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The Development of Augmented Reality to Improve Critical Thinking and Digital Literacy Skills of Elementary School Students

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Abstract
This research objective was to develop augmented reality-based learning media to improve elementary school students' critical thinking skills and digital literacy. This research method was Research and Development (R&D) with the ADDIE model. The research results showed: (1) the analysis stage was carried out by media, curriculum, and material analyses as guidelines for efficient and effective media design; (2) the design stage was carried out by designing an augmented reality media framework and making research instruments; (3) the development stage was carried out by developing the design of learning media and research instruments, assessments from experts with very decent results and revising the media based on criticism and suggestions; (4) the implementation stage was carried out through AR media development trials and pretest-posttest analysis of critical thinking skills and digital literacy using normality test, N-gain score, and independent t-test; and (5) the evaluation stage was carried out with the final revision and analysis of student response questionnaires which indicated that the level of practicality of the product was categorized as very practical. This research concluded that AR media effectively improved elementary school students' critical thinking skills and digital literacy.
Keywords: *Augmented reality, critical thinking skills, digital literacy, elementary school, ADDIE model*

Abstrak
Tujuan penelitian ini adalah untuk mengembangkan media pembelajaran berbasis augmented reality untuk meningkatkan keterampilan berpikir kritis dan literasi digital siswa sekolah dasar. Metode penelitian ini adalah Research and Development (R&D) dengan model ADDIE. Adapun hasil penelitian menunjukkan: (1) tahap analysis dilaksanakan dengan analisis media, analisis kurikulum dan analisis materi sebagai pedoman perancangan media yang efisien dan efektif; (2) tahap design dilaksanakan dengan merancang kerangka media augmented reality serta pembuatan instrumen penelitian; (3) tahap development dilaksanakan dengan mengembangkan rancangan media pembelajaran dan instrumen penelitian, penilaian dari para ahli dengan hasil sangat layak serta merevisi media berdasarkan kritik dan saran; (4) tahap implementation dilaksanakan melalui uji coba pengembangan media AR serta analisis pretest-posttest keterampilan berpikir kritis dan literasi digital menggunakan uji normalitas, N-gain score dan uji independent t-test; (5) tahap evaluasi dilaksanakan dengan revisi akhir dan analisis angket respon siswa yang menunjukkan bahwa tingkat kepraktisan produk dikategorikan sangat praktis. Simpulan penelitian ini adalah media AR efektif untuk meningkatkan keterampilan berpikir kritis dan literasi digital siswa sekolah dasar.
Kata kunci: Augmented reality, keterampilan berpikir kritis, literasi digital, sekolah dasar, ADDIE model

INTRODUCTION

The 2013 curriculum that the 21st-century learning paradigm guides seek to facilitate students with learning that prepares and directs the next generation to become a generation with 21st-century skills. Education in the 21st century integrates knowledge, skills, attitudes, and mastery of information and communication technology (ICT). One of the essential 21st-century skills is critical thinking skills. Critical thinking skills are an open, clear, fact-based thought process to collect, categorize, analyze, and evaluate information accompanied by clear evidence and reasons (Sarwanto, Fajari & Chumdari, 2021). Critical thinking skills are defined as a systematic process that allows students to evaluate the evidence, assumptions, logic, and language that underlie their own and other people's opinions with the aim of in-depth understanding (Sari, 2021; Fajari et al., 2020). Supratman et al. (2021) state that critical thinking skills involve analyzing and evaluating thinking to improve it. In other words, think independently, be disciplined, self-monitored, and self-corrective. Furthermore, Sidiq et al. (2021) state that skills related to critical thinking are the abilities to understand problems, select problems, understand assumptions, formulate and select relevant hypotheses, draw valid conclusions and determine the validity of conclusions. The indicators of critical thinking skills in this research refer to the indicators proposed by Facione (2015), which include interpretation, analysis, inference, evaluation, explanation, and self-regulation.

Based on the importance of critical thinking skills in students, the Indonesian government implemented the 2013 curriculum focusing on these skills. However, according to the PISA research data, the facts obtained that Indonesia's reading, mathematics, and science scores were at the lowest level. Indonesia's score was ranked 70 out of 78 countries in the science category. Furthermore, the observations in the field showed that critical thinking skills were very low due to the following reasons: (1) students were not involved in learning; (2) learning was still dominated by conventional methods such as lectures; (3) students were more passive and listen; and (4) the learning media used were still limited, such as books, not involving information technology (Fajari, Sarwanto & Chumdari, 2020; Syawaluddin, Gunahardi & Rintayati, 2019).

The 2013 curriculum, which carries the concept of familiar learning with information and communication technology, involves aspects of students' digital literacy. Digital literacy in elementary schools is the ability to use digital media properly, correctly, and responsibly to obtain learning information, find problem solutions, complete learning assignments, and communicate various learning activities with other learning people. Tang & Chaw (2016) and Chan, Churchill & Chiu (2017) define digital literacy as the use of technology that involves the ability to understand, analyze, and evaluate the information received to find and use information as thought and disseminate that information through digital platforms. It is in line with several expert opinions which state that digital literacy is an individual's awareness, attitude, and ability to use digital components to identify, access, understand, integrate, manage, evaluate, analyze, criticize, and synthesize information to build new knowledge, communicate with others or elicit constructive social action (Durriyah & Zuhdi, 2018; Wright & Wilson, 2011; Soepriyanti et al., 2022). Furthermore, Soepriyanti et al. (2022) define seven digital literacy elements: media literacy, information literacy, *digital scholarship*, learning skills, communication and collaboration skills, career management, and technology and information literacy. Spires & Bartlett (2012), Rochet (2017), and Lukitasari et al. (2022) describe that digital literacy has three dimensions, namely a technical dimension related to information technology, a cognitive dimension related to one's skills in processing information, and a *social-emotional* dimension which is an online socialization skill. Digital literacy indicators in this research

comprised media literacy, information literacy, communication and collaboration skills, and *social-emotional* skills.

Furthermore, students' digital literacy was also found to be still very low. It was indicated by the fact that students were still unfamiliar with technology because of point (4) above. Students were only proficient in using technology such as smartphones to play games and social media, so their digital literacy was not channeled for learning purposes. Digital literacy in elementary school students was seen as attitudes, knowledge, and skills to use digital media around to use digital media to find information, entertainment, and learning. However, the field facts showed that many schools prohibited their students from playing digital media in the classroom. Students were asked to accept limited lessons based on the teacher's wishes in applying the media. According to the teacher, information was also obtained based on the interview results. The application of digital media in elementary schools was tricky because students asked many questions about the application of the media and the class was not conducive (Perdana et al., 2019; Nelson et al., 2011).

Based on these problems, it is necessary to have the right solution. One of them is by utilizing technology in learning. The use of technology in learning dramatically affects students' critical thinking and digital literacy skills through learning media. One of the suitable learning media for 21st century learning to improve critical thinking skills and facilitate students' digital literacy is *augmented reality*. This *augmented reality* technology can add specific information into the virtual world and display that information in the real world with the help of equipment such as *webcams*, computers, *Android smartphones*, or special glasses (Shoutthaboualy, Chatwattana & Piriyasurawong, 2021). *Augmented reality* can improve students' understanding by displaying 3D objects, text, images, video, and audio, involving students to interact actively with virtual objects and providing fun and exciting learning. AR is also easy to operate by simply pointing the camera at the body, book, or other objects (Nurhasanah, Widodo & Riandi, 2019; Hsu, Wenting & Hughes, 2018).

Several studies have stated the effectiveness of *augmented reality* in improving critical thinking skills, such as the research of Faridi et al. (2020), Fendi, Suyatna & Abdurrahman (2021), Dilmen & Atalay (2021), and Syawaluddin, Gunahardi & Rintayati (2019). Furthermore, there were also several studies stating the effectiveness of augmented reality in improving students' digital literacy, including the research of Shoutthaboualy, Chatwattana & Piriyasurawong (2021), Nurhasanah, Widodo & Riandi (2019), and Hsu, Wenting & Hughes (2018). Therefore, researchers researched the development of *augmented reality*-based learning media that met valid criteria in terms of content, constructs, and practical criteria and could be used to improve elementary school students' critical thinking skills and digital literacy.

METHOD

This research used a type of research and development known as the *Research and Development* (R&D) ADDIE model, which consists of five stages: *Analysis, Design, Development, Implementation,* and *Evaluation* (Almelhi, 2021). The first stage was the *analysis* stage. At this stage, the researcher analyzed the importance of developing learning media to know the initial needs in developing this learning media. The analysis carried out in this stage included media, curriculum, and material analyses. Second, the *design* stage aimed to produce an initial product (*prototype*) or product design that was adapted to the analysis that had been carried out. The activities carried out at this stage were the selection of the initial format and framework as well as the selection of research instruments.

The third was the *development* stage. This stage consisted of several steps, including (1) the development of a design framework for learning media and

instruments made in the previous stage, which experts then evaluated, and (2) the assessment of media carried out by competent experts in the field of media, material, and language as well as being able to provide criticism and suggestions for better media preparation, and (3) revision of the media that experts have validated based on considerations and suggestions as well as criticism from media, material, and language experts. Fourth, the *implementation* stage was indicated by the application of learning media products that had been developed and declared worthy of testing by media expert lecturers, linguists, and material experts then tested on research subjects on a small scale. At this stage, a *pretest-posttest* was conducted to measure the effectiveness of improving critical thinking skills and digital literacy before and after using media. Then, the *evaluation* stage was carried out by the final revision of the learning media developed based on student response questionnaires and observation sheets obtained in the field.

The data obtained from this development research consisted of qualitative and quantitative data. The qualitative data in this research were: (1) criticism and suggestions as well as input from material experts, media experts, and language experts; and (2) the results of observations were described in the form of descriptions of responses and learning conditions. The results of the data analysis were used as the basis for revising the product to be developed. The quantitative data in the research included: (1) critical thinking skills test; (2) digital literacy questionnaire; (3) media validation questionnaire; (4) student response questionnaire. Data on critical thinking skills used an open description test instrument, while data for digital literacy was obtained using a questionnaire instrument. The *pretest* and *post-test* results to measure the improvement of critical thinking skills and digital literacy before and after the use of the developed learning media were analyzed using statistics in the form of normality test, *N*-Gain, and *independent t-test*.

RESULTS AND DISCUSSION

The product developed was *augmented reality*-based learning media on *android* devices with the *Assemblr application* as a support for human motion system material. This learning media was expected to facilitate educators' and students' learning. Students were expected to be able to construct their thoughts by stimulating the materialization of the human motion system material so that learning could improve critical thinking skills and digital literacy in using Android.

The first stage of this research was the analysis stage. This analysis stage included media, curriculum, and material analyses. Media analysis was carried out using the observation method. The results of field observations also showed that critical thinking skills were very low due to the following reasons: (1) teachers did not involve students in learning; (2) teachers still dominated learning with lectures; (3) students were more silent and became passive listeners; and (4) teachers only used books in teaching, write learning materials on the blackboard or dictate to students. Furthermore, the learning carried out never used smartphone-based media. Even students were not allowed to bring smartphones. Based on the results of interviews, most students stated that they often use their smartphones to play games, and only a small percentage stated that they used smartphones to look for subject matter that was not in the book. Curriculum and material analysis were also conducted to determine suitable science material combined with AR. Furthermore, some abstract science materials can be concretized with AR in grade 5, namely: (1) the human movement system; (2) the respiratory system of living things; (3) the human digestive system; (4) the human circulatory system; (5) the earth and its surroundings; and (6) the water cycle and natural events. Based on the consideration of the timing of the research, the

appropriate material was the human movement system in Theme 1 '*Animal and Human Movement Organs*' and Subtheme 2 '*Humans and the Environment*'.

The results of this analysis stage were supported by the results of Samsudin et al. (2021) and Mariam (2019), which stated that the primary things that must be carried out at the analysis stage were analyzing the problem, determining teaching objectives, analyzing student characteristics, examining the resources used and material analysis. The research results were in line with the theory of Salas-Rueda et al. (2020), which stated that the stages of the ADDIE model analysis analyze students in terms of their needs, problem analysis, and task analysis so that the output of this analysis process is in the form of student characteristics, gap identification, identification of needs and analysis of tasks in the form of solutions to their needs. Trust & Pektas (2018) and Thesalonika et al. (2019) also states that development research departs from existing problems such as current or available products that are no longer relevant to the needs of the target, learning environment, technology, student characteristics, and so on.

The second stage in this research was the *design* stage. The activities carried out at this stage were the selection of the initial format and framework as well as the selection of instruments. At this stage, researchers began to examine the most effective applications used to create *augmented reality*. The selected application was *Assemblr*. The researcher then downloaded the Assemblr application and tried to make AR according to the material that had been determined. Researchers also designed sentences displayed on AR to be more effective and efficient when AR media was used. At this stage, researchers also began to make assessment instruments in the form of *pretest* and *post-test* questions on critical thinking skills and digital literacy questionnaire instruments. The question instruments were adjusted to the material taught using AR, while the digital literacy instruments were adjusted to the psychological development stage of students. The results of the design stage research were in line with the theory, which stated that design activities in the ADDIE development research model were a systematic process that started from designing the concepts and content in the product. Designs were written for each product's content. Instructions for implementing the design or manufacture of products were sought to be written clearly and in detail. At this stage, the product design was still conceptual and underlie the development process at the next stage (Thesalonika et al., 2019; Samsudin et al., 2021; Ngussa, 2014).

Development stage. This stage consisted of several steps, including a) developing a design framework for learning media and instruments made in the previous stage, which experts then validated, and b) assessing learning media carried out by competent experts in the field of media, materials, and language as well as being able to provide criticism and suggestions for better media preparation, and c) revising the media that experts had validated based on considerations and suggestions and criticisms from media, material and language experts. Development in the ADDIE development research model contained activities to realize product designs that had previously been made (Tu et al., 2021). A conceptual framework for implementing a new product had been developed in the previous stage. The conceptual framework was then realized into a product ready to be implemented (Sarwanto, Laksmi & Chumdari, 2021). Figure 1 below is a design framework for learning media that would be developed.

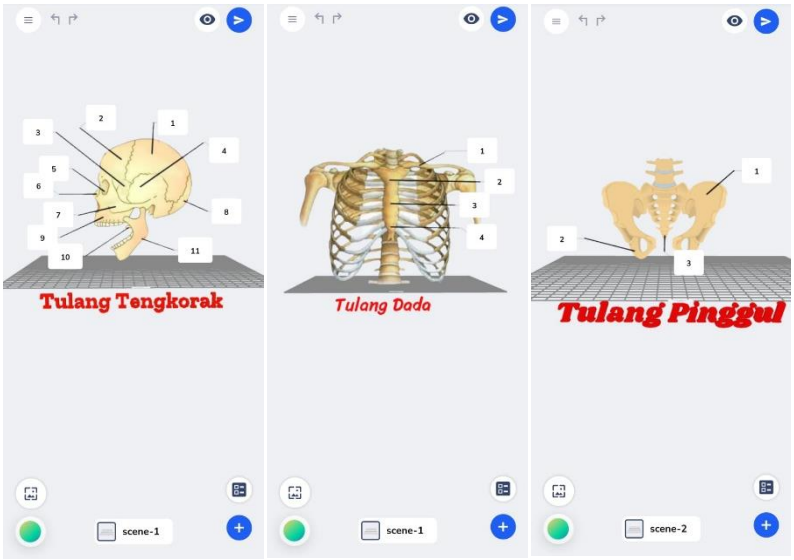

Figure 1. Design of Augmented Reality about Human Movement System

To test the feasibility of the AR, the researchers conducted a series of judgments on related experts and stakeholders, namely media experts, material experts, linguists, and users. Meanwhile, after the judgment process, the researcher revised the media that had been validated by experts based on suggestions and criticisms. Based on the results of the assessments, it obtained the following data:

Table 1. Expert and User Assessment of AR Media

No	Evaluator	Score	Appropriateness
1	Media expert	3.56	Very appropriate
2	Material expert	3.52	Very appropriate
3	Linguist	3.96	Very appropriate
4	User 1	3.80	Very appropriate
5	User 2	3.88	Very appropriate

Based on Table 1, it was obtained information that the assessment of the developed media according to several experts and users stated that the media was appropriate to use. Furthermore, the criticisms and suggestions were used as guidelines for improvement and continuing research at the *implementation* stage. The appropriateness of learning media at the elementary age level was significant because the presence of the media helped students understand a particular concept. Students still thought concrete and actual at this age, and could not think abstractly, especially low-grade elementary school students. Therefore, teachers should choose the correct media according to learning objectives and are appropriate and effective to use (Puspitarini & Hanif, 2019).

The *implementation* stage was the stage of applying learning media products that had been developed and declared appropriate based on the testing by media expert lecturers and material experts. Then, it was tested on research subjects on a small scale (Priyanka & Selamat, 2021). The application of the product in the ADDIE development research model was intended to obtain *feedback* on the product being made/developed. Initial feedback (early evaluation) can be obtained by asking questions about product development goals (Ismiyani, 2021). At this stage, a pretest-posttest was conducted to measure the effectiveness of students' critical thinking skills and digital literacy. The data from the pretest-posttest results are presented in Figure 2 below:

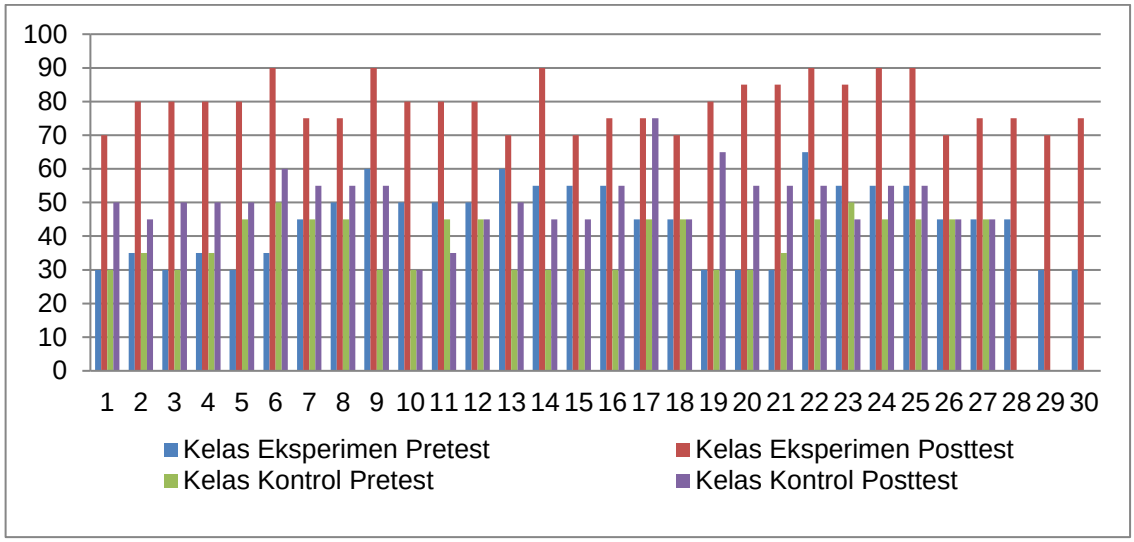

Figure 2. Pretest-Posttest Data for Critical Thinking Skills

Based on Figure 2, information was obtained that visually, there was an increase in the value of students' critical thinking skills in both the experimental and control classes. The post-test scores for the critical thinking skills of the experimental class students were much higher than the post-test scores for the critical thinking skills of the control class students. However, further data analysis was needed to confirm this fact. The prerequisite test that was needed was the normality test. Table 2 below is a recapitulation of the normality test of this research.

Table 2. Recapitulation of Normality Test

Variable	Control Class				Experimental Class			
	Pretest CTS	Posttest CTS	Pretest DL	Posttest DL	Pretest CTS	Posttest CTS	Pretest DL	Posttest DL
N	27	27	27	27	30	30	30	30
Asymp. Sig. (2-tailed)	0.69	0.107	0.082	0.103	0.083	0.110	0.76	0.089

Based on Table 2, it was obtained information that the value of Asymp. Sig. (2-tailed) > 0.05, and it can be concluded that the data were normally distributed. Then, the research continued with data analysis using the N-gain score. N-gain score aimed to determine the effectiveness of the use of AR. The N-gain score test was carried out by calculating the difference between the pretest and posttest scores. The following were the results of the N-gain score test on this research's critical thinking skills data.

Table 3. N-gain Score Test Results for Critical Thinking Skills

Class			Statistic	Std.Error
Experiment	Mean		61.8330	5.06601
	95% Confidence Interval for Mean	Lower Bound	43.3288	
		Upper Bound	65.9561	
Control	Mean		40.7407	3.07710
	95% Confidence Interval for Mean	Lower Bound	24.2710	
		Upper Bound	31.8781	

Based on Table 3 above, it was known that the mean N-gain score for the experimental class was 61.833 or if it was rounded up to 62%. Based on the category table for the interpretation of the effectiveness of the N-Gain score (%), it can be

concluded that using AR in the experimental class effectively improved elementary school students' critical thinking skills. Furthermore, it was known that the mean N-gain score for the control class was 40.741 or if it was rounded up to 41%. Based on the category table of the effectiveness of the N-Gain score (%), it could be concluded that using conventional media (printed books only) in the control class was ineffective for improving critical thinking skills. Furthermore, the next step was to compare the differences in the effectiveness of using AR media with the use of book media in improving the critical thinking skills of elementary school students through an independent sample *t-test*. Table 4 below is the result of the t-test in this research.

Table 4. Results of t-test Critical Thinking Skills

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Ngain_ Percent	Equal variances assumed	.005	.946	2.334	28	.049	21.09230	8.743	.9384	34.117
	Equal variances not assumed			2.354	26.803	.049	21.09230	8.743	.9886	34.087

Based on Table 4, it is known that the significance value (Sig) on Levene's Test for Equality of Variances was 0.946 > 0.05. Thus, it can be concluded that the variance of the N-Gain data (%) for the experimental and control classes was the same or homogeneous. Meanwhile, the value of Sig. (2-tailed) was 0.049 < 0.05. Thus, it can be concluded that there was a significant difference in critical thinking skills between experimental class students who used AR media and control class students who used book media. *Augmented Reality* can be used in the learning process because it supports science learning to be more interactive (Vari & Bramastia, 2021). *Augmented Reality* technology can realize the virtual world into the real world so that the application of AR technology in science learning will lead students to find physics concepts independently (Herliandry et al., 2020; Waliyuddin & Sulisworo, 2021). Furthermore, this research was supported by the results of Sirakaya & Alsancak-Sirakaya (2018) and Setyawan (2019), who stated that *Augmented Reality* was considered to train critical thinking skills because students required the ability to imagine and understand an image called visual literacy skills. *Augmented Reality* media had images that function as visual media so that it was related to visual literacy.

Furthermore, digital literacy data is obtained from the distribution of digital literacy questionnaires adapted to elementary school students' development. Figure 3 below summarizes the digital literacy pretest and post-test data for students in this research.

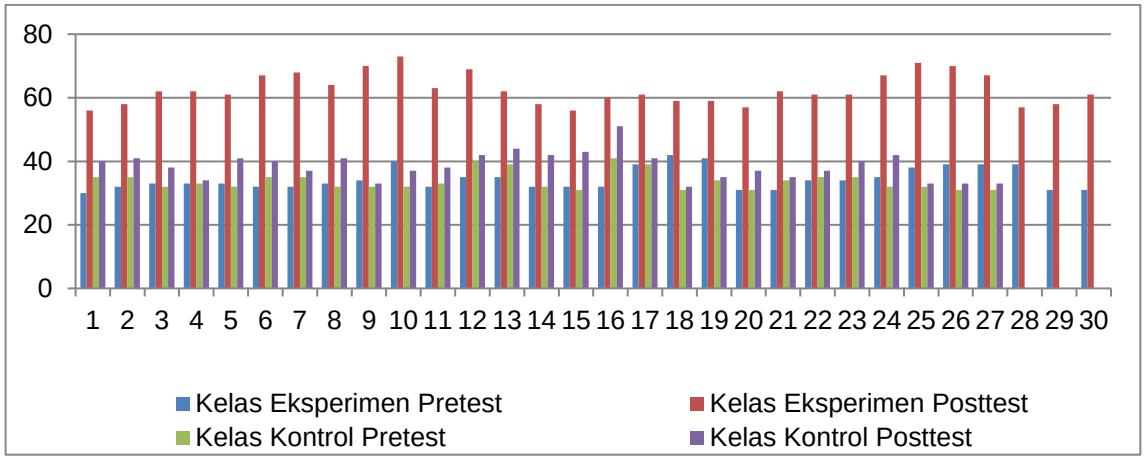

Figure 3. Digital Literacy Pretest-Posttest Data

Based on Figure 3, information was obtained visually. There was an increase in students' digital literacy in the experimental and control classes. The digital literacy post-test scores of the experimental class students were much higher than the control class students' digital literacy post-test scores. Then, the research continued with data analysis using the N-gain score. The following are the results of the N-gain score test on the digital literacy data of this research:

Table 5. N-gain Score Test Results for Digital Literacy Data

No.	Experimental Class			Control Class		
	Pretest	Postest	N-gain	Pretest	Postest	N-gain
1	30	56	57.7778	35	40	12.5
2	32	58	60.4651	35	41	15
3	33	62	69.0476	32	38	13.9535
4	33	62	69.0476	33	34	2.38095
5	33	61	66.6667	32	41	20.9302
6	32	67	81.3954	35	40	12.5
7	32	68	83.7209	35	37	5
8	33	64	73.8095	32	41	20.9302
9	34	70	87.8049	32	33	2.32558
10	40	73	94.2857	32	37	11.6279
11	32	63	72.093	33	38	11.9048
12	35	69	85	40	42	5.71429
13	35	62	67.5	39	44	13.8889
14	32	58	60.4651	32	42	23.2558
15	32	56	55.814	31	43	27.2727
16	32	60	65.1163	41	51	29.4118
17	39	61	61.1111	39	41	5.55556
18	42	59	51.5152	31	32	2.27273
19	41	59	52.9412	34	35	2.43902
20	31	57	59.0909	31	37	13.6364

21	31	62	70.4546	34	35	2.43902
22	34	61	65.8537	35	37	5
23	34	61	65.8537	35	40	12.5
24	35	67	80	32	42	23.2558
25	38	71	89.1892	32	33	2.32558
26	39	70	86.1111	31	33	4.54546
27	39	67	77.7778	31	33	4.54546
28	39	57	50			
29	31	58	61.3636			
30	31	61	68.1818			
Mean	34.467	62.667	69.648	33.852	38.519	11.375

Figure 4 above shows that the mean N-gain score for the experimental class was 69.648 or if it was rounded up to 63%. Based on the category table for the interpretation of the effectiveness of the N-Gain score (%), it could be concluded that using AR in the experimental class effectively improved elementary school students' digital literacy. Furthermore, it was known that the mean N-gain score for the control class was 11.375 or if it was rounded up to 11%. Based on the category table of the effectiveness of the N-Gain score (%), it can be concluded that using conventional media (printed books only) in the control class was ineffective for increasing digital literacy. Furthermore, the next stage was to compare the differences in the effectiveness of using AR media with the use of book media in increasing the digital literacy of elementary school students through an independent sample t-test. Table 6 below is the result of the t-test in this research.

Table 6. Digital Literacy t-test Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Ngain_Pecent	Equal variances assumed	.005	.877	1.455	25	.029	11.85463	4.09234	.97975	24.94357
	Equal variances not assumed			1.455	26.803	.029	11.85463	4.09234	.97975	24.94357

Based on Table 6, it was known that the significance value (Sig) on Levene's Test for Equality of Variances was 0.877 > 0.05, so it can be concluded that the variance of the N-Gain data (%) for the experimental and control classes was the same or homogeneous. Furthermore, the value of Sig. (2-tailed) was 0.029 < 0.05. Thus, it could be concluded that there was a significant difference in digital literacy between experimental class students who used AR media and control class students who used book media.

This research strengthened the theory of Hsu, Wenting & Hughes (2018), which states that the introduction of digital-based literacy for elementary school students must be adjusted to the psychological side and abilities of children at that age stage by providing digital literacy through images, videos, animated videos, interactive

animation, and *augmented reality*-based animation. The elementary school students could and wanted to learn actively. They could build knowledge independently, utilizing fun learning to maximize learning outcomes. Furthermore, smartphones were among the primary sources of information that could be used and were familiar to students. The *augmented reality* application in this research required a smartphone to scan QR-AR markers. The use of smartphones in learning was a new and effective step. These digital-based information sources must be used properly and help students to learn to be prepared optimally (Waliyuddin & Sulisworo, 2021). It means that digital-based information must be created by maximizing the potential of technological progress, which is packaged attractively (Shoutthaboualy, Chatwattana & Piriyasurawong, 2021; Nurhasanah, Widodo & Riandi, 2019; Hsu, Wenting & Hughes, 2018).

Figure 4. Pretest-posttest work and implementation of augmented reality

The *evaluation* stage was completed with a final revision of the learning media developed based on criticism and suggestions from experts and users and student response questionnaires to the media. The evaluation stage in the ADDIE model development research was conducted to provide feedback to product users so that revisions were made according to the evaluation results or needs that the product had not met. The final objective of the evaluation was to measure the achievement of development goals (Salas-Reuda et al., 2020; Samsudin et al., 2021).

Based on the analysis of the data from the assessments of experts and users, it was concluded that the developed product was appropriate to use without the need for revision, but considering the suggestions and inputs given by material and media experts. Furthermore, the researchers followed up with improvements. Furthermore, after testing the product on students, the product's practicality would be measured through a student response questionnaire sheet. The recapitulation of the assessment of student responses to the practicality of the product developed is presented in the following table:

Table 7. Recapitulation of Student Response Assessment to the Practicality of the Product

No.	Aspect	Percentage	Criteria
1.	Media	90%	Very Practical
2.	Material	88%	Very Practical
3.	Benefit	85%	Very Practical
4.	Interest	90%	Very Practical
	Mean	88%	Very Practical

Based on the data presented in Table 7 above, the mean percentage of student response assessments was 88%, and it can be concluded that the practicality level of the product was included in the very practical category. The research results were in line with the theory of Darma et al. (2021), which stated that the practicality of learning media could be viewed from the implementation of learning media in learning activities and teacher responses to learning media, student responses to learning media. This research also meant that the media's condition and application were ideal for students. In the practical aspect of learning media, several aspects needed to be considered that supported the media. First, the media was seen from the available formats, the time used, and the costs incurred. The second was the suitability of students, namely the suitability of media content with the development and experience of students, and the third was the suitability of educators, namely the suitability of the media with learning carried out by educators and being able to facilitate students to understand the material through the developed media (Darma et al., 2021; Indang, 2020; Madona, 2018).

CONCLUSION

Based on the results and discussion, it could be concluded that AR media effectively improved elementary school students' critical thinking skills and digital literacy. These results were obtained from the following research stages. First, the analysis stage carried out in this stage included media, curriculum, and material analyses. Thus, it was decided to make AR media on the science material with Theme 1 'Animal and Human Movement Organs', Subtheme 2 'Humans and the Environment' with the subject matter Human Movement System in grade 5 at odd semesters. Second, the design stage was carried out by determining the AR application maker, designing AR, and making research instruments. Third, the development stage was carried out by developing the design of the learning media framework and instruments made in the previous stage, which experts then evaluated. Competent experts assessed the learning media in media, material, and language with decent results. It made revisions to media that experts had validated based on considerations, suggestions, and criticisms from media, material, and language experts.

Fourth, the implementation stage was carried out by testing the research subjects. Analysis of media effectiveness at this trial stage was conducted by analyzing the pretest and post-test of critical thinking skills and digital literacy. The normality test of all data showed that the data came from a normal distribution. The mean score of N-gain critical thinking skills for the experimental class was 62%, so it can be concluded that using AR in the experimental class effectively improved the critical thinking skills of elementary school students. The mean score of digital literacy N-gain for the experimental class was 63%, so it can be concluded that using AR in the experimental class effectively improved the digital literacy of elementary school students. Furthermore, the t-test of critical thinking skills showed the value of Sig. (2-tailed) was $0.049 < 0.05$. Thus, it can be concluded that there was a significant difference in critical thinking skills between experimental class students who used AR media and control class students who used book media. Then, the value of Sig. (2-tailed) digital literacy on the t-test was $0.029 < 0.05$. It could be concluded that there was a significant difference in digital literacy between experimental class students who used AR media and control class students who used book media. The last stage was the evaluation stage. It was carried out with a final revision of the learning media developed based on criticism and suggestions from experts and users as well as student response questionnaires to the media by 88% and could be categorized as very practical.

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