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The Development of Science Teaching Materials Based on Android Mobile to Improve Critical Thinking Skills in Junior High School Students

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ABSTRACT

The development of science teaching materials based on android mobile is based on the need for teaching materials that are suitable for 21st-century learning which is synonymous with the use of technology, information, and communication. This research aims to know the validity, practicality, and effectiveness of science teaching materials based on android mobile in improving students' critical thinking skills. The manufacture of teaching materials also aims to improve the low critical thinking skills of junior high school students. The research conducted is development research with the ADDIE development model. The subject of the study was a grade 7A student of SMPN 2 Maesan, Bondowoso. This study used instruments in the form of validation sheets, practicality sheets, and critical thinking skill tests. Data analysis techniques used in research consist of validity test analysis, practicality test analysis, and effectiveness test analysis. The results showed that (1) the percentage of validity of science teaching materials based on android mobile is 92% of the average of three validators, (2) the percentage of the practicality of science teaching materials based on android mobile is 86%, (3) the effectiveness score of science teaching materials based on android mobile 86%, (4) the effectiveness score of science teaching materials based on android mobile is 0.69 obtained from the N-gain test and 75% from the student response questionnaire so that it can be concluded that science teaching materials based on android mobile are valid, practical and effective for improving the critical thinking skills of junior high school students.

Keywords: science teaching materials, critical thinking skills, android mobile

INTRODUCTION

Learning in the 21stcentury is learning that must grow HOTS (high order thinking skills), where the HOTS includes the ability to think critically (creative thinking), critical thinking skills, communication, collaboration, compassion, and computation or commonly referred to as the 6Cs according to (Junaidi & Wulandari, 2020). Critical thinking skills are used in mental activities such as making decisions, solving problems, analyzing assumptions, persuading, and conducting scientific research (Zuniari, 2022). Critical thinking skills and analytical thinking skills are problem-solving skills (Ridlo, 2020). Teachers are expected to be able to present critical thinking skills to students through aspects of critical thinking skills, namely interpretation, analysis, however, in conventional learning, namely the teacher as the center

,it is found that students are less responsive, passive, and tend to be less able to solve problems on their own (Noviani, 2021).

Table 1. Critical Thinking Skill Indicators

Critical Thinking Aspects	Sub Indicators
Interpretation	• Group by group • Making meaning • Clarity of meaning
Analysis	• Testing ideas • Introduction to arguments • Introduction of reasons • Introduction to questions
Evaluation	• Providing value to the quality of the question • Giving value to the quality of an argument made through deductive and inductive considerations • Creating and determining the results of considerations
Inference (Conclusion)	• Stating evidence • Jumping to conclusions
Explanation	• Mentioning results • Supports action • Presenting opinions
Self-Regulation	• Self-monitoring • Self-improvement

The development and improvement of critical thinking skills is a condition that is the focus of school learning. According to Rachmantika (2019), when students develop critical thinking skills can make them as successful learners, because they become individuals who can solve a problem by analyzing and generalizing ideas based on the facts they obtain, to be able to draw a conclusion and be able to solve existing problems systematically through correct arguments so that important critical thinking skills are developed on various subjects, especially science so that students can be critical when solving problems and then be able to make decisions. Teachers must be able to develop the right teaching materials to support learning. When teaching materials are developed, along with the formation of positive student responses, it is also able to improve students' critical thinking skills (Ulandari, 2018).

Problems about the factors causing students' low critical thinking skills can be overcome, one of which is by developing teaching materials in digital format so that they can be accessed easily through students' androids. This is in line with Utama's opinion (2022), namely that use of android-based teaching materials is effective in improving students' critical thinking skills. In addition, the development of android-based mobile teaching materials can overcome shortcomings in printed teaching materials while adjusting to technological developments in the current 21st century (Farhana et al., 2021). The

development of interactive teaching materials based on android mobile is useful in the teaching and learning process to improve students' low reading interest and to produce improvements in critical thinking skills. Teaching materials developed using codular become more effective in the teaching and learning process in the classroom than those not using codular (Pamungkas & Husni, 2020).

Problem of Research

Through observations and interviews with science teachers at SMPN 2 Maesan, it was found that students' critical thinking skills are still relatively low, this is due to the low interest in reading by students. This is in line with Anisa et al opinion (2021) saying that one of the factors of students' skill to think critically in Indonesia is relatively low because of the lack of interest in reading that students have. Students who lack an interest in reading will get little information and knowledge, making the student's critical thinking skill low. According to Ramdani et al (2020), the skill to think critically and master concepts in science learning owned by students is quite low. This is in line with research conducted by Maslakhatunni'mah et al (2019), it was obtained that the critical thinking skill of science students of class VII MTs Al Hidayah Karanggupito, Ngawi is still in the low category, reaching 41.18% on self-regulation indicators, 33.33% on inference indicators, 16.47% on explanatory indicators, 62.75% on analysis indicators, and 50.20% on interpretation indicators.

Research Focus

Based on these various descriptions, researchers intend to develop *android-based* teaching materials on science learning to see the validity, practicality, and effectiveness of *android mobile* in improving the critical thinking skills of these students. Validity is conformity with the provisions that should be assessed from three aspects, namely the validity of the content, the validity of the language, and the validity of the media (Prilianti et al., 2018). Practicality means that the product being developed is easy to use in this study, namely for students (Setiawati et al., 2017). In this aspect of practicality, there are experts or commonly called observers who will assess the practicality of the product. Students with the final result that has been achieved are the effectiveness of a product developed in research (Setiawati et al., 2017). If the student's posttest results are better than the student's pretest results, it is said that the media developed has been effective because it can improve the critical thinking skills of the self-employed.

METHODOLOGY OF RESEARCH

General Background of Research

This research was conducted at SMPN 2 Maesan, Bondowoso, Jawa Timur, Indonesia. The research conducted is development research with the ADDIE development model (*Analyze, Design, Develop, Implement, Evaluate*). In the use of the ADDIE model,

there are 5 pipelines, namely 1) analysis 2) design; 3) development; 4) implementation; and 5) evaluation (Tegeh & Kirna, 2013).

The plots in the ADDIE development model can be more clearly seen in figure 1 below.

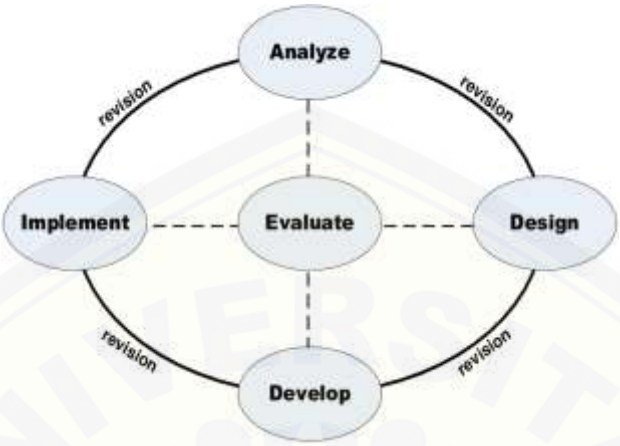

Figure 1. ADDIE development model

Subject of Research

The research subjects in the study conducted by the researcher were 24 students of grade VII A of SMPN 2 Maesan. This determination is because SMPN 2 Maesan is by the criteria of the researcher as a research subject. As for the observer, 3 observers have been determined and there are three experts including material experts and media experts as validators.

Instrument and Procedures

In this study, several research instruments were used, namely validation sheets, practicality sheets, and critical thinking skill tests. The validation sheet used in this study was used to validate the android-based teaching materials that the researchers developed. The practicality sheet aims to measure the practicality of android mobile-based teaching materials that have been developed by researchers and used in the learning process. In this study, researchers applied two tests, namely the pretest, and the posttest. Pretests are given at the beginning before learning and used to understand the initial abilities related to students' critical thinking skills. While the *posttest* is given at the end, after learning to understand the improvement of students' critical thinking skills after learning using the android-based teaching materials. The tests used by researchers are in the form of multiple choice and essays according to the indicators of critical thinking skill used. Researchers use several data collection techniques: observation interviews, questionnaires, and documentation.

Before conducting development research, there is a development procedure which is a stage that must be done first by developers (Rayanto, 2020). In the development of teaching materials, it is necessary to pay attention to how the form or model of development in order to improve the quality of teaching materials in supporting the effectiveness of learning. The teaching material development model is ADDIE development.

The ADDIE development model is one of the systematic models. This model programs the stages of activities gradually to solve learning problems that are following the needs and character of students because of the right learning resources. This model is composed of five steps, namely: (a) analysis, (b) design, (c) development, (d) implementation, and (e) evaluation (Tegeh & Kirna, 2013).

Data Analysis

The data analysis techniques used consist of validity test analysis, practicality test analysis, and effectiveness test analysis. The validity test is used as a test of whether the instrument used is valid. Measurement of students' critical thinking skill is carried out if the instrument has been declared. Assessment instruments and scoring techniques in more detail are found on the validity sheet. The scope of the assessment instrument consists of material aspects, content feasibility, design of android mobile-based science teaching materials, and linguistic aspects. After the assessment is carried out, the validity test is carried out with the formula used as follows:

$$V = \frac{T_{SE}}{T_{SM}} \, x \, 100\%$$

Information:
V: percentage of validity
T_{SE} : total score achieved
T_{SM} : maximum total score

The values of the three validators are then calculated by looking for the average of the values. The average gain of the total values of the three validators will be calculated by the following formula:

$$Va = \frac{V_1+V_2+V_3}{3}$$

Information:
Va : Average total expert validation score
V_1 : Validator value 1
V_2 : Validator value 2
V_3 : Validator value 3

The validity criteria based on the validation results can be seen in table 1 below:

Table 2. Validity Assessment Criteria

Interval	Validity Level
86% - 100%	Highly Valid
71% - 85%	Valid
56% - 70%	Quite Valid
41% - 55%	Less Valid
25% - 40%	Invalid

The practicality of the android-based science teaching materials developed by Android Mobile is measured based on the results of observer assessments. More detailed assessment guidelines and scoring techniques are found on the observation sheet. According to Akbar (2013), to find out the practicality of the product on the observation sheet can be calculated by the formula used as follows:

$$Kp = \frac{number\ of\ scores\ obtained}{maximum\ number\ of\ scores}\ x\ 100\%$$

Information:
Kp: percentage of practicality

The practicality criteria based on observer assessment can be seen in table 3 below:

Table 3. Practicality Assessment Criteria

Interval	Level of Practicality
81% - 100%	Very Practical
61% - 80%	Practical
41% - 60%	Less Practical
33% - 40%	Impractical

In the effectiveness test, there were 2 data used, namely student critical thinking skill test data and student response questionnaire data. The purpose of conducting an effectiveness test is to determine the improvement of students' critical thinking skills. The test techniques used for the effectiveness test are *pretest* and *posttest*, then the scores of the two tests are tested using the *N-gain* test. *N-gain* test to determine the improvement of students' critical thinking skills. The N-gain formula according to Hake (1999) is as follows:

$$(g) = \frac{S_{post} - S_{pre}}{S_{max} - S_{pre}}$$

Information:
(g) : average gain score
S_{post} : average posttest score
S_{pre} : average pretest score
S_{max} : maximum score

The N-gain criteria can be seen in the following table 4 (Hake, 1999):

Table 4. N-gain Criteria

N-gain	Criteria
(<g>) ≥ 0,7	High
0,7 > (<g>) ≥0.3	Moderate
(<g>) < 0.3	Low

Student response questionnaires are used to measure student responses to the use of android-based science teaching materials. Response questionnaires are given to students after learning ends and have completed all tests. All student questionnaire results are accumulated to obtain a percentage of student responses or responses to the use of android-mobile-based science teaching materials. The formula used to calculate the percentage of student responses is:

$$Percentage\ of\ learner\ response\ (P) = \frac{A}{B} x\ 100\%$$

Information:
P = percentage of student response
A= score of the item obtained
B= maximum score

The criteria for student response can be seen in table 5 below:

Table 5. Student Response Criteria

Percentage	Criteria
81,25 < P ≤ 100	Excellent
62,5 < P ≤ 81,25	Good
43,75 < P ≤ 62,5	Not good
25 < P ≤ 43,75	Enough bad

RESULTS AND DISCUSSION

Research by developing codular-based science teaching materials is different research from previous research. Rismayanti et al (2022) has conducted research by developing codular-assisted teaching materials to improve critical thinking skills in mathematics in junior high school, with good results. The research currently carried out is different from previous research, namely the development of teaching materials in the field of science, where in science subjects a clear visualization is needed which is presented in the codular in the form of learning video features so that students can observe natural phenomena clearly. In addition, the codular-assisted science teaching materials developed are also equipped with a menu of exercises and evaluations containing questions with indicators of critical thinking so that students are active and interact with the material in the teaching materials. Teaching materials developed using codular become more effectively used in the teaching and learning process in the classroom than not using codular (Pamungkas & Husni, 2020). The development design used in this study is the ADDIE (*Analyze, Design, Develop, Implement, Evaluate)* development model.

Analyze Stage

In the *following analysis* stage, there are several analyses carried out, namely, student needs analysis, student characteristic analysis, curriculum analysis, and product analysis.

In the analysis of student needs, based on the results of observations and interviews that have been conducted with science teachers in class VII of SMP 2 Maesan, information was obtained that at the time of learning students only get information from educators' explanations directly with material obtained from makeshift teaching materials such as printed books. In addition, printed teaching materials used by educators only contain complete material information without student involvement to find information, so students tend to be less critical in solving problems of daily activities in the learning process.

Design Stage

The next stage that is carried out is the design stage. At the design stage, researchers prepare a learning plan followed by making android-based science teaching materials on substance materials and their changes. At the product creation stage, it begins with creating a design through website editing at *canva.com*. The design is carried out to make teaching materials contain material, learning videos, and practice questions to make students familiar with the material and its changes with indicators of critical thinking skill in it.

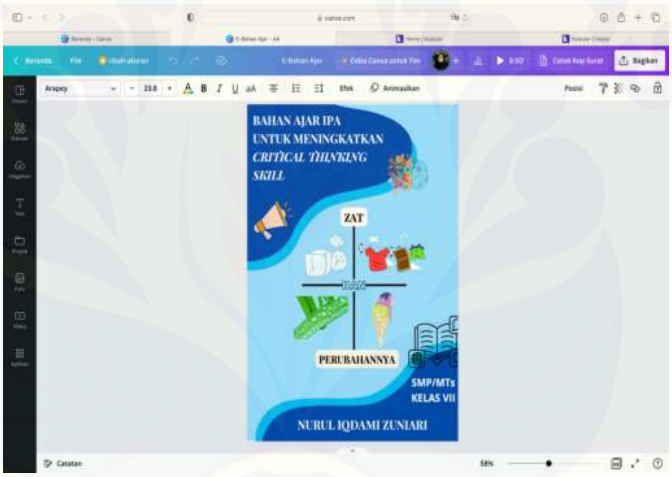

Figure 2. The material plan teaches on *the canva.com*

After designing through *canva.com editing websites*, the design of teaching materials based on critical thinking skills that have been made is imported on a codular *website*.

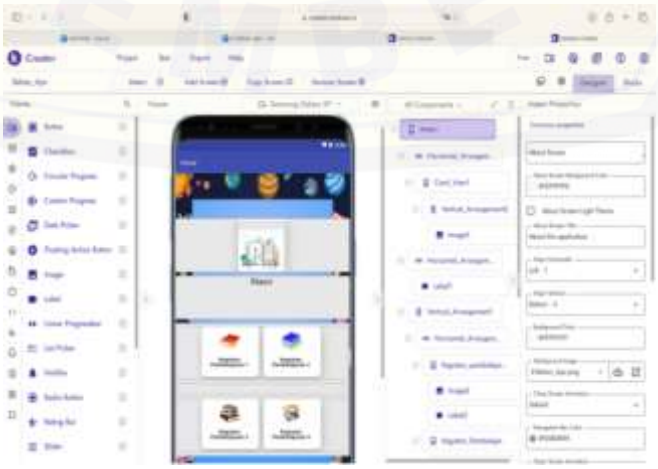

Figure 3. Plan of the material teaching on the codular

Develop Stage

In this development, product validation activities are carried out in the form of teaching materials. In this media validation, there are 3 expert validators

Table 6. Validation Results of android mobile-based science teaching materials

No.	Assessed aspects	Validator 1 (%)	Validator 2 (%)	Validator 3 (%)	Average (%)
1	Validity of contents	95	90	90	92
2	Construct Validity				
	1. Material aspects	91	85	82	86
	2. Aspects of presentation	96	88	88	91
	3. Graphic aspects	96	93	93	94
	4. Language aspects	100	95	95	97
Average percentage					92
Score criteria					Very valid

Based on the results that have been presented in table 6, it was found that the validity of android-mobile-based science teaching materials from the three validators showed an average percentage of 92% with very valid criteria. The validity of teaching materials occurs if there is a percentage with valid categories based on the results of an assessment of several aspects (Widjayanti et al., 2019). The aspects contained in the validation sheet include aspects of assessing the validity of the content and the validity of the construct (Ayona & Hidayah, 2020). The results of the assessment of the three expert validators on each aspect have also achieved very valid criteria with a percentage of the validity of the content of 92%, the material aspect of the validity of the construct at 86%, the presentation aspect of the validity of the construct by 91%, the graphing aspect on the validity of the construct by 94%, and the language aspect on the validity of the construct by 97%, with a total overall average percentage of validation results of 92% with very valid score criteria. This explains that the android-based science teaching materials are worth using with minor revisions.

Implementation Stage

The implementation stage is the stage of conducting trials on science teaching material-based android mobile products that have been declared valid. The subjects in the product development test were grade VII students of SMPN 2 Maesan with a total of 24 students. The results of the development test were obtained from learning implementation data obtained from 3 observers who assessed the learning process which was practicality analysis data.

Figure 4. The learning process uses android mobile-based teaching materials

The practicality data of android mobile-based science teaching materials obtained can be seen in table 7 as follows:

Table 7. Practicality Test Results of Android Mobile-Based Science Teaching Materials

No	Assessment Activities	Meeting (%)									Presented	Category
		1	2	3	4	5	6	7	8	9		
I	Introduction	94	97	100	92	95	95	92	95	80	93	Very practical
II	Core											
	a. Accessing Teaching Materials	75	83	83	75	92	92	83	75	100	84	Very practical
	b. Watch videos	75	83	83	83	92	83	83	83		83	Very practical
	c. Read the material on teaching materials	75	83	92	75	83	92	83	83		83	Very practical
	d. Ask answer	75	75	83	83	92	83	83	83		82	Very practical
	e. Group activities	83	92	83	92	83	83	83	83		85	Very practical
	f. Answer questions	75	83	83	92	83	83	92	92		85	Very practical
	g. Presentation of discussion results	83	83	92	83	83	75	92	92		85	Very practical
	h. Conclusion	75	83	83	83	75	92	83	92		83	Very practical
III	Closing	95	92	86	92	97	92	92	95	92	93	Very practical
	Average Score	81	85	87	85	88	87	87	87	91	86	Very practical

Based on the results that have been described in table 7, it was found that the implementation of learning using android-based science teaching materials mobile displays an average percentage of 86% with very practical criteria at 9 meetings filled by 3 observers. This is in line with the opinion of Al Azka, et al (2019), namely that teaching materials get a practical category if the application of teaching materials and student responses are relatively good. Thus, it can be concluded that codular-assisted interactive materials on substance materials and changes are very practical to use in the learning process because all the activity steps listed in the teaching module have been carried out properly.

Evaluate Stage

In the evaluation stage, after getting the implementation results, it is continued by conducting an evaluation related to the learning outcomes that have been carried out in class. In the test instruments, namely pre-test, and *post-test*, calculations are carried out using *N*-

gain, while in the student response questionnaire, analysis is carried out using certain formulas to find out the score results. The results obtained by researchers from the use of android-based science teaching materials on substance materials and their changes in improving students' critical thinking skills obtained from the test results. The tests used are pre-test and *post-test*, where the results of the two tests are then analyzed regarding the difference in the results of the two. The average critical thinking skill test scores can be seen in figure 5 as follows:

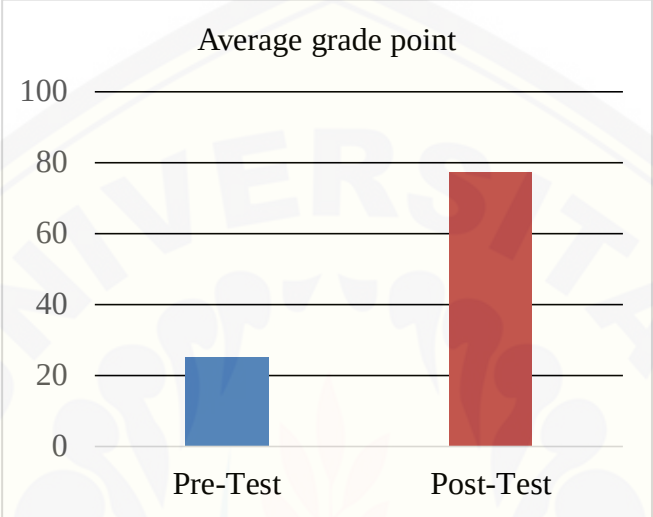

Figure 5. Average Critical Thinking Skill Test Scores

Through the data above, it can be seen that the use of android-mobile-based science teaching materials has increased. The average result of students' pre-test scores before using android-mobile-based science teaching materials is lower than the average *post-test* score of 25.16. The results of the pre-test showed that students' critical thinking skills were relatively low because students were not familiar with the indicators of critical thinking training (Agnafia, 2019). Meanwhile, there was an increase in the average *post-test* results carried out by students after using teaching materials, which was 77.25.

Based on figure 4, it can be concluded that there is an increase in students' critical thinking skills. The calculation of the improvement in students' critical thinking skills after the use of android-mobile-based science teaching materials calculated using *N-gain* can be seen in table 8 as follows:

Table 8. The Effectiveness of Critical Thinking Skills

Data	**Class VII A**		***N-gain*<g>**	**Criteria**
	Pre-Test	***Post-Test***		
Number of students	24	24	0,69	Keep
Lowest value	6	60		
Top rated	40	94		

Through table 8 above, it can be seen that the results of the N-gain score on the test carried out by students are as large as, so it can be concluded that there is an increase in critical thinking skills in students after being given treatment in the form of implementing android-based science teaching materials in the learning process, especially in substance materials and changes. The results of data analysis improved pre-test and post-test results on each student's critical thinking indicators carried out using *N-gain*, it can be seen in table 9 as follows:

Table 9. Results of The Achievement of Each Critical Thinking Skill Indicator

Critical Thinking Skill Indicators	Average pre-test	Average post-test	N-gain	Category
Interpretation	28,12	77,08	0,68	Moderate
Analysis	23,26	83,68	0,78	High
Evaluation	27,08	87,5	0,82	High
Inference	27,08	75,83	0,66	Moderate
Explanation	25	64,58	0,52	Moderate
Self-regulation	18,75	87,5	0,84	High

Based on table 9, the test on critical thinking skill uses 15 multiple-choice questions and 5 *essay* questions that refer to 6 indicators of critical thinking skill. Each indicator of students' critical thinking skill, shows that the explanatory indicator gets the lowest N-gain value of 0.52 and is included in the moderate category. According to Maslakhatunni'mah et al (2019), students are not used to focusing on the meaning of the question so students find it difficult to explain the answer to the question according to the material and use a complete explanation. In addition, doubts students about the answers that have been written proves that the student is weak in the skill to explain (explanatory) (Basri & As'ari, 2017). In addition to the explanatory indicators (explanations), 2 other indicators get a moderate category, namely the interpretation indicator of 0.68 and the inference indicator of 0.66. There is a self-regulation indicator getting the highest N-gain value of 0.84 with a high category. High self-regulation will have an impact on students because it will help students to learn discipline and independently to improve students in critical thinking and problem-solving skills (Budiwiguna et al., 2022). This is in line with Darmiany (2016) that students with high *self-regulation* have curiosity so that students can solve problems. In addition to self-regulation, 2 other indicators get a high category, namely the analysis indicator of 0.78 and the evaluation indicator of 0.82. In line with the opinion of Ningrum et al., (2021) that students must have curiosity by carrying out self-regulation activities or self-control in solving the problems presented.

Table 10. Results of Student Response Questionnaire Analysis

No	Aspects	Percentage	Category
1	Interest	86%	Excellent
2	Motivation	77%	Good
3	Language	63%	Good
Average student response		75%	Good

Judging from table 10, it can be seen that the analysis of student response questionnaires after using android-based science teaching materials from 24 students produced an average percentage of 75% with good criteria. In addition, each of the assessment indicators also achieves goodcriteria. Products that are developed and get a good response from students to show that the product is easy to understand (Rostikawati & Permanasari, 2016). This is following research conducted by Arini & Lovisia (2019) that the positive response on the response questionnaire proves that the teaching materials used can stimulate student interest.

Based on the research that has been done, shows that the development of science teaching materials based on Android mobile can improve students' critical thinking skills considering that students' critical thinking skills are still relatively low. This is in line with research conducted by Maslakhatunni'mah et al (2019), it was found that the critical thinking skill of science students of grade VII MTs Al Hidayah Karanggupito, Ngawi is still in the low category, reaching 41.18% in self-regulation indicators, 33.33% in inference indicators, 16.47% in explanation indicators, 62.75% in analysis indicators, and 50.20% in interpretation indicators. According to PISA data on the scientific literacy of Indonesian students, 60% of students are still below level 2, and 40% of students are classified as level 2 or above. The highest level achieved by students from Indonesia is Level 4 (Schleicher, 2019). In addition, there is also a study conducted by Rismayanti et al (2022) which explains that the results of interviews conducted with teachers stated that students' mathematical critical thinking skills are still low as seen from the way students solve the given questions and the lack of courage of students in expressing opinions or asking questions. One of the low mathematical critical thinking skills of students occurs because of the teacher-centered mathematics learning process, from this research Rasmayanti made a Codular Assisted E-Module on a Smartphone and was able to Improve the Mathematical Critical Thinking Skill of Junior High School Students. Through research that has been conducted, Anisa et al (2021) said that one of the factors in students' skill to think critically in Indonesia is low because of the lack of interest in reading that students have. Students who lack interest in reading will get little information and knowledge, making the student's critical thinking skill low. In addition, there is also a study conducted by Susilawati (2020) with the results showing that 21% of students have critical thinking skills in the medium category, 64% of students in the low category, and 15% of students in the very low category.

CONCLUSIONS

Science teaching materials based on android mobile get an average validity of 92% with a very valid category so science teaching materials based on android mobile can be used as teaching materials in science learning in junior high schools. The practicality of science teaching materials based on android mobile on substance materials and their changes from the three observers reached an average of 86% and were in very high criteria so that science teaching materials based on android mobile were practically used as teaching materials in

science learning in junior high schools. The effectiveness of science teaching materials based on android mobile on substance materials and their changes in the pre-test and post-test obtained an N-gain score of 0.69 with a moderate category, which means that students' thinking skills are quite improved. Meanwhile, in the questionnaire, student responses reached a score of 75% with a good category, so science teaching materials based on android mobile can be used as teaching materials in science learning in junior high schools.

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