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Development of Interactive E-Modules Based on Auditory Intellectually Repetition (AIR) to Improve Students Critical Thinking Skills

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Abstract: This research is a development research that aims to determine the effectiveness of using e-modules as a developed product. Innovation in the form of interactive e-modules based on AIR is essential considering the development of science and technology and the flow of globalization that has an impact on the field of education, as well as the involvement of students in active learning, improving skills and being able to solve problems is essential with increasing critical thinking skills. This study uses the 4D model. Data collection was carried out using observation, questionnaires, and interviews. The research sample was three junior high schools for observation and one school for trials, with 32 students. The results of the validation of the e-module development show that the e-module has met the validation standards of material experts, validation of language experts, and validation of design experts with very good qualifications, and individual user tests of 88% with very good qualifications. Based on the results of learning using interactive e-modules based on AIR, it can be used as a learning resource in schools. Proven by the increase in critical thinking skills of students, especially those that are very much needed as one of the demands of 21st-century skills. Through small group trials, the percentage of effectiveness of increasing critical thinking skills was 83.4% with high qualifications, and in large group trials was 81.9% with high qualifications. Based on these results, it can be concluded that there is an increase in critical thinking skills of students after using interactive e-modules based on AIR as a learning resource.

Keywords: Develompent; E-Module; Interactive; AIR; *Critical thinking skill*

1. INTRODUCTION

The development of digital technology today has indirectly encouraged the use of technology in the world of education to be important to do. The latest technology is used to help expand learning content and improve student learning efficiency. (Lase, 2019; Du Bing et al, 2021). Integration of technology in learning must be done with the hope of encouraging students to learn not only the skills and knowledge needed but also identify sources to learn skills and knowledge simultaneously. The development of technology brings challenges as well as opportunities for the world of education. To answer these challenges, learning is carried out in order to prepare students to have 4C skills including: 1) critical thinking and problem solving, 2) creativity, 3) collaboration, and 4) communication (Wetchasit, et al., 2020; Umamah et al., 2020; Sumardi, et al., 2020). These skills are needed by students to think innovatively, creatively and interactively in learning and daily life as preparation for the future.

Students are asked to be fully involved in the learning process so that they can accept challenges and enjoy an interactive learning environment (Anaelka, 2018). On the other hand, the conventional learning model which makes educators the center of learning activities is no longer relevant to current developments (Giunta, 2017; Permana et al., 2018) ease of access to information via the internet has replaced books and is part of the source of information (Umamah et al., 2016). This raises challenges in the form of changes to specific learning content, such as platforms that are friendly to students or learners (Adedoyin & Soykan, 2020). Interactive relationships and the use of technology are learning processes that build and empower students to increase individual responsibility for information, so that students become more active, motivated, and able to learn knowledge independently. (Rufaidah et al., 2021).

Information received by students through technology applications should be examined first by means of critical thinking. Critical thinking is rational thinking to determine what to believe or what to do (Lorencová et al., 2019; Ocampo JR & R, 2018). Students are required to have critical thinking skills in the learning process and everyday life because they produce interpretations, analyses, evaluations, and conclusions as well as explanations of concepts, methodologies, criteria, evidence and contextual considerations (Facione, 2020; Safitri, et al., 2018). Critical thinking has a positive correlation with academic achievement (Taghva, et al., 2020), especially in the cognitive processes of analyzing, evaluating, and synthesizing. (Cirik, Colak, & Rich, 2016).

Problems related to learning content are very complex, especially in social studies learning. In this case, social studies learning, which is a study of social problems that contain many theories, makes it difficult for students to understand and remember the

material (Udodirim et al., 2020). Educators as learning facilitators are challenged to be able to develop relationships between various theories and methods or learning models, as well as to be able to develop teaching materials and provide good educational practices (Egmir & Ocak, 2020). In general, students are required to have critical thinking skills to process information logically in learning, especially social studies learning (Lorencová et al., 2019). This makes critical thinking skills very urgent to be developed in students regardless of the demands of meeting 21st century skills.

Students have different critical thinking abilities from each other. Likewise, the results of the identification of the questionnaire on the initial critical thinking level of students from the adaptation of Facione (2020). Based on the results of initial observations regarding the critical thinking skills possessed by students in the 3 schools, it is still relatively low, with a percentage size reaching 48.8%. This proves that increasing CTS is very urgent for students to have. Furthermore, to confirm more deeply by examining the phenomena that occur in schools, by conducting performance analysis and needs analysis for both educators and students.

Based on the results of the analysis of educator performance, the problems found in social studies learning in the 3 schools were: (1) 66% of educators experienced obstacles related to materials, (2) 100% of educators had difficulty developing teaching materials, (3) 100% of educators experienced obstacles in delivering materials due to a lack of primary sources, (4) 66% of educators stated that the material in the textbooks did not match the CP, (5) 100% of educators stated that the depth of the material in the textbooks was not deep enough, (6) 100% of learning methods were in the form of lectures, (7) 66% had difficulty choosing certain learning methods and models. The results of the analysis prove that educators have not been able to deliver learning materials optimally because they are constrained by a lack of learning resources and supporting methods or models.

Based on the results of the analysis of student performance, the problems found in social studies learning in the 3 schools were: (1) 62% of students had difficulty remembering social studies learning materials, (2) 75% of students had difficulty understanding the material, (3) 72% of students had difficulty re-explaining the learning materials, (4) 86% of students were not yet able to learn independently with textbooks, (5) 69% of learning methods were in the form of lectures, (6) 58% of learning methods were less enjoyable. The results of the analysis prove that educators have not been able to deliver learning materials optimally because they are constrained by the lack of learning resources and supporting methods or models.

The results of critical thinking skills, performance analysis results and needs analysis that have been carried out can identify gaps related to social studies learning in 3 schools, namely SMPN 1 Tapen, SMPN 1 Wonosari, and SMPN 1 Klabang, which concluded that the teaching materials that exist and are currently used are still focused on Package books and LKS so that interactive and innovative learning facilities are needed, one of which is the need to develop teaching materials that are supported by learning models that support the improvement of students' critical thinking skills. E-modules are considered appropriate based on the results of the needs analysis that have been carried out because they can meet the achievement of 4C Skills, increase interest, motivation, and learning outcomes expected by educators and students. This is in line with efforts to realize the implementation of social studies learning in accordance with the current independent curriculum, one of which is by improving the quality and effectiveness of social studies learning so that it leads to an increase in critical thinking skills so that good student learning outcomes are obtained

This problem-solving solution is supported by the need for teaching materials desired by students to optimize social studies learning, especially in improving critical thinking skills. So the teaching materials will be designed in the form of E-modules based on AIR (Auditory Intellectually Repetition). AIR-based interactive e-modules were chosen for several reasons, namely: (1) The AIR Learning Model is a model that is oriented towards students so that they are active in the learning process (Maureen, 2017; Shoimin, 2018), (2) students have the opportunity to build their own knowledge (Hieggelke et al., 2021), (3) Students can draw conclusions with data analysis and discussion (Shoimin, 2018), (4) Students can collaborate in self-managed teams to understand concepts (Bonatua et al., 2021; Maureen, 2017), (5) Students can reflect on what has been learned and improve student performance (Maloney et al., 2019), (6) develop processing skills such as problem solving and critical thinking skills of students (Maureen, 2017).

Research and development of interactive E-Modules based on AIR has the following objectives: (1) Producing validated and usable products; (2) Producing products to help improve critical thinking skills of students in social studies learning.

2. RESEARCH METHODS

This research is a type of development research using the 4D model. The 4D development model has 4 main stages, including define, design, develop, and disseminate (Thiagarajan, 1974). This development model can be used for various forms of development products such as learning models, learning methods, learning strategies, learning media, learning resources, or teaching materials. This model offers a systematic and structured approach to creating quality teaching materials. The argument for choosing the 4D development model is also based on the specifications of the model, which is effective, suitable, and easier to use to develop teaching materials (E-modules). The subjects of this study consisted of 1 social studies educator and 32 students. The data analysis techniques used were qualitative and quantitative analysis techniques. Qualitative data analysis was obtained

from observations, questionnaires, expert advice, and documentation at school. Quantitative data analysis was used to determine the quality of interactive E-modules based on AIR, which were developed based on expert and user validation, as well as student learning outcomes after using the e-modules as learning resources. The validity test was calculated using the assistance of the IBM V.23 for Windows Statistical Product and Service Solutions (SPSS) software program to determine the results of expert validation and user trials on critical thinking skills before and after using the AIR-based interactive E-module, with the following formula.

$$P = \frac{\sum X}{\sum Xi} \text{ x } 100\%$$

Information :
P : Presentase
∑X : Total score of respondents answers
∑Xi : Total ideal value in 1 item
(Cohen, Manion, & Morrison, 2018)

The results of the questionnaire percentage calculation will be analyzed through product eligibility criteria. The following is table 1 of product eligibility criteria.

Table 1 . product eligibility criteria

Average score	Classification	Conclusion
85%-100%	very good	no need for revision
75%-84%	good	no need for revision
65%-74%	fairly good	revision
55%-64%	not good	revision
0-54%	very poor	revision

Source: Cohen, Manion, & Morrison (2018)

The results of the pre-test and post-test scores of students during the small group trial and large group trial using the interactive e-module design that has been developed will be used to measure the level of effectiveness of critical thinking skills in social studies learning. The critical thinking skill data analysis technique is measured in the critical thinking skill test with the following criteria: (1) Interpretation; (2) Analysis; (3) Evaluation; (4) Inference; (5) Explanation; and (6) Self-Regulation. Determining student scores for each indicator uses an assessment scale with a range of 1 to 5, a value of 1 means very poor, 2 means poor, 3 means sufficient, 4 means good, and 5 means very good. The data obtained is then analyzed using the following formula:

$$S\,A = \frac{\sum SP}{\sum SM} \text{ X } 100$$

Information:
SA = Final score
∑SP = Total scores obtained
∑SM = Maximum of scores obtained
(Kemendikbud, 2014)

The determination of the criteria for assessing critical thinking skills will be analyzed using the criteria contained in the table below.

Table 2 . critical thinking skills assessment criteria

Category range	criteria	Item
≥80	Very high	5
60-70	High	4
40-59	Quite	3
20-39	Low	2
<20	Very low	1

Source: Kemendikbud (2014)

Furthermore, the increase in the percentage of critical thinking skills of students after using E-modules in social studies learning can be calculated using the following formula:

$$\text{Increase formula} = \frac{Y1 - Y}{Y} \text{ x } 100\%$$

Information:
Y1 = Nilai post-test

Y = Nilai pre-test
(College, 2014)

The improvement of students' Critical Thinking can be known if the indicators are met. In this case, the developer conducted a Pre-test and Post-test to students. The average (mean) Pre-test and Post-test scores of students after applying the interactive E-module based on Auditory, Intellectualy, Repetition (AIR) are used to determine the level of students' critical thinking skills.

3. RESULT AND DISCUSSION

Result

A. Validity Trial Results

a) Material expert validation

Data analysis contains a description of the assessment results carried out by expert validators in the field of study on AIR-based e-modules. The results of the analysis are used to determine the level of feasibility of the content of the AIR-based e-module product material that is being developed. The results obtained from the presentation of expert validation data are as follows.

$$P = \frac{54}{55} \times 100\% = 98{,}1\%$$

Based on the results of expert assessment of AIR-based e-modules, a percentage of 98.1% was obtained. If adjusted to the product eligibility qualifications, it shows that the results of the material expert validation are in the "very good" category and do not require revision.

b) Linguist expert validation

Data analysis contains a description of the assessment results carried out by language expert validators on AIR-based e-modules. The results of the analysis are used to determine the level of grammatical feasibility of the AIR-based e-module products developed. The results obtained from the presentation of language expert validation data are as follows.

$$P = \frac{46}{50} \times 100\% = 92\ \%$$

Based on the results of expert assessment of AIR-based e-modules, a percentage of 92% was obtained. If adjusted to the product eligibility qualifications, it shows that the results of the language expert validation are in the "very good" category and do not require revision.

c) Design expert validation

Data analysis contains a description of the assessment results carried out by expert design validators on AIR-based e-modules. The results of the analysis are used to determine the level of feasibility of the media design of the developed AIR-based e-module product. The results obtained from the presentation of expert design validation data are as follows

$$P = \frac{52}{55} \times 100\% = 94{,}5\ \%$$

Based on the results of expert assessment of AIR-based e-modules, a percentage of 94.5% was obtained. If adjusted to the product eligibility qualifications, it shows that the results of the design expert validation are in the "very good" category and do not require revision.

B. Product Trial Results

Product development has gone through a validation process by three experts (material, language, and design) and passed the trial, the next step that must be taken is a trial on educators and students as users of AIR-based e-module products. Users are asked to provide feedback on the e-module product as users in the field. This trial stage aims to determine whether the quality of the e-module can improve students' critical thinking skills.

a) Educator user trials

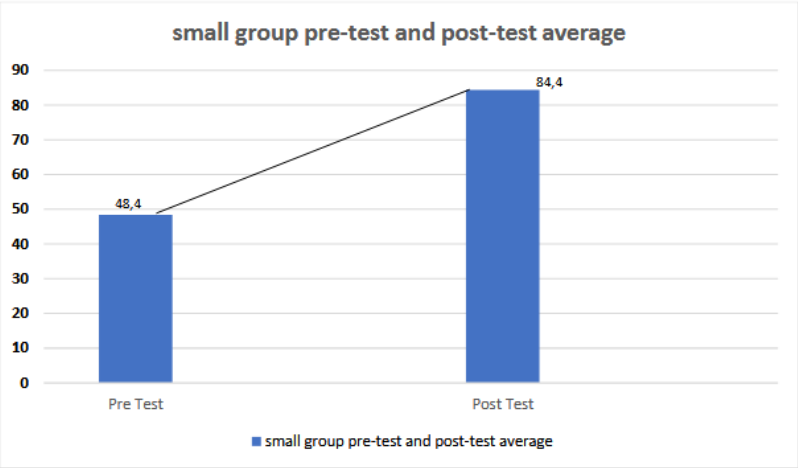
Data analysis contains assessment data obtained from educators as a user test of AIR-based e-module products. The results of the analysis are used to determine the level of e-module product feasibility. The value results obtained from the presentation of user test data are as follows.

$$P = \frac{44}{50} \text{ x } 100\% = 88\%$$

Based on the results of the user test assessment of the AIR-based e-module, a percentage of 88% was obtained. When adjusted to the product eligibility qualifications, it shows that the results of the user test data are in the "very good" category and do not need revision.

b) Student small group trials

Small group trials were conducted after conducting user trials with educators. Small group trials were conducted involving 9 students using AIR-based interactive e-modules. The number of evaluation questions given consisted of 25 multiple-choice test items and performance assessments in the form of paper products. Both tests were developed to measure students' critical thinking skills based on the critical thinking skill indicators adapted from Facione (2020). The pre-test and post-test score data were used as material to determine the effectiveness of the product in improving students' critical thinking skills through student learning outcomes as follows.

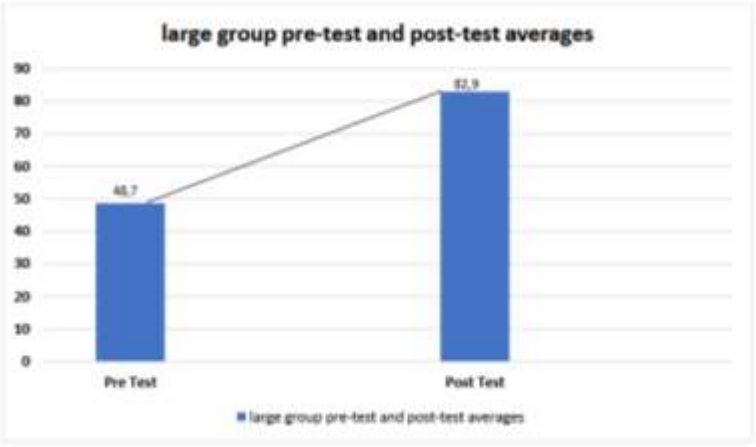


Source: primary data processed

Based on the diagram above, the evaluation value of the small group test above, obtained an average pre-test value of 48.4 and a post-test value of 84.4. The average post-test value is greater than the pre-test value. Thus, it can be concluded that there is an increase in critical thinking skills of students in the small group trial before and after using AIR-based e-modules

c) Student large group trials

Large group trials were conducted after conducting user trials with educators. Large group trials were conducted involving 32 students using AIR-based interactive e-modules. The number of evaluation questions given consisted of 25 multiple-choice test items and performance assessments in the form of paper products. Both tests were developed to measure students' critical thinking skills based on the critical thinking skill indicators adapted from Facione (2020). The pre-test and post-test score data were used as material to determine the effectiveness of the product in improving students' critical thinking skills through student learning outcomes as follows.



Source: primary data processed

Based on the field test evaluation value diagram above, the average pre-test value was 48.7 and the post-test value was 82.9. The average post-test value was greater than the pre-test value. Thus, it can be concluded that there was an increase in students' critical thinking skills in the field trial before and after using the AIR-based e-module.

C. Increase In Critical Thinking Skill

The average results of the pre-test and post-test scores are used to measure the effectiveness of AIR-based e-modules in improving students' critical thinking skills. The level of effectiveness can be measured to see where there is a difference between the pre-test and post-test.

a) Improving critical thinking skills in small groups

Improving students' critical thinking skills in small group trials conducted by 9 people with the results in the following table.

Table 3 . Improving critical thinking skills in small groups

Indicator *Critical Thinking Skill*	Sub Indicator	Type of assessment	Y (%)	Y1 (%)	improvement (%)	Category
Interpretation	Understand the meaning or significance of an event	Cognitive	55,6	88,9	85,1	VH
	Recognize the problem in events	Cognitive	50,0	83,3		
Analysis	Analyze arguments	Cognitive	41,7	72,2	75,4	H
	Identify the problem	Cognitive	50,0	80,6		
Evaluation	Assessing the credibility of a statement	Cognitive	47,2	80,6	80,9	VH
	Assessing the quality of information	Cognitive	52,8	83,3		
Inference	Logically identify evidence	Psychomotor	36,1	80,6	86,1	VH
	Formulate conjectures or hypotheses	Psychomotor	41,7	91,7		
	Consider and draw conclusions	Psychomotor	44,4	88,9		
Explanation	Presenting results	Psychomotor	50,0	86,1	82,3	VH
	Presenting arguments	Psychomotor	41,7	80,6		
Self-Regulation	Evaluate/review answers	Psychomotor	55,6	91,7	90,7	VH
Average increase (%)					**83,42**	**VH**

Based on the assessment results using the formula above, it can be concluded that the level of effectiveness of the product developed in the small group trial is 83.4% with the ST category (Very High). Thus, it can be concluded that the trial of the development product in small groups using AIR-based E-modules is able to improve students' critical thinking skills in social studies learning.

b) Improving critical thinking skills in large groups

Improving students' critical thinking skills in large group trials conducted by 32 people with the results in the following table.

Table 4 . Improving critical thinking skills in large groups

Indicator *Critical Thinking Skill*	Sub Indicator	Type of assessment	Y (%)	Y1 (%)	Improvement (%)	Category
Interpretation	Understand the meaning or significance of an event	Cognitive	52,3	85,9	83,4	VH
	Recognize the problem in events	Cognitive	43,8	82,8		
Analysis	Analyze arguments	Cognitive	35,9	77,3	75,2	H
	Identify the problem	Cognitive	50,8	75,0		
Evaluation	Assessing the credibility of a statement	Cognitive	42,2	78,1	78,3	VH
	Assessing the quality of information	Cognitive	46,1	80,5		
Inference	Logically identify evidence	Psychomotor	43,8	78,1	80,3	VH
	Formulate conjectures or hypotheses	Psychomotor	53,1	84,4		
	Consider and draw conclusions	Psychomotor	50,0	81,3		
Explanation	Presenting results	Psychomotor	53,1	87,5	84,9	VH
	Presenting arguments	Psychomotor	50,0	84,4		
Self-Regulation	Evaluate/review answers	Psychomotor	56,3	90,6	89,6	VH
Average increase (%)					**81,95**	**VH**

Based on the assessment results using the formula above, it can be concluded that the level of effectiveness of the product developed in the large group trial is 81.9% with the ST category (Very High). Thus, it can be concluded that the trial of the

product development in a large group using AIR-based E-modules is able to improve students' critical thinking skills in social studies learning.

Based on the presentation of the data results above, it can be concluded that the study of the AIR-based E-module that was developed has undergone a process of improvement. This AIR-based E-module product has gone through several stages of trials, namely; user trial stage, small group trial and field trial. This AIR-based E-module has been declared feasible and has succeeded in improving students' Critical thinking skills. This can be seen from the results of product trials in small groups and field trials. This study looks at the difference in average scores before and after using the e-module.

Discussion

The following is a description of the results of the research conducted. The interactive e-module based on AIR was declared feasible to use after being assessed with a percentage of achievement of 98.1% by material experts, 92% by language experts, and 94.5% by design experts in the initial testing process (validation). According to Cohen, Manion, and Morrison (2018), the results of expert evaluations with an average score included in the "very good" category and did not need to be revised, indicating that the product was feasible to use. Another important finding in this study was that some of the 32 students who took part in the field trial with the results of the interactive e-module based on AIR could improve students' critical thinking skills in the social studies learning process after being assessed with a percentage of achievement of 83.4% in small group trials with an average post-test evaluation result of 84.4 and a percentage of achievement of 81.9% in large group trials with an average post-test evaluation result of 82.9. The development process of this e-module also involves the performance of several programs and software such as Flip PDF Professional, Quiz Creator, Hyzine, Microsoft Office, and Flash Player. The output of this e-module product is a digital book file, which in this case contains the contents of the module (e-module) with the file extension exe and sw.

Based on observations after the product trial was conducted, this situation arose due to the enthusiasm of students in reading and understanding the contents of the e-module which were considered interesting with various features in it so that it could indirectly stimulate students' critical thinking skills, because previously students only used conventional learning resources that were less interesting and not motivating. This is certainly very different from the existence of learning resources in the form of interactive AIR-based e-modules which indirectly motivate and make students active during learning and have an impact on critical thinking skills which are marked by an increase in student learning outcomes which are much better than before using the e-module. The results of the product trial are also in line with previous studies, as shown by Solehah, Umamah & Sumardi (2023) and research by Bettencourt, Velho & Almeida (2020) which states that interactive e-modules can improve the critical thinking skills of students who use them. Furthermore, there is also previous research from Artuz & Roble (2021) and previous research from Agustin, Maharani, & Astuti (2023) which states that the effectiveness of using the AIR model can improve students' critical thinking skills.

4. CONCLUSION

Based on the results of expert validation, product trials, and improving critical thinking skills through AIR-based e-modules, it can be concluded that the AIR-based interactive e-modules have been validated by experts. The results of expert validation of the content of the material reached a percentage of 98.1% with very good qualifications, validation of language experts reached a percentage of 92% with very good qualifications, and validation of design experts reached a percentage of 94.5% with very good qualifications. This means that the e-module product is worthy of being used or implemented.

Based on the user trial stage, a percentage of 88% was obtained with very good qualifications. The results of the product trial involving a small group trial involving 9 students showed a pre-test value of 48.4 and a post-test of 84.4. The average post-test value was greater than the pre-test value. The success of the development of AIR-based E-modules in improving students' critical thinking can be seen from the percentage in the small group trial, which showed an increase of 83.4% with a "very high" qualification. So it is concluded that there is an increase in critical thinking skills in small groups after using AIR-based e-modules. In the field trial involving 32 people, an average pre-test value of 48.7 and a post-test value of 82.9 were obtained. The average post-test value was greater than the pre-test value. The success of the development of AIR-based E-modules in improving critical thinking skills can be seen from the percentage in the field trial, which increased by 81.9% with a "very high" qualification. So it can be concluded that there is an increase in students' critical thinking skills in social studies learning in the field trial after using AIR-based e-modules.

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