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Android-assisted LKPD development with a STEM approach to improve critical thinking skills

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Abstract: Critical thinking is a basic skill needed in the 21st century. This research aims to determine the feasibility, effectiveness, influence and response of Android-assisted LKPD students using a STEM approach to improve students' critical thinking skills. This type of research is R&D with the ADDIE type. This research sample used a purposive sampling technique in small-scale and large-scale trials at SMP Negeri 2 Demak. The aspects of critical thinking ability studied are aspects of explaining, analyzing, evaluating, concluding, interpreting, synthesizing, inferring. The research results show that, 1) Android-assisted LKPD with a STEM approach is suitable for use in learning science and optical instrument material; 2) Android-assisted LKPD with a STEM approach is able to improve critical thinking skills with an N-Gain value of 70.82% in the high category; 3) Android-assisted LKPD with a STEM approach has an effect on critical thinking skills with a tcount of 24.484; 4) Student responses to Android-assisted LKPD with a STEM approach obtained a percentage of 85% with the strongly agree category. Based on the results of this research, it can be concluded that Android-assisted LKPD with a STEM approach is suitable for improving critical thinking skills.

Keywords: Critical thinking; Android LKPD; STEM

Introduction

In the 21st century, access to information requires everyone to have the ability to be able to face competition to enter the world of work. Students must have critical thinking skills which are achieved through the learning process (Firdaus, 2020). Data from The Program for International Students Assessment (PISA) 2018, Indonesia got a score of 396 and experienced a decrease from 2015 which got a score of 403 from an average score of 500. This data shows that Indonesia's score on the PISA questions is below average and includes lower level. PISA questions emphasize students' skills and competencies acquired at school and can be used in everyday life. 21st century skills include 4C, namely creativity, critical thinking, collaboration and communication.

LKPD has an important role in supporting the learning process by helping students master scientific knowledge and develop scientific attitudes (Nugraheny, 2018). In an era of rapid technological development, students tend to be more interested in using smartphones as a means of entertainment and play, so that this has an impact on learning activities. This type of gadget with Android OS is currently popular in Indonesia (Zaini, & Soenarto, 2019). The use of Android-assisted technology in LKPD shows good and feasible results in improving students' critical thinking (Melania et al., 2021). The use of LKPD can also improve the quality of learning, both in terms of the process and learning outcomes (Diani & Sriwijaya, 2019).

SMP Negeri 2 Demak is one of the schools that integrates technology in its learning. Based on observations with science subject teachers at SMP

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Negeri 2 Demak, students have difficulty understanding learning material because learning is still conventional and teachers have not used media that is integrated with technology. Apart from that, students' LKPD still uses print media which is less interactive. Apart from that, the LKPD used is still conventional and students feel bored when working on the LKPD. Students at SMP Negeri 2 Demak find it difficult to understand the Optical Equipment material, which according to them is an abstract concept and has lots of formulas.

Schools that implement a STEM approach can support the development of 21st century skills (Stehle & Peters-Burton, 2019). The STEM approach combined with Student Worksheets (LKPD) will give students the opportunity to carry out activities to identify problems that are in accordance with what is given, then from this identification they will try to focus their attention on solving problems in the form of making a product (Hasanah et al., 2021). The STEM approach has been proven to be able to improve various problem-solving abilities such as critical thinking, creative thinking, conceptual understanding, and learning motivation (Afifah & Ellianawati, 2019). Special learning designs in STEM integrated learning can lead students to be more motivated in relating science concepts to the real world (Struyf et al., 2019).

The development of telecommunications technology in the 4.0 revolution era is very fast. Various technologies and scientific supporting applications are developing in various fields, including education. The need for innovative LKPD is based on technological developments in the 21st century learning process by creating various innovative LKPD according to learning needs and objectives, including ICT-assisted LKPD (Azhar et al., 2020).

The development of innovative LKPD is very important to meet the demands of 21st century learning (Suryaningsih et al., 2021). In the current condition, LKPD in paper form is considered less effective and impractical, so LKPD also requires innovation, namely interactive technology-assisted LKPD. One of the online assisted applications that contains interactive LKPD is Android assisted. Almost everyone has a cellphone but they don't use it properly, so Android-assisted learning can make it easier for students to understand the learning material. Apart from that, students can open and study the application anywhere and at any time without having to carry books.

Several studies show that STEM LKPD can improve 21st century skills, namely critical and creative thinking (Silvia & Simatupang, 2020; Sulistiyowati et al., 2018). Learning with a STEM approach is effective in improving the medium category. This increase is supported by 21st century skills in student creativity (Siswanto, 2018). Implementation of the STEM approach can improve problem solving abilities (Dewi et al., 2018). From the problems and literature studies that have been described, researchers developed STEM LKPD assisted by Android to improve 21st century skills, namely the ability to think critically. The research aims to determine the feasibility of Android-assisted LKPD with a STEM approach, determine the effectiveness of Android-assisted LKPD with a STEM approach, determine the effect of Android-assisted LKPD with a STEM approach and determine student responses when Android-assisted LKPD with a STEM approach is applied. The benefits of Android-assisted LKPD with a STEM approach for students are to improve students' critical thinking to be more active in learning science by using digital-based technology in their learning. Apart from that, the benefits for teachers and schools can improve the quality of science learning in schools by focusing on developing critical thinking.

Method

Research Design and Procedures

The research method used is the Research and Development (R&D) type ADDIE (Analysis, Design, Development, Implementation, Evaluation) research method. The design stage of ADDIE model development can be seen in Figure 1.

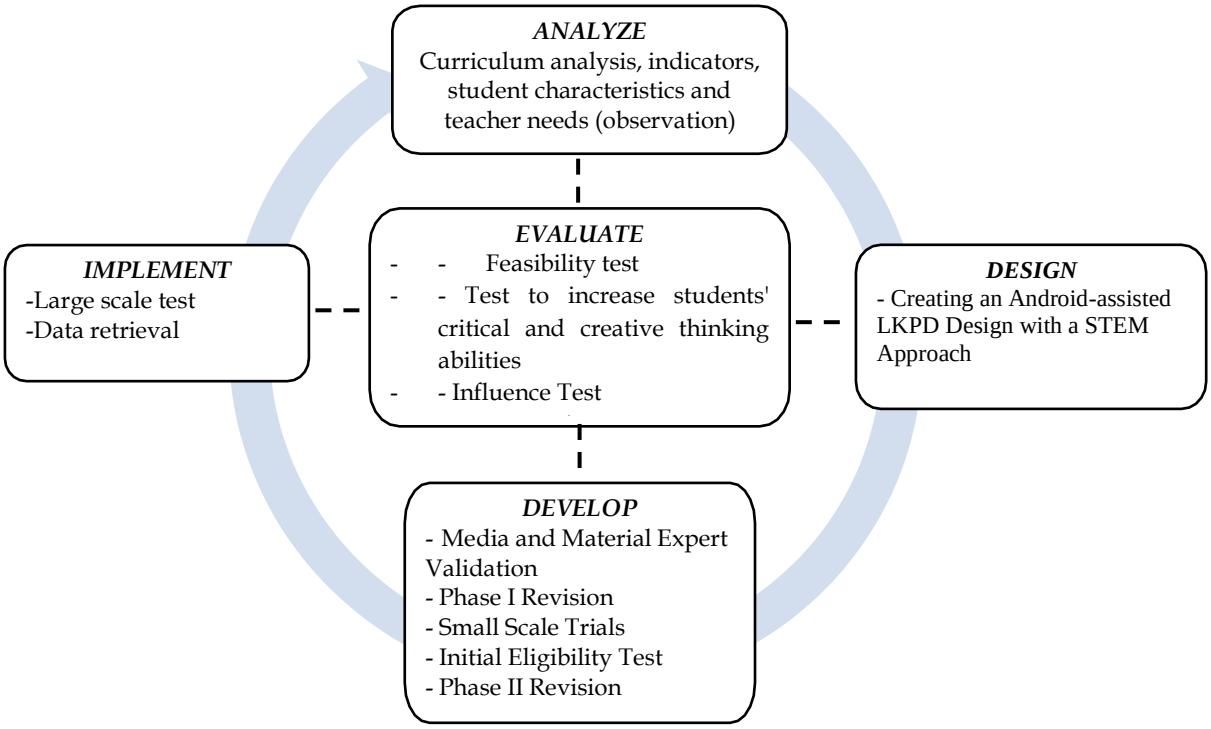

Figure 1. ADDIE Development Model Stages

The research was carried out on 10 May-30 May 2023, Even Semester of the 2022/2023 Academic Year. This research sample took 6 students for the small-scale test and two classes consisting of 40 students for the large-scale test, with a population from all class VIII using purposive sampling techniques.

The procedure in this research is to test feasibility through validation of material experts and media experts by one lecturer and three teachers using the LKPD validation questionnaire instrument for experts. After being validated by experts, the LKPD was tested on a small scale using a random sample of 6 students. Small-scale trials are used to determine the feasibility of LKPD to be implemented in schools on a mass scale. LKPD that has been tested is revised if there are still deficiencies. If it is suitable for use, the LKPD can be applied to large-scale tests.

In the large-scale test, students are given an initial test (pretest) which is used to determine their critical thinking skills before implementing the Android-assisted LKPD with a STEM approach. Next, Android-assisted LKPD was implemented using a STEM approach. After that, a final test (posttest) is given with the same questions as the initial test to determine the increase in students' critical thinking abilities. The indicators used as a reference in this research to develop critical thinking tests can be seen in Table 1.

Table 1. Critical Thinking Indicators

Skills Aspect	Sub Indicators
Analysis	- -Identify ideas, arguments and information.
Explain	- Put forward ideas, arguments and information.
Evaluation	- Evaluate the weaknesses/strengths of ideas, arguments and information.
Interpretation	- Interpret the meaning of ideas, arguments or information into another form.
Synthesis	- Connect information and arguments and use various information to form an opinion.
Conclude	- Conclude the relevance of the argument/opinion/information provided to the concept.
Inference	- Make guesses based on information.

Data analysis technique

The data analysis technique for this research includes instrument analysis of reasoned multiple choice questions to test critical thinking skills with test validity, reliability, level of difficulty and distinguishing power. Test the normality of pretest and posttest scores. LKPD feasibility test by Experts with V-Aiken. The N-Gain test was carried out to determine the increase in students' critical thinking abilities. The Paired Sample t-test was carried out to determine the effect of LKPD on critical thinking skills. A questionnaire test was carried out to determine students' responses to Android-assisted LKPD with a STEM approach.

Calculations to determine product suitability are obtained from assessments given by several experts (expert judgment) which are then processed using the V-Aikens formula. The scores obtained are then analyzed using formula 1. The feasibility of LKPD is categorized in Table 2.

$$V = \frac{\Sigma s}{[n\,(c-1)]} \quad (1)$$

Note:
s = r – lo
n = number of validators
c = highest rating number
lo = lowest assessment number
r = the number given by the appraiser

Table 1. LKPD Eligibility Percentage Category

Percentage (%)	Criteria
V < 0.4	Not Worth It
0.4 ≤ V ≤ 0.8	Worthy
V ≥ 0.8	Very Worth It

Calculations for increasing critical thinking use pretest and posttest which are analyzed using N-gain calculations, with the following calculations and criteria.

$$< g >= \frac{< S_f > - < S_i >}{100 - < S_i >} \quad (2)$$

Note:
<g> : factor N-gain
$<S_f>$: mean critical thinking pretest score
$<S_i>$: mean critical thinking posttest score

The calculation of the N-gain analysis results is categorized into several N-gain criteria in Table 3.

Table 3. Criteria for Improving Critical Thinking

Percentage	Criteria
g ≥ 0.7	High
0.7 > g ≥ 0.3	Medium
g < 0.3	Low

Paired sample t-test is used to determine the effect of LKPD by comparing the tcount value with ttable. The formula for calculating the significance of the t-test in terms of learning completion, according to Sugiyono (2013), is as follows:

$$t = \frac{x - \mu_0}{\frac{s}{\sqrt{n}}} \quad (3)$$

Note:
x : Average pretest and posttest scores
μ_0 : Minimum completeness value
s : Standard deviation
n : The number of students

The data used in this analysis is pretest as initial data and posttest as final data. The Paired Sample t-test was carried out using IBM SPSS Statistics 22. The hypothesis used in this test is:
a. Ho: There is no significant difference before and after treatment
b. Ha: There is a significant difference before and after treatment.

Calculation of student response questionnaires to LKPD assisted by Android using a STEM approach. The formula is as follows:

$$N_p\,\% = \frac{n}{N} x 100\% \quad (4)$$

Note:
Np : percentage of score obtained
n : total score obtained
N : maximum score

The calculation of the N-gain analysis results is categorized into several criteria in Table 4.

Table 4. Interpretation of Np Values

Percentage (%)	Classification
$0 \leq Np < 25$	Strongly Disagree
$25 \leq Np < 50$	Don't agree
$50 \leq Np < 75$	Agree
$75 \leq Np \leq 100$	Strongly agree

Result and Discussion

This research is research and development of Android-assisted LKPD with a STEM (Science, Technology, Engineering, Mathematics) approach which was developed through 5 stages of ADDIE (Analyze, Define, Development, Implementation, AMD Evaluation). This research aims to determine the feasibility, effectiveness, influence and response of

students to Android-assisted LKPD with a STEM approach to improve students' critical thinking skills.

The Analyze stage is carried out to determine the needs of teachers and students as well as the obstacles faced during the learning process in class. Apart from that, the research also aims to understand the curriculum and indicators used in the school. Information regarding the curriculum and indicators was obtained through an interview process that had been carried out, LKPD assisted by Android with a STEM Approach at SMP Negeri 2 Demak using the 2013 Curriculum. The material developed was Optical Instruments in class VIII with learning indicators in the form of: 1) Explaining optical instruments, 2) Analyzing the working principles of optical instruments, image formation and magnification in optical instruments, 3) Identifying angles on periscopes, 4) Identifying magnification on loupes, 5) Identifying the length and magnification of binoculars, 6) Identifying image formation on cameras. Learning activities are designed according to indicators and applied to the development of student worksheets (LKPD) which lead students to improve students' critical thinking skills and creativity.

The design stage is in the form of an Android-assisted LKPD development plan with a STEM approach which is prepared according to learning indicators, student worksheets that are integrated into STEM in accordance with the curriculum and can be accessed online. This worksheet is called an Android-assisted STEM LKPD by integrating a STEM approach. This application can help teachers change paper worksheets into interactive online worksheets. The development of this digitally assisted worksheet uses the Ispring Suite 10 development application. This LKPD is equipped with projects with a STEM approach, videos and quizzes. This quiz consists of indicators of students' critical thinking and creativity.

The development stage consists of developing LKPD by testing the suitability of 4 material and media expert validators with 1 expert validator from the lecturer and 3 validators from the teacher. Based on the material feasibility test, all validators stated that the Android-assisted LKPD with the STEM Approach obtained a V-Aiken value of 0.82 in the feasible category. There are several improvements suggested, namely: 1) adding videos of optical phenomena for student stimulus, 2) adding dimensions to the design for making periscopes, 3) adding units to the formula. Based on the media feasibility test, all validators stated that the Android-assisted LKPD with the STEM Approach obtained a V-Aiken score of 0.9 with very feasible criteria. There are several revisions to the validator, namely: 1) adding video tutorials for each experiment, 2) adding button instructions to direct students, 3) changing the navigation buttons to simple ones. The Android-assisted LKPD with a STEM approach was then improved according to the validator's suggestions and then tested on a small scale. After the LKPD was validated and stated that it was very suitable for use, then a trial of questions with indicators of critical thinking and creativity was carried out in class IX as many as 20 students. Test questions are used to determine the validity of the instrument.

A small-scale trial was carried out using a random sample of 6 students from class VIII of SMP Negeri 2 Demak, with the consideration that the students had received optical instrument material. Small-scale trial students provide suggestions and considerations in improving the media. Based on the research results in Table 4.6 regarding student responses to small-scale tests, it shows that the Android-assisted LKPD with the STEM Approach received a response from students of "Strongly Agree". The Android-assisted LKPD was then tested in classes with more respondents or on a large-scale test. The large-scale test was carried out in class VIII with 40 students as respondents.

In the implementation stage, the Android-assisted LKPD was implemented in class VIII of SMP Negeri 2 Demak with a random sample of 40 students from a population of 310 students. Android-assisted LKPD with a STEM approach was tested directly in four meetings using the Project Based Learning learning model by the teacher. Each learning activity is carried out in groups. The introductory learning process in the LKPD is viewing videos of optical phenomena in everyday life and learning material about optical instruments. The theme of the first activity is a simple periscope for students to understand the periscope optical equipment on submarines. The theme of the second activity is simple loupe for students to learn about loupe optical devices. The third activity theme is binoculars for students to learn about several binoculars they encounter in everyday life. The theme of the fourth activity is camera obscura for students to see the nature of shadows on the camera. Next, students are asked to open the learning application that has been installed on each student's cellphone, then students are grouped for each practical activity. Students can analyze the results of practical activities in the analysis column that is presented in the application on the cellphone. Apart from that, students provide conclusions about the practical activities that have been carried out. Then, students answer the quiz questions that are available in the application. The quiz includes questions that correspond to aspects of critical thinking indicators.

Android-assisted LKPD Feasibility Test with a STEM approach using an instrument sheet in the form of a scale. The feasibility test scale in this research was

carried out by four validators, namely, one lecturer and three science teachers as material experts and media experts. A recapitulation of validation results is presented in Table 5.

In the revision stage, the Android-assisted LKPD is revised according to the suggestions given by the validators. Revisions to the validation of materials and media proposed by the validators can be shown in Figures 2 to Figure 7.

Table 5. Recapitulation of Android-assisted LKPD Material Validation Results

Aspect	Aiken's V Value	Information
Didactic Aspect	0.88	Very Worth It
Construction Aspects	0.83	Very Worth It
Technical Aspects	0.79	Worthy
Quality Aspects	0.81	Very Worth It
STEM aspects	0.83	Very Worth It
Final Average	0.84	Very Worth It

Figure 2. Video Revision

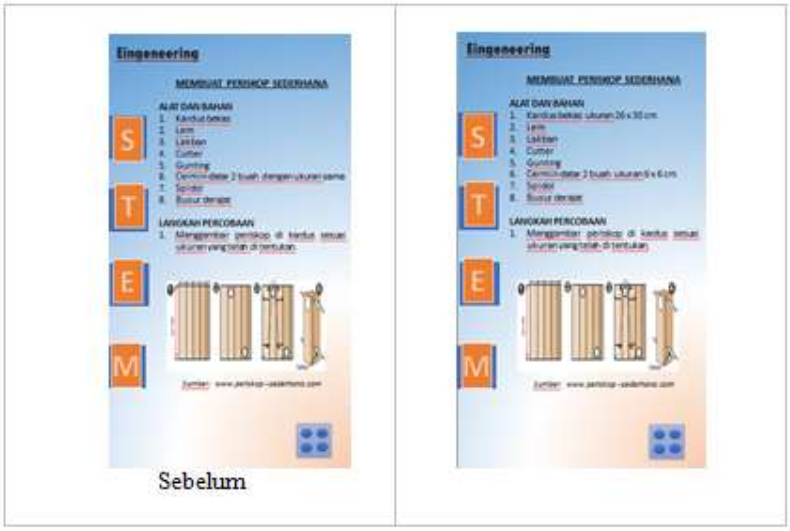

Figure 3. Revisi Konten Periskop

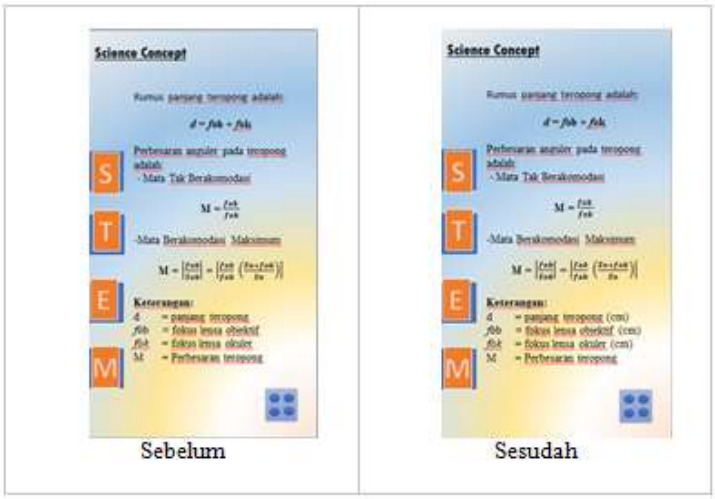

Figure 4. Revise the addition of units to the formula

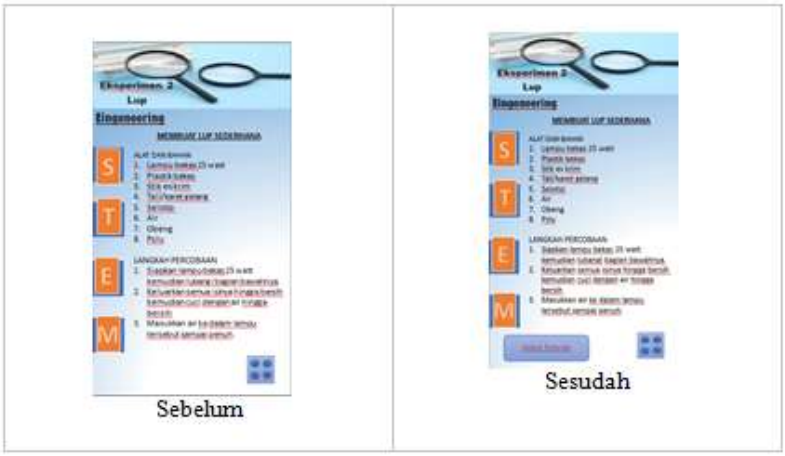

Figure 5. Revise the Video Tutorial for Each Experiment

Figure 6. Revised Changes to Instructions

Figure 7. Revised Navigation Buttons

Based on the recapitulation of the final results of material validation shown in Table 5, it was found that the average V-Aiken score for material validation was 0.84 with very decent score criteria. The recapitulation results show that the Android-assisted LKPD with the STEM approach is materially very suitable for use. The conclusions obtained from the validation sheet showed that 50% suggested that the LKPD could be used without revisions, and 50% suggested that the LKPD should be used with minor revisions. A recapitulation of media validation results for LKPD is presented in Table 6.

Table 6. Recapitulation of Media Validation Results

Aspect	Value V Aiken	Information
LKPD display	0.88	Very Worth It
LKPD letters and writing	0.81	Very Worth It
Presentation of LKPD material	0.75	Very Worth It
Benefits of LKPD	0.92	Very Worth It
Final Average	0.83	Very Worth It

Based on the recapitulation of the final media validation results shown in Table 6, it was found that the average V-Aiken score in media validation was 0.83 with very decent score criteria. The recapitulation results show that the Android-assisted LKPD with the STEM media approach is very suitable for use. The conclusions obtained from the validation sheet showed that 50% suggested that the LKPD could be used without revisions, and 50% suggested that the LKPD should be used with minor revisions. This is in line with research into the development of STEM-assisted LKPD which is in the feasible category and can be used in learning (Faradiba, 2019; Sari & Herlina, 2021; Meishanti & Lutfiyah, 2021).

In large-scale trial classes, before the lesson they are given pretest questions and after the lesson they are given posttest questions. The question instruments tested have been tested and declared valid and reliable. Table 7 shows the results of the pretest and posttest scores in the large-scale test class for critical thinking ability aspects.

Table 7. Student Pretest-Posttest results data

Information	Pretest	Posttest
The number of students	40	40
Average Value	50.63	85.96
Lowest Value	36	79
The highest score	68	93

Based on data from Table 7, the average critical thinking ability before implementing Android-assisted LKPD with the STEM approach was 50.63 and after applying the STEM learning approach, the average critical thinking ability of students increased by 85.96. These results indicate an increase in students' critical thinking abilities after implementing learning using Android-assisted LKPD with a STEM approach.

Increased critical thinking skills after implementing Android-assisted LKPD in a large-scale trial with a sample of 40 students using the N-gain test). The N-Gain test is calculated using the Microsoft Excel 2010 program. The increase in critical thinking skills is shown in Table 8.

Table 8. General Critical Thinking N-Gain Test

Average value *Pretest*	Average value *Posttest*	N-Gain (%)	Interpretation
50.63	85.96	0,71	High

Table 8 shows that the mean value of critical thinking skills in the large-scale trial class increased significantly. The N-Gain value of the large-scale trial

class is in the N-gain range > 0.7. Based on this table, the increase in students' critical thinking skills is in the high category according to Hake's (1999) interpretation. The increase in students' critical thinking skills in each aspect is shown in Table 9.

Table 9. N-Gain Test for Each Aspect of Critical Thinking

Aspects of Critical Thinking	Mean value *Pretest*	Mean value *Posttest*	N-Gain (%)	Categories
Explain	47.81	90.31	81.43	High
Analysis	46.25	88.13	77.92	High
Evaluation	53.44	83.13	63.77	Currently
Interpretation	54.38	83.13	63.02	Currently
Synthesis	46.56	87.50	76.61	High
Conclude	51.25	82.19	63.47	Currently
Inference	54.69	87.19	71.73	High

Table 9 shows that the N-gain value for the aspects of explaining, analyzing, synthesizing and evaluating obtained an N-Gain score of > 0.7, which is in the high category, while the evaluation, interpreting and concluding aspects are in the medium category. The increase in critical thinking aspects shows that Android-assisted LKPD with a STEM approach is able to help students improve every aspect of their critical thinking abilities. This is in accordance with research (Putri, C.D., Pursitasari, I.D., & Rubini, 2020), that increasing students' critical thinking skills through STEM learning has high significance test results. The graph of increasing critical thinking skills in each aspect is shown in Figure 8.

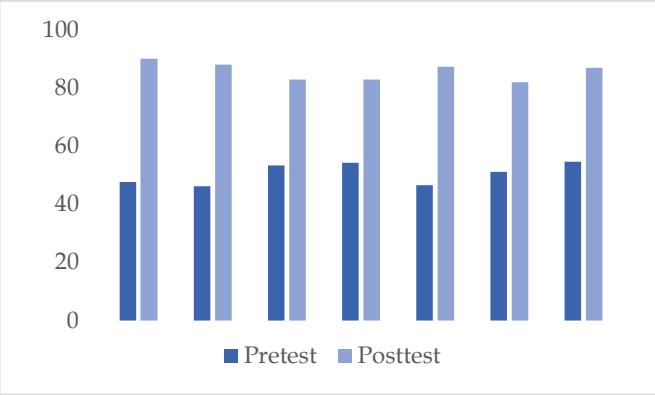

Figure 8. Graph of Improvement in Each Aspect of Critical Thinking

The explaining aspect of the LKPD includes material regarding the position of mirrors on submarines to produce clear objects and explaining the nature of light on the working principles of a simple periscope. The explaining aspect is assessed based on students' skills in expressing opinions using reasoning results that are appropriate to the context of the problem. Research from Benyamin et al. (2021) states that in the explanation aspect a person is able to present in a convincing and coherent way the results of reasoning. In the aspect of explaining that obtaining N-Gain is higher than other aspects. The increase in the average pretest and posttest score was 81.43% in the high category, so that efforts to increase critical thinking skills in the explanation aspect using Android-assisted LKPD with a STEM approach were going well.

The analyzing aspect of LKPD is analyzing the correct position of objects when the eye has maximum accommodation and analyzing the diameter of objects that are far away using binoculars. Based on Table 5, it shows that the research results have increased critical thinking skills in the analytical aspect. This is shown by an increase in the average pretest and posttest scores. The average pretest score was 46.25 then after learning activities using LKPD the average score became 88.13 with high improvement criteria. Research from (Pertiwi, 2018) stated that providing material by identifying concepts can improve critical thinking skills. In this research, learning activities using Android-assisted LKPD with a STEM approach experienced an increase, supported by pretest and posttest scores with an increase of 77.92%.

The evaluation aspects contained in the LKPD include material on the advantages of the loupe optical device when the eye is not accommodating and expressing opinions on the formation of images on the optical device. In this research, the evaluation aspect is the student's ability to evaluate and express the weaknesses or strengths of what has been studied. Starting from identifying information, students are asked to evaluate several optical tools. This is in accordance with research (Benyamin et al., 2021) which states that accuracy determines the resolution of a problem. Learning activities using Android-assisted LKPD with a STEM approach can improve evaluation aspects. This is shown by the average pretest and posttest scores which have increased by 63.77% in the medium category.

The interpretation aspect in this research is assessed based on students' ability to interpret the meaning and explain the reasons for a concept. In Android-assisted LKPD with a STEM approach, students are asked to interpret the meaning of the optical instruments of a camera, loupe and microscope. Improving the interpretation aspect using Android-assisted LKPD with the STEM approach in this research is able to improve critical thinking skills. This is shown

by the results of the pretest and posttest which obtained an N-Gain value of 63.02% in the medium category.

The synthesis aspect is that students are asked to make an argument for the direction of the camera when used to photograph very distant objects and determine the angular magnification of the loupe. Research from (Purwana & Saputra, 2019) states that students who are unable to carry out analysis, synthesis and evaluation have critical thinking skills that are not well developed. Increasing the synthesis aspect using Android-assisted LKPD with the STEM approach in this research is able to improve critical thinking skills. This is shown by the results of the pretest and posttest which obtained an N-Gain value of 76.61% in the high category.

The concluding aspect means that students are able to draw conclusions regarding the effect of binocular magnification and optical instrument experimental activities. The concluding aspect of this research is based on students' skills in giving conclusions according to the relevance of the opinions given in relation to the material. Improving the concluding aspect using Android-assisted LKPD with the STEM approach in this research is able to improve critical thinking skills. This is shown from the results of the pretest and posttest which obtained an N-Gain value of 63.47% in the medium category.

The inference aspect is that students are asked to determine the location of objects on the loop and draw conclusions in an experiment. The inference aspect in this research is assessed based on students' ability to make conclusions or predictions based on patterns contained in the concept. Increasing the inference aspect using Android-assisted LKPD with the STEM approach in this research is able to improve critical thinking skills. This is shown by the results of the pretest and posttest which obtained an N-Gain value of 71.73% in the high category

The Paired Sample T-test in this research was used to find out whether the implemented Android-assisted LKPD had an effect on critical thinking skills. The t-test is used to test differences in the means of one group that has the same subjects but is given treatment. The initial data used in both classes is the pretest and the final data is the posttest. Paired Sample t-test using the IBM SPSS Statistics 22 program. The influence of Android-assisted LKPD with the STEM Approach on students' critical thinking abilities is generally shown in Table 10.

Table 10. Critical Thinking Ability t-test values

Data	Note	Gain Equal Variances Assumed
t-test for Equality of Means	T	24,484
	Df	39
	Sig (2-tailed)	0,000

If tcount ≤ ttable then Ho is accepted and the two classes have no difference. Table 10 shows that the tcount for 5% significance is 24.484, while the ttable with a sample size of 40 and a significance level of 5% is 1.684. Based on the data it is known that tcount > ttable. So Ho is rejected and there is an influence of providing Android-assisted LKPD with a STEM approach on students' critical thinking abilities. When viewed from the significance of the data (sig. 2-tailed), Ho is accepted if the significance is > 0.05. The significance in the table is 0.000 < 0.05. So, Ho is still rejected and there is an influence of providing Android-assisted LKPD with a STEM approach on students' critical thinking abilities. The influence of LKPD on improving critical thinking skills is also supported by the STEM-integrated content contained in it. This is in line with research by Fithri et al. (2021), stated that the implementation of STEM-assisted LKPD had an effect on students' critical thinking abilities with a significance of 0.000 < 0.5. Research carried out by (Hasanah et al., 2021) shows that the results of the independent sample t-test obtained Sig 0.000 < 0.05, so Ha is accepted, so it is concluded that there is a difference in students' KBK between the experimental class and the control class on environmental pollution material in class X at SMAN Bireuen.

Student responses to Android-assisted LKPD with a STEM approach after testing the questionnaire analysis that had been filled out by students. Student responses were taken after small scale and large scale trials, for the small scale with six students and the large scale with 40 students can be seen in Table 11.

Table 11. Analysis of Student Responses to LKPD assisted by Android

Class	Percentage (%)	Criteria
Small Scale Trials	84.24	Strongly agree
Large Scale Trials	74.8	Strongly agree

Table 11 shows students' responses to LKPD assisted by Android with a STEM approach in small-scale and large-scale trials. Based on student response data in the small-scale trial, it was obtained at 84.24 with the criteria of strongly agree, while in the large-scale trial it was obtained at 74.8 with the criteria for strongly agree. Based on this data, students are interested in learning using Android-assisted LKPD with a STEM approach because it can raise their motivation to learn science.

The learning process using Android-assisted LKPD with a STEM approach is more effective and active in improving students' critical thinking skills. Integrated

STEM education has the potential to increase student motivation and interest (Thibaut et al., 2018). Students are guided to find their own answers to the material taught. Students are guided to observe, see, try, organize and communicate videos of phenomena that occur in everyday life (Science as a process). The next stage, students are given pictures presented on the LKPD containing the application of physics in everyday life which is related to the material to be presented (Technology as the application of science).

At this stage students begin to develop their critical thinking skills by identifying possible answers obtained and determining the steps used to solve them.

Figure 9. Submarines as a Technology of Optical Devices

Students are given a broader picture using the development of technology which is engineering engineering design (Engineering as scientific engineering).

Figure 10. Periscope as Engineering of Optical Instruments

In the final stage, students are directed to formulate mathematical equations from the material that has been taught (Mathematics as a tool). Students discover new knowledge at this stage by using the knowledge they have obtained during learning, so that from learning students can solve problems with conclusions. This research was supported by (Edi & Rosnawati, 2021) which states that previously acquired knowledge can be developed to solve conclusions.

Figure 11. Periscope Mirror Observation of Angle Size

Learning using Android-assisted LKPD with a STEM approach in this research can be said to have the advantage of improving students' critical thinking skills. Critical and creative thinking skills have a major contribution to student learning outcomes (Siburian et al., 2019). This can be seen from the tests carried out on the pretest and posttest scores which experienced a significant increase. Science learning with a STEM approach can train 21st century skills, especially students' creative abilities and critical thinking in connecting the four fields of exact science, so that students have a deep understanding and can improve their 21st century skills (Herak & Lamanepa, 2019). On the other hand, in each aspect the level of students' critical thinking abilities is classified as medium and high for each aspect. This is thought to be because students are not yet accustomed to learning using technology and engineering of the material being studied. In the learning process so far, students have only reached the knowledge and mathematics stage, namely by presenting the material contained in the guidebook. STEM education has a positive effect on students' critical thinking abilities (Gandi et al., 2021; Hacioglu & Gulhan, 2021).

Another factor that causes less than optimal critical thinking is the different intrinsic motivation of each student. Students who have high intrinsic motivation will more easily absorb new things and try to solve problems, while students who have low intrinsic motivation will only follow the learning and follow the flow.

Conclusion

The conclusions of this research are 1) Android-assisted LKPD is very suitable to be used to improve critical thinking skills with an average V Aiken of 0.84 on the critical thinking ability indicator. Android-assisted LKPD is effective in improving critical thinking skills with an N-Gain test score of 70.82% in the high category. 2) The Android-assisted LKPD has an effect on improving students' critical thinking skills and creativity with a t-count of 24.484 on the critical thinking ability indicator. Student responses to Android-assisted LKPD with a STEM approach were 85% with the strongly agree category. The suggestion in this research is that Android-assisted LKPD with a STEM approach can help teachers change paper worksheets into interactive online worksheets. Apart from that, this Android-assisted LKPD can be applied to other science material according to student needs. This is in line with the fact that LKPD is quite effective in improving students' critical thinking and has a significant influence on the t-test.

Author Contribution

Syi'r Anantut T menyusun manuskrip, Bambang Subali mereviu draft manuskrip, Suharto L bertugas mereviu tata tulis, Ellianawati bertugas mengalisis hasil penelitian dan Muhammad Mubararak mereviu referensi

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Conflict of Interest

Penulis menyatakan tidak ada konflik kepentingan. Penelitian ini dilakukan untuk meningkatkan kualitas pembelajaran IPA di sekolah dengan fokus pada pengembangan berpikir kritis.

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