mathematics learning as a teaching material based on open-ended problems assisted by a valid and practical LIMIT application utilizing the MiKIR approach. In developing this e-LKM, 4D models are used that consists of the define stage, the design stage, the developing stage, and the disseminated stage. Participants in the study were prospective elementary school teacher students at the University of Muhammadiyah Prof. Dr. HAMKA. However, the product will be tested to students of madrasah ibtidaiyah teachers at UIN STS Jambi. The instruments used are validation instruments and practical instruments. The results of the defined stage are the needs of the e-LKM for mathematics learning, including the indicators and goals achieved by students in the e-LKM. The results of the design stage are the design of the mathematics learning e-LKM, where the components in this e-LKM are the e-LKM title, group name column, instructions for use, lecture objectives and achievements, and questions, answer columns, conclusions, and reflections. The results of the development stage are the value of the validation instrument for e-LKM, namely 77.33% in terms of material, 80.00% in terms of language, and 76.92% in terms of media e-LKM is in the correct category. Practicality instruments obtained 83.76%, so e-LKM is in the practical category. The results of the dissemination stage will be in the form of responses from students and lecturers about the practicality of using e-LKM. This study recommends that lecturers or teachers make e-LKM and apply it in the learning process using the LIMIT application. Moreover, further research can develop an e-LKM with an open-ended problem-based MiKIR approach for other materials.

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1. INTRODUCTION

There are so many problems in learning, including in learning mathematics, that it causes learning objectives to be challenging to achieve. (Bobyliev & Vihrova, 2021) found several problems in learning, including errors in strategy selection, choosing learning approaches, availability of teaching materials and learning media, and inappropriate time effectiveness. The problem that is the root cause of the difficulty in achieving learning objectives is an error in choosing an approach or strategy in learning (Simbolon, 2014). The approach will be a reference or guideline for the learning process (Lutvaidah, 2016). Active learning is the process of making students the center of their learning (Peterson, 2001). A learning approach that can help achieve learning objectives is active learning.

Various studies have studied the application of various active learning models, including active learning designs with metacognitive strategies. Active learning collaboration and metacognitive strategies make students actively communicate and interact with peers and improve metacognitive skills in understanding and mastery of mathematical concepts (Abu Bakar & Ismail, 2020). Then active learning research has been carried out using debate strategies. The research results allow students to develop knowledge acquisition skills, think and act strategically, understand the context and speak without preparation (Woods, 2020). Active learning stimulates higher-order cognitive processes such as reasoning, critical thinking, and analysis (Fatmawati et al., 2021). Active learning involves students' activities, stimulates higher order thinking, problem-solving, reasoning, and critical analysis, and provides teachers and students feedback about the learning process. The benefits of active learning are also related to exploring student attitudes, values, and habits and can increase students' motivation to learn and improve their abilities (Gleason et al., 2011). Active learning that is popular and growing in Indonesia is MiKIR.

MiKIR is an active learning approach initiated by the Tanoto Foundation in 2018. The creation of the MiKIR approach aims to put existing approaches into practice so that in learning the teacher has no difficulties in the active learning process (Muhammad F& Rusilowati, 2020). This approach invites students to be able to learn creatively, work in groups and be critical during the learning process (Prastyo E, 2021). MiKIR stands for Experiencing, Interaction, Communication, and Reflection (Prasetyo E, 2019; Rusilowati A, Supriyadi, Pangestu MH, 2022). This MiKIR approach has also been widely studied in various studies, including research on needs analysis of student worksheets based on MiKIR on the theme of always being energy efficient, which describes the level of need for MiKIR-based LKS reaching 85% (suhandi, Pamela, Oktavia, Mubarok, & Amri, 2020). The "MiKIR" learning approach will add variations to learning that are more interesting and fun, involve students, increase student activity and cooperation, and when learning is given worksheets to find out how far students understand the material presented by the teacher.

In learning activities, the presentation of learning materials must be able to motivate students and lead to activities so that students play an active role in the learning process. Realizing active learning requires teaching materials that can activate students. Teaching materials are arranged excitingly and systematically, containing material content, methods, and learning outcomes to achieve the expected competencies to motivate students to study actively and independently (Mardia & Sundara, 2020). One of the teaching materials that can be used is student worksheets, which in the future will be referred to as LKM. LKM is a form of teaching material that can help students understand lecture material. According to (Danial & Sanusi, 2018), LKM is one of the learning media that contains guidelines for investigation or problem-solving activities. Based on this, it can be seen that the LKM has an important function and role

in the learning process, which is in line with the function of the LKM. According to (Prastowo, 2011), the primary function of the LKM is teaching materials that can activate students and assist the role of educators in the learning process. Worksheets as a support in improving students' critical thinking skills and creative thinking abilities (Mardita M, Alim JS, Hermita N, Wijaya TT, 2022). Therefore, the design and content of the LKM must be considered and adapted to the function of its use.

Today the presentation of LKMs continues to grow and can even be developed on an electronic basis or e-LKM. This e-LKM presentation is a problem that must be solved to stimulate students' thinking. Problems in e-LKM can be presented in two forms: open-ended and closed-ended. (Zan, Wu, Guo, & Yu, 2020) suggest that open-ended problems require much cognitive effort compared to closed-ended problems, which provide room for more information. (Nisa. R & Zulyanty, 2021) also stated that non-single methods or solutions could solve open-ended problems, and the solutions found can be varied (non-single solutions). This open-ended problem affects the students' ability to solve daily problems (Bahar & June Maker, 2015) According to (Lin & Lien, 2013), open-ended has the advantage that in solving open-ended problems, students can show more and more complex abilities than solving closed-ended problems.

The fact that was found from the results of initial observations on mathematics learning courses at the PGMI Study Program, Faculty of Tarbiyah, and Teacher Training at UIN STS Jambi, showed that there were weaknesses in students' mathematical abilities. It can be seen in the inability of students to find patterns in solving mathematical problems, so it is not easy to draw conclusions related to mathematical ideas. From the test results, only about 22% of students can solve math problems, and the rest of the students have not been able to solve the problems well. Furthermore, based on further analysis related to learning media in mathematics courses at the PGMI Study Program, Faculty of Tarbiyah, and Teacher Training at UIN STS Jambi, which lecturers had used, it was found that only simple LKMs were used. The LKM is only in the form of sheets that tend to be informative, have simple illustrations, and only contain practice questions. So that students find it challenging to develop their knowledge.

This e-LKM is made using the LIMIT application, namely online Mathematical worksheets. This application is an application designed and created by researchers in this study. The advantage of this application is that mathematical tools can be used to write mathematical formulas in writing questions and answering questions. Of course, this e-LKM will be combined with MiKIR's active approach and questions in e-LKM based on open-ended problems.

Based on these observations, it is appropriate to research the collaboration of the MiKIR approach with open-ended problems in the form of e-LKM in mathematics learning courses assisted by the LIMIT application. This study aims to develop e-LKM for mathematics learning as teaching materials based on open-ended problems with the help of valid and practical LIMIT applications by utilizing the MiKIR approach. To achieve the research objectives, the discussion in this study is divided into two, namely:

(1) How is the development of an e-LKM for mathematics learning as a teaching material based on open-ended problems assisted by the LIMIT application utilizing the MiKIR approach?

(2) How is the e-LKM trial for mathematics learning courses as teaching materials based on open-ended problems assisted by the LIMIT application utilizing the MiKIR approach?

The innovation in this research lies in the e-LKM for learning mathematics which includes components of the MiKIR stages on each question in the form of open-ended problems with the help of the LIMIT application. The findings of this kind of research will also further popularize MiKIR learning and the LIMIT application among educators in the world, especially in Indonesia

2. METHODS

Research Design

This research was conducted using a research and development paradigm. It is because the research results are a product that is expected to be valid and practical. The research and development model used is 4D (four-D models). According to (Thiagarajan, Semmer, I, & Semmel, 1974), 4D models

(four-D models) consist of the following: Define, Design, Develop, and Disseminate. The dissemination stage is carried out on a limited scale, namely other classes or universities, according to the needs of researchers. The university where the dissemination was carried out was Universitas Muhammadiyah Prof. Dr. HAMKA.

Participant

The subjects in this study were student candidates for elementary school teachers at Muhammadiyah University, Prof. Dr. HAMKA. However, before that, the product will be tested first on prospective students of Madrasah Ibtidaiyah teachers at UIN Sulthan Thaha Saifuddin Jambi.

Instrument

The instruments used in this study align with the research objectives, namely to produce valid and practical products. So that the instrument used in general consists of two things: the instrument of validation and the instrument of practicality.

The validation instrument helps determine the validity of the designed e-LKM. The validation sheet contains assessment aspects which include content validity, construct validity, language, and e-LKM display. The practicality instrument is used to collect practicality data from the e-LKM; this instrument consists of a lecturer response questionnaire and a student response questionnaire to obtain lecturer responses and student responses to the practicality of using the developed e-LKM. Lecturers and students filled out this questionnaire after learning using e-LKM open ended.

Procedure

This research and development follow a 4D model, which consists of four steps: define, design, develop, and disseminate, as shown in Figure 1. Define, in the define stage, the researcher establishes, understands, and defines all the requirements for designing the LKM and analyzing the lecture process. at this early stage, discussing with the research team and lecturers who teach mathematics courses in the Madrasah Ibtidaiyah teacher education study program at UIN Sulthan Thaha Saifuddin Jambi and Prof. University. Dr. HAMKA regarding the MiKIR approach in ongoing lectures, questions based on open-ended questions given by lecturers to students, and mathematical applications that lecturers have used in daily lectures.

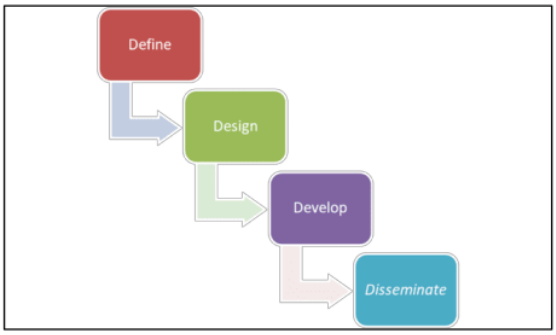


FIGURE 1. 4D model research steps.

At this stage, the researcher prepares an initial design for the e-LKM by choosing the format and production of the first version of the e-LKM based on the results of the discussion and analysis in the define phase.

Develop at the development stage; it will produce an e-LKM product that has been revised based on the results of validators from material, language, and media experts. The step at this stage is validation by experts; experts have given suggestions, then the validation results are used as a guide to making revisions. Then, a limited group trial at UIN Sulthan Thaha Saifuddin Jambi will be carried out after revisions.

At this dissemination stage, the e-LKM will be disseminated to other classes, namely classes at Prof. University. Dr. HAMKA. At this stage, it will produce responses from students and lecturers about the practicality of using e-LKM.

Data Analysis

Data from all instruments were analyzed using descriptive statistics to get the average percentage value. Data analysis techniques consist of validity data analysis and practical data analysis. This data is obtained from the results of filling out the instrument, which is compiled using a Likert scale so that later a score will be obtained for each item. Finally, from the average value of the percentage, conclusions will be drawn for each analysis.

3. FINDINGS AND DISCUSSION

e-LKM Development

The results of the research and development of e-LKM using the open-ended problem-based MiKIR approach used in Mathematics learning are described based on the research and development syntax based on the 4D model. The PGMI study program's curriculum contained in the National Qualifications Framework-based Curriculum (abbreviated as KKN) states that the MI/SD Mathematics learning course is one of the courses that PGMI students must follow as prospective MI/SD teachers. This course should be about materials and concepts basics, mathematics, and integrating mathematics material (content) with its methodology while integrating it with ways of teaching mathematics for the MI/SD level. To fulfill the description of mathematics learning, lecturers must be skilled in practicing active learning in the classroom so that students are familiar with the habituation of the application of active learning. One of the active learning methods that can be applied in the classroom is the MiKIR approach. The MiKIR approach is able to provide learning meaning for students because it connects the knowledge acquired with the environment so that students' reasoning abilities can be improved (Mahmud Alpusari, dkk, 2020). With the MIKiR approach, each student is invited to be directly involved and more active in the teaching and learning process in class to develop their learning potential better (Jeanne Miera Mangangantung, 2021). MiKIR's approach can collaborate with the usual models or strategies in mathematics learning, for example, open-ended. It can be integrated into the form of an open-ended e-LKM based on the MiKIR approach in collaboration with open. Therefore, researchers developed an open-ended e-LKM based on Thinking, which resulted in e-LKM being easily accessible by students and could be used to solve open-ended problems in learning mathematics.

Define

The researcher with a lecturer in mathematics at the Madrasah Ibtidaiyah Teacher Education study program at UIN Sulthan Thaha Saifuddin Jambi and a lecturer in the Elementary School Teacher Education Study Program at the University of Prof. Dr. HAMKA discusses what is needed to design an e-LKM with an open-ended problem-based MiKIR approach as follows: analyzing the material and the objectives of the lecture, in the mathematics learning course consisting of a rhombus, kite, number operations, fractions, number recognition, presentation of data, squares, and rectangles, and units of weight. The needs of the e-LKM for learning mathematics that are discussed are the indicators and objectives students in the e-LKM achieve.

Design

In this design stage, the researcher designed an e-LKM for mathematics learning. The components in this e-LKM are the e-LKM title, group name column, instructions for use, lecture objectives and achievements, questions, answer columns, conclusions, and reflections.

In this study, the use of e-LKM using the LIMIT application. The LIMIT app is an Online Mathematical Liveworksheets app designed by the research team. The LIMIT application can now be accessed online based on a website. The advantages of the application compared to existing worksheets such as Liveworksheets, quiziz, Kahoot, etc. are that LIMIT can be used easily (user friendly), designs can be made according to the author's wishes without being limited, supporting files can be in the form of doc, pdf, and jpg. The application contains mathematical tools that can be used when writing questions and answering questions. The advantages of mathematical tools when answering questions are the central point for researchers to create this application because researchers find it difficult to find applications that contain mathematical tools when answering questions. Most existing applications only have mathematical tools in the section for making questions. This is urgent because researchers create an open-ended problem-based e-LKM that requires students to answer questions by describing the correct answers and various forms of appropriate solutions.

The stages in designing this application are problems that arise when researchers want to use existing worksheets. However, researchers do not find mathematical tools to answer questions because the form of questions presented is in the form of essays. Then the researchers designed an application that contained mathematical tools for writing and answering questions. This application can also upload questions that the author has designed, or the author can write directly on the application. On the first page of this application, there is a username and password column, then log in, and users who have not registered can click on the words "Create an account."

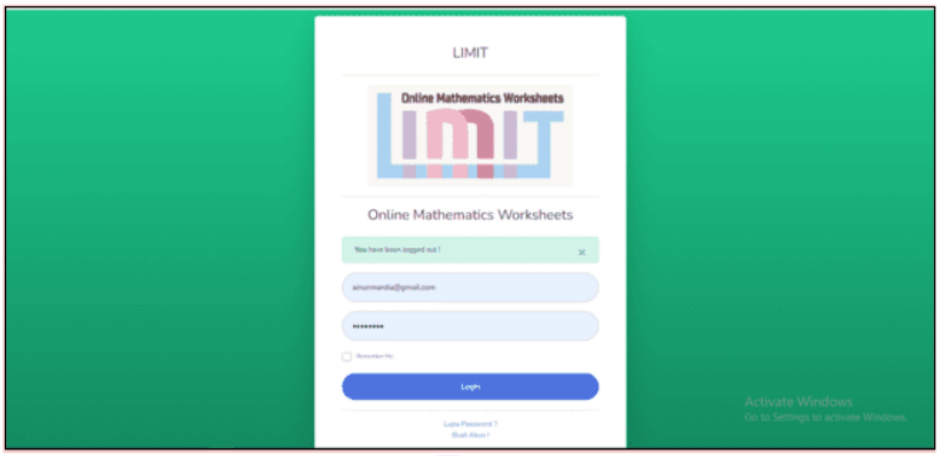


FIGURE 2. *login page view*

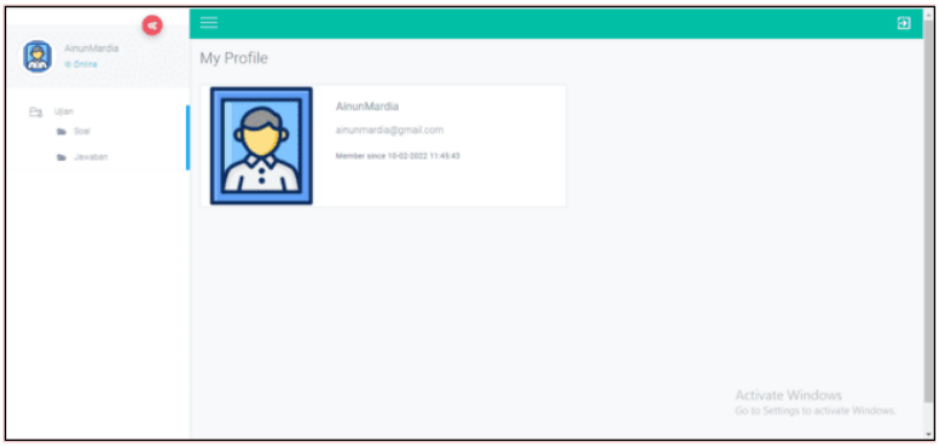


FIGURE 3. *main page view*

On the next page, figure 3, it can be seen that there is a test menu and a question and answer sub-menu, and a user identity on the right side of the page. In the upper right corner are tools to log out of this application.

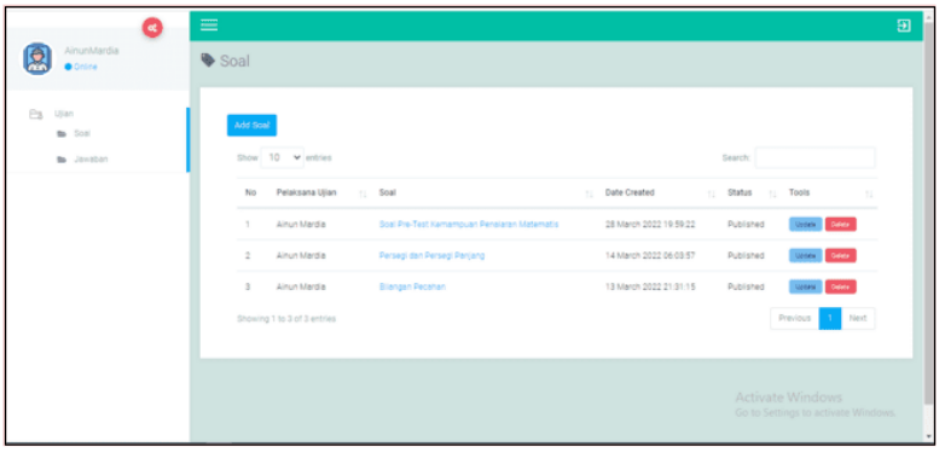


FIGURE 4. *question page view*

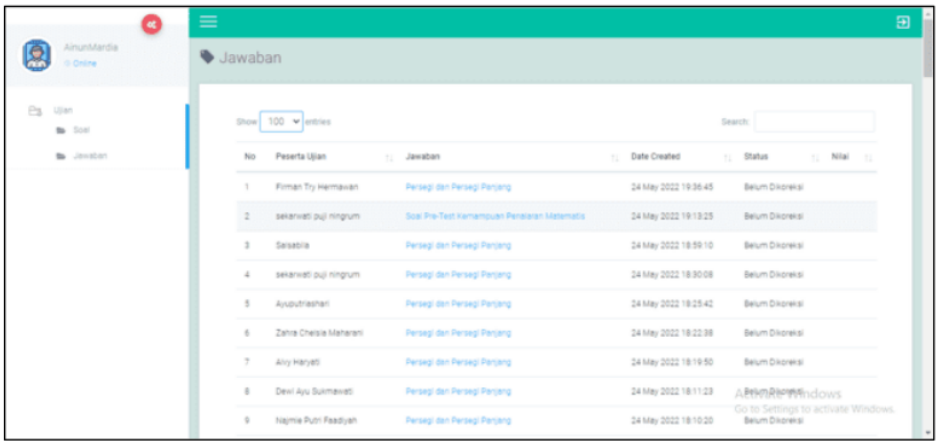


FIGURE 5. *answer page view*

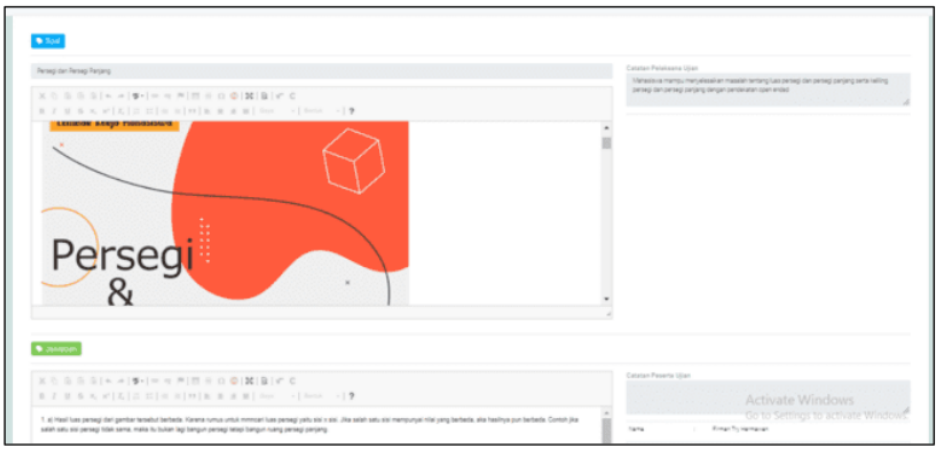


FIGURE 6. *e-LKM and answer view.*

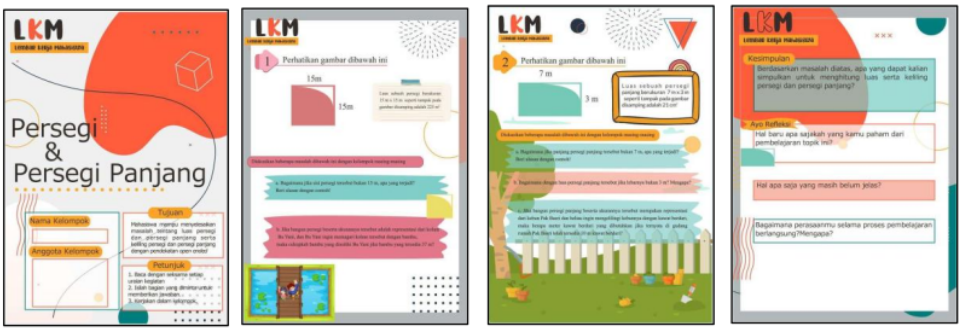


FIGURE 7. *e-LKM with open-ended based MiKIR Approach*

Develop

The stages of e-LKM development are validated and evaluated by three experts to observe the quality of the designed e-LKM and whether it is suitable for use. e-LKM validation and test instruments consist of 3 components that are assessed by the validator, namely the material aspect consisting of several criteria, namely the e-LKM component (identity, topic, and purpose); the suitability of the topic and purpose of the e-LKM; the suitability of the contents of the e-LKM with the topics and needs of students as well as mathematical concepts; the e-LKM work stage provides space to go through the MiKIR phase; presentation of e-LKM and depth of e-LKM content and benefits of e-LKM. The language validation aspect consists of several criteria, namely information, commands, questions, and symbols in e-LKM; the language used in the e-LKM follows the correct Indonesian language rules; the language used in e-LKM is effective and efficient; mathematical symbols in e-LKM using equation math; the language in the e-LKM is easy to understand and does not cause ambiguity and is following the characteristics of students; systematic question construction in e-LKM. The media validation aspect consists of several criteria, namely the appearance of the e-LKM cover; use of e-LKM letters (types and

fonts); e-LKM layout arrangement; e-LKM background; illustrations, pictures, and photos in e-LKM; e-LKM color composition; e-LKM display design; e-LKM usability and e-LKM flexibility; availability of space to write opinions.

TABLE 1. The Results of The Validation by Expert in Material Aspect, Language Aspect, and Media Aspect

Validator	Total Poin	*Persentase*	*Criteria*
Material aspect	58	77,33%	Valid
Language aspect	32	80,00%	Valid
Media aspect	50	76,92%	Valid

From Table 1, it can be concluded that the results of the validation by the experts obtained an average value that was included in the correct category. Therefore, the higher the validity of the teaching materials developed, the better the conclusions, the level of meaning, and the usefulness of the teaching materials, therefore they are suitable for the teaching and learning process (S. Hartini, 2018). The next stage is to test the level of practicality of the e-LKM with the open-ended problem-based MiKIR approach. At this stage, the e-LKM is tested on prospective teacher students of the PGMI UIN Sulthan Thaha Saifuddin Jambi study program. Questionnaires were given to 10 students in the trial class to see the practicality of the developed e-LKM. This questionnaire was filled out by students who had worked on the developed e-LKM. This questionnaire assesses appearance, grammar, writing and pictures, learning steps, materials, questions, and the MiKIR phase.

After the questionnaire was distributed to students, the results of the practicality questionnaire were 83.76% according to the practicality indicators, and the practicality of the open-ended problem-based e-LKM MiKIR approach was declared practical. The practical elements in question are:

- the attractive appearance of the e-LKM,
- the writing and pictures on the e-LKM are clear and attractive, and
- the suitability of the e-LKM at the MiKIR stage.

Practicality leads to student perceptions. Students' perceptions of worksheets are influenced by various things, for example writing, pictures, and colors can affect students' motivation in studying worksheets. In addition, the practice questions in it allow students to gain knowledge and train them to study independently (Sulistyowati, Nur Inayah Syar, 2021).

Discussion/Trial Plan

When this report was written, trials had not yet been conducted. Nevertheless, the preparation is 90% already prepared. Because it is related to the publication deadline given by the party who funded this research, the trial plan will be carried out at the collaborative research university in the PGSD study program at the University of Muhammadiyah Prof. Dr. Hamka in July 2022. Future trials will result in responses from students and lecturers regarding the practicality of using e-LKM as well as the effectiveness of using open ended E MFIs in learning. The temporary hypothesis of MiKIR-integrated open endeed E-LKM is able to improve students' mathematical reasoning abilities. Strengthened by the results of the study found that the MIKiR active learning approach had a positive effect on improving mathematical abilities. This can be seen from the student-centered learning process, and is able to stimulate students to be active in learning. There are aspects of interaction and communication in the MIKiR active learning approach which provide opportunities for students to discuss with friends to

learn and understand the subject matter. Through communication and interaction activities, students are accustomed to learning in an active environment to express opinions and share ideas. Such a learning environment is able to facilitate student thinking, reasoning and communication (Intan Kartika Sari, 2020). In line with the results of research which found that learning with the MiKIR approach will condition and encourage students to reason well and stimulate the emergence of abstract thinking skills and deductive thinking (Pramudya I, Mardiyana, dkk, 2020).

4. CONCLUSION

The open-ended E-LKM was developed using the MiKIR approach with a 4D development model design (four-D models) consisting of defining, designing, developing, and disseminating. The development of this e-LKM resulted in an e-LKM with an open-ended problem-based MiKIR approach as valid and practical teaching material.

In line with the resulting e-LKM, this study recommends that lecturers or teachers make e-LKM and apply it in the learning process using the LIMIT application. Researchers also hope there will be dissemination related to the spread of good practices by utilizing open-ended e-LKM. In addition, because the scope of material in the e-LKM produced in this study is still limited, further research it can be done to develop an e-LKM with an open-ended problem-based MiKIR approach for other materials.

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