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Development of Artificial Intelligence-Based Logic Mind Applications in Improving Computational Thinking Skills

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Abstract

Life in the 21st century demands human resources who have many skills and competencies. Indirectly, human resources who are always creative and innovative in developing technology are also needed. Technological developments occur very rapidly depending on the quality of human resources themselves. If human resources are able to process technological sophistication properly and carefully, technological development can develop rapidly. Likewise, if the quality of human resources is lacking in processing existing technology, then technological development will also be slow. Integrating technology in a targeted and meaningful way is the right foundation of education today. Nowadays amazing technologies based on Artificial Intelligence have emerged. The problems that occur during the learning process when students are given stimulus are problems where students are less active in responding. The results of students in providing solutions are still not precise and coherent. This shows that students' computational thinking skills are still lacking. The ADDIE approach is used to conduct research. Meanwhile, a quantitative descriptive approach will be used to collect and analyze research data using the T-test. The results of the validation of learning media or mobile routing applications give a rating of 80%, meaning that they are considered suitable for use. Based on research conducted on students who took the pretest and posttest, their average score was 71.69 in the pretest and 88.13 in the posttest. Thus, this can indicate that there is a significant impact and variation in the results of the averages achieved.

Keywords: Computational Thinking, Application, Artificial Intelligence, Android, Education.

INTRODUCTION

Life in the 21st Century demands human resources to have many skills and competencies. Indirectly, it also demands to become human resources who are always creative and innovative in developing technology (Mardhiyah et al., 2021). Technological developments occur very rapidly depending on the quality of human resources. If the human resources are able to utilize technological sophistication well, wisely and carefully, then technological development is able to develop rapidly (Faiza & Firda, 2018). Likewise, vice versa, if the quality of human resources is lacking in processing existing technology, technological development is also slow.

Some of the skills that should be possessed include critical thinking, problem-solving, cognitive, and digital literacy (Cynthia & Sihotang, 2023). The skill of always thinking critically in developing creative ideas and innovations to solve every problem, including computational thinking, gets special attention. Because this skill is the main thing that must be applied to basic problem-solving.

Computational thinking requires several development components, including (a) the ability to analyze problems and decipher them into elements or parts (analytical thinking); (b) the ability to plan a series of actions or steps to achieve problem-solving (algorithmic thinking); (c) the ability to monitor and correct errors in the implementation of the plan (debugging, (Buitrago Flórez et al., 2017) and (d) the ability to identify the most relevant aspects of the problem and generalizable algorithms (abstractions), which allow application to other problems what has been studied (Román-González et al., 2017).

Integrating technology in a directional and meaningful way is the basis of proper education today. This must be done in order to be able to keep up with technological developments that occur so that education is able to compete in accordance with the latest conditions. The call to use AI as a means to improve student skills in the 21st century is already happening in research (Asunda et al., 2023). In the study, it is argued that schools need to provide opportunities to facilitate the development of AI competencies. This is supported by research (Su & Yang, 2023), which ensures that to keep up with changes in the field of education, educational institutions can take advantage of the latest technological advances. Without realizing it, in everyday life AI has done its job and interacted with humans, for example, when searching on the internet and getting recommendations from search results that you want to search for or some videos recommended by YouTube (Celik et al., 2022). The advantages of AI are the ability to change the way people live and work in a more positive direction.

Currently, extraordinary technologies based on Artificial Intelligence have emerged, one of which was developed by OpenAI, namely ChatGPT. This technology is able to be in the spotlight for providing solutions with common generative models (Klimova et al., 2023). In particular, this technology is capable of providing its users with multiple answers to questions asked in a conversation to complete several tasks, such as essays and coding (Lo, 2023). The potential and ability possessed by ChatGPT is to create exercises that are in line with students' proficiency levels, interests, and goals (Baskara, 2023). The sophistication of today's technology is able to give rise to several Artificial Intelligence whose uses are almost the same or similar. The Artificial Intelligence technologies are WriteSonic and Claude. The relationship between Artificial Intelligence and education has important relationships, such as E-Learning, engineering education and computing education that are integrated with each other (Polat et al., 2024).

The problems during the learning process when students are given a stimulus are in the form of students being less active in responding. The results of students in providing solutions

are still not appropriate and lacking. This shows that the computational thinking skills possessed by students are still lacking. This happens because students lack practice to develop critical thinking skills. In addition, the use of technology as a learning medium to support the progress of the teaching and learning process is also still lacking in its use due to the limited time that teachers have in making learning media. This makes the learning process less effective.

Previous research shows that the use of AI-based technologies, including in the development of computational thinking skills, has been shown to be effective in some contexts. However, research on applications specifically designed to develop AI-based logical thinking skills among students is still relatively limited. Research by (Hakim et al., 2024) highlights the potential of AI in education, but does not specifically address the application of AI-based logic in improving computational thinking skills. The research gap of this study lies in the lack of research that focuses on the development of AI-based applications for logical thinking skills in the Indonesian educational context, especially those that integrate between technological and pedagogical aspects in improving computational thinking skills. The novelty of this research is the development of an artificial intelligence-based application specifically designed to improve students' computational thinking skills, with an integrated approach between technology and innovative teaching strategies. This research will not only fill the gap in the literature on the use of AI in education, but also make a practical contribution to the development of technology-based learning media.

Based on the background description above, the purpose of this study is to determine and analyze the development of artificial intelligence-based logic mind applications in improving computational thinking skills. The benefits of this research are to make theoretical and practical contributions in the field of education, especially in the development of innovative learning technologies. Theoretically, this research is expected to add to the literature on the use of artificial intelligence to improve computational thinking skills. This research can also provide new insights into the effectiveness of AI-based applications in the context of education. Practically, the results of this study are expected to be a reference for educational application developers and educators in designing and implementing technology that can strengthen computational thinking skills among students.

METHOD

This study uses an experimental method to achieve certain goals on several variables to be tested. This goal is able to influence the independent variable to the bound variable. This experimental research will be carried out by conducting a scientific examination where one variable will be changed and applied to one dependent variable to see its effect. The influence that occurs is observed and recorded to help researchers reach conclusions between the relationships between variables. The experimental research design consists of time in establishing

cause-and-effect relationships, consistent cause-and-effect behaviors and understanding the importance of cause and effect.

Outlining the steps involved in conducting research, including how to prepare research materials, research design, research processes (such as using pseudocode or algorithms), testing, and gathering results. There is also a theoretical foundation in this section. Pretest and posttest are part of the quasi-experimental research design used. The ADDIE development model is the method used in this study which consists of five steps:

Analyze

The first stage is the process of analyzing the condition of students' computational thinking skills. This analysis process is given by providing a trigger question to find out how active and critical the student is in solving a problem. It turns out that the results of students in solving problems are still not solved properly. This means that students' competence in computational thinking or thinking to solve problems critically and logically is still lacking. This is a fairly serious problem and there must be follow-up action, because thinking computing is the basic foundation in all fields to solve problems. The action that can be taken in solving this problem is to develop learning media. These problems can arise due to the lack of use of technology to train students' thinking skills.

Anonymous

According to ADDIE's research and development model, design activities are a methodical process that begins with the creation of concepts and content for the final product. Three steps make up this design stage. The first involves creating learning materials at the same time as the design production stage. The process of designing an application storyboard consists of parts: practice questions, AI, videos, materials, KI KD, home, and evaluation. The collection of learning media research tools is the second stage of design. Gathering content for the app is the third design step. It includes understanding computational thinking, the basics of computational thinking, practice questions, and assessment. To make it easier for students to understand, take a look at some of the accompanying videos.

Development

In ADDIE's research and development methodology, development refers to the actions taken to bring to life a product design that has been previously developed. A conceptual framework for the implementation of the new product has been created in the early phases. After that, the conceptual framework is transformed into a ready-to-use finished product. This product is in the form of an android application called "Logic Mind". This application is made using GlideApps which offers the facility of creating applications without coding. The Logic Mind application contains materials, audio, video, practice questions and is integrated with Artificial Intelligence. The results of the design that have been made are:

Home

Home view is the initial view seen by the user. This page is the main homepage of the application that displays various information and access to the features provided. The information contained on the home page is a brief introduction to the application and its functions. Contains a video about the importance of having the ability to think computationally.

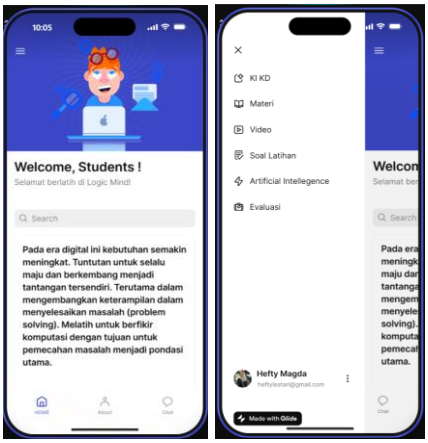

Figure 1. Home Page

In the image above, it can be seen that on the Home menu, there is access in the form of a button on the left side to go to the KI KD page, Material, Video, Practice Questions, Artificial Intelligence, and Evaluation. Below is also the app creator's profile. Finally, there is the written made wiht Glide is a marker that the application was made using GlideApps.

KI KD

On this KID KD page, it displays a list of core competencies with basic competencies that students should master. This menu explains in detail what competencies must be mastered along with their achievement indicators. There are two core competencies, 2 basic competencies and 2 learning objectives.

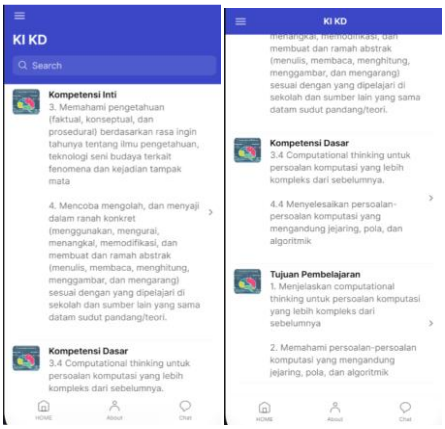

Figure 2. KI KD Page

Based on Figure 2 on the KI KD page of the Logic of the Mind application, there are two core competencies, namely: 4. Trying to process and present in the concrete realm (using, parsing, handling, modifying, and creating) and in the abstract realm (writing, reading, calculating, drawing, and composing) in accordance with what is learned in school and other sources that have the same viewpoint/theory. 5. Understand knowledge (factual, conceptual, and procedural) based on their curiosity about science, technology, art, and culture related to phenomena and visible events.

The two fundamental abilities are: 3.4 Thinking computationally for more complex computational problems and 4.4 Solving computational problems including networks, patterns, and algorithms. There are 2 learning objectives that must be achieved, namely explaining that computational thinking is a more complex computational problem than before and understanding computational problems that contain patterns, networks, and algorithms.

Material

On the material page, learning materials that are arranged based on basic competencies will be displayed. Material on the meaning of computational thinking, basic concepts of computational thinking, application in everyday life and the advantages of having computational thinking skills. In this feature, it is explained in full and uses language that is easy for students to understand. The following is a display of material features like Figure 3 below.

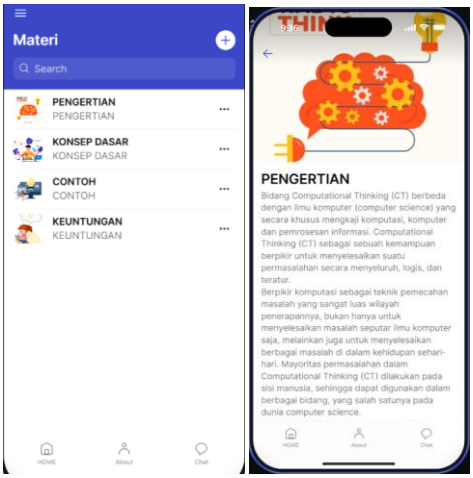

Figure 3. Material Page

Video

On the video page provide several videos related to the material. With this video video, it will make it easier for students to understand the material. By seeing moving and vocal visuals, students are more interesting and understand them more easily. The content of the videos includes the introduction to computational thinking, the definition of computational thinking, the basic concepts of computational thinking, the application of computational thinking to examples of questions to train computational thinking improvement. Students will not be bored and interested in learning more. The video page display is as shown in figure 4 below.

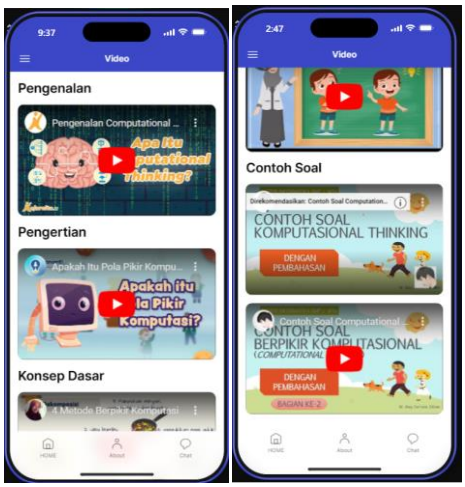

Figure 4. Video Page

Practice questions

This practice question page contains questions that are used to train students' computational thinking skills so that they are used to solving problems critically, concisely and logically. These questions will test how high the level of students' computational thinking skills is. It is hoped that by continuing to train with various kinds of problems, students will be able to solve by thinking computationally. Because solving by thinking computing has many advantages, including problems can be solved faster, more effectively and efficiently. The display of the practice page can be seen from figure 5 below.

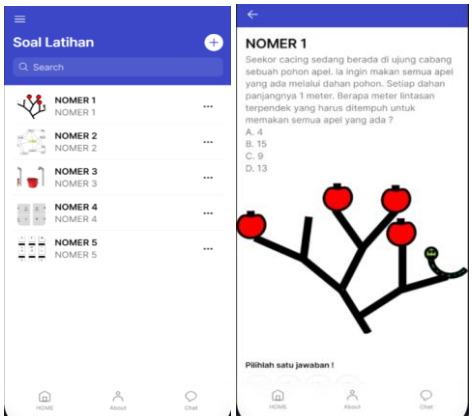

Figure 5. Practice Questions Page

Artificial Intelligence

This Artificial Intellegene page is a solution for students in solving the problems they face. This is a mainstay feature for students in practicing solving problems critically, logically and logically. By using AI features consisting of ChatGPT, WriteSonic and Claude. With the latest technology, it can be used as a medium for student learning. The following is the view of the Artificial Intelligence page as shown in figure 6 below.

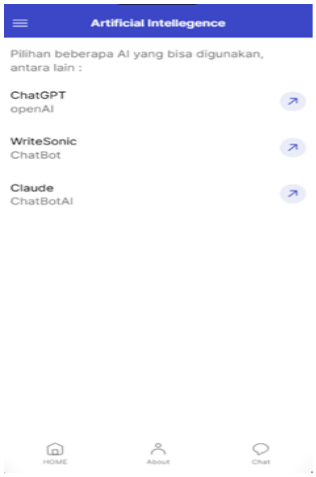

Figure 6. Artificial Intelligence Page

Evaluation

The Evaluation Page is the last page on the Logic Mind Application that provides various questions as evaluation materials. This evaluation material is to find out how students feel in using the Logic Mind Application. The page view can be seen in figure 7 below.

Figure 7. Evaluation Page

Implementation

At the implementation stage, there are two steps that must be completed. The first step is called black box testing. The lower and upper limits of data are the basis of the black box testing methodology (Cholifah et al., 2018). This experimental phase of "black box" testing focuses on the functionality or functional requirements of the software (Vikasari, 2018). This stage does not discuss the internal aspects of the application, such as coding, program code or the programming language used. Input, processing, output, and test results of buttons with additional functions are the main focus in the testing process of this application. Testing the results of the pretest and posttest completed by students is the second stage. In conducting the test, the t-test is used to find out if there is a difference between the pretest and posttest that is carried out.

Evaluation

After the implementation stage, the evaluation stage is the last. All the results of the previous stages will be combined in this stage. Black box testing has yielded results that show that the app's features can operate flawlessly when used, free from errors or obstacles. The mobile routing program may load on Android 7 or Nougat phones up to Android 11, according to the findings of the testing stage. The high specifications of today's smartphones are no longer a barrier. In addition, the app's small size also contributes to its ability to function properly and without difficulty.

The application is tested to students at the evaluation stage, which is the last stage. The purpose of this trial is to ensure how suitable the application is for the educational process. The trial phase of this application involved 32 students of grade VIII Multimedia MTsN 2 Mojokerto. Students are immediately subjected to a trial during the learning process. Based on the findings of the research, it is evident that this application provides significant assistance to students. It is easier for students to understand and solve challenges successfully. The results of the pretest and posttest provide evidence of this. As a result, the program functions well and is suitable for use during the learning process.

RESULTS AND DISCUSSION

The research was conducted at MTsN 2 Mojokerto for grade VIII students specializing in multimedia. This research uses computational thinking material and is carried out on informatics subjects. The five-stage ADDIE approach is the process used to build applications. The phases consisting of several stages are analysis, design, development, implementation, and assessment. Students undergo a pretest and posttest as part of their research stage.

Pretest questions are used to collect observations at the beginning of the learning process. The program that students will use to navigate between mobile devices as they study is being tested in the second stage. Students take a posttest at the end to gauge their level of competence. The normality test is used to analyze the data because each stage has its own achievements. To ascertain whether the numbers are regularly distributed or not, a normality test is used. The next stage is to conduct a t-test, namely the Paired Sample T-Test which is carried out to find out the extent of student competency development. The following are the results of student competencies:

Normality Test

The normality test is a test that is carried out with the aim of finding out whether the results of the available value data are normally distributed or not (Sukestiyarno & Agoestanto, 2017). This testing process was carried out using IBM SPSS Statistic 26 which obtained the following results.

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Table 1. Normality Test Results

Tests of Normality						
	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PRETEST	.135	32	.145	.953	32	.177
POSTEST	.175	32	0.14	.926	32	.030

a. Lilliefors Significance Correction

The results of the normality test of the data obtained can be shown in table 1. The data obtained were tested and considered to be normally distributed if the significance value was greater than the value of a (0.05), in accordance with the criteria of the Lilliefors Shapiro-Wilk test. A significance level of 0.05 indicates that the tested data is not normally distributed. The pretest results obtained were 0.117 and the posttest value obtained was 0.030 in accordance with the results of the research that had been carried out. Based on these findings, the value data is distributed regularly because the sig > a (0.05).

Uji T-Test

When comparing the average of a group observed at two separate times, or when comparing the average of two groups of individuals or corresponding cases, a paired sample t-test may be helpful. The t-test is known as a repeated-size t-test if the same group is re-examined using the appropriate size (Ross et al., 2017). After conducting a normality test passed, then the T-Sample test.

Table 2. Paired Sample Statistical Results

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRETEST	71.69	32	12.630	2.233
	POSTTEST	88.13	32	4.125	.729

Figure 2 shows that the average student gets a score of 71.69 in the pretest, but 88.13 in the posttest after using the application. The results showed an increase in posttest scores. This shows that after utilizing the mind reasoning application, students' competence has improved. Paired Sample T-Test is a parametric test that can be used in this kind of research to test the average variation between two paired samples or related to using two paired data sets (Agus, 2015).

Certain criteria or decision-making processes apply to this exam, such as: The existence of influence and change can be shown by looking at the significance value (2-tailed) < 0.05, which is the value of the significant difference between the variables at the beginning and the end. inserted after treatment. This can indicate that there is a significant change in the treatment applied to

each variable, if the significance value (2-tailed) > 0.05, it indicates that there is no significant difference from the variable at the beginning and at the end after the treatment. This may indicate that not all variables are significantly affected by the given treatment.

The paired t-test findings obtained by comparing the pretest and posttest results are shown in Figure 9. The computed sig (2-tailed) value of 0.000 obtained the result that there was a considerable influence and difference between the variables at the beginning and the end. The treatment provided through the Logic Mind program has a significant impact. Meanwhile, the difference between the mean pretest and posttest yields a mean value of 16.437 in the first column

CONCLUSION

The results of the ongoing research have obtained results with the conclusion that for use in the educational process, the results of the application validity test show a percentage of 80% with a valid category. Meanwhile, the results of the validity test of the pretest and posttest questions of 73% were declared valid, meaning that it could be carried out. Arikunto claimed that the pretest and posttest questions designed for the Android platform, along with the table of eligibility criteria and the mobile routing application, are suitable for use by students. The average pretest score in the research conducted using the Logic Mind application was 71.69, while the average posttest result was 88.13. These findings show that student competence has increased. The results of the pretest and posttest that have been completed are proof of this. Because the average score of the posttest is more valuable compared to the results of the pretest.a *hypertext link* and *the bookmark section* will be removed. If the paper needs to refer to an email address or URL in an article, the full address or URL should be typed in plain font.

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