

DEVELOPMENT OF AREAS (AUGMENTED REALITY ECOSYSTEM) ON ECOSYSTEM MATERIAL TO IMPROVE DIGITAL LITERACY SKILLS OF CLASS V STUDENTS OF ELEMENTARY SCHOOL

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Abstract. The lack of integration of technology-based learning media in learning causes low student digital literacy. The objectives of this study are: (1) to determine the feasibility of AREAS, (2) to determine students' response to AREAS, (3) to determine students' digital literacy skills after using AREAS. This research is a development research based on the ADDIE model, namely analyze, design, develop, implement, and evaluate. The instruments utilized in this research are media expert validation questionnaire, a material expert validation questionnaire, a student response questionnaire, and a digital literacy test assessment. Observation, interviews, and questionnaires were employed to gather data for this study. The data analysis technique used was quantitative data analysis and digital literacy ability analysis. The results showed that AREAS was feasible to use with a feasibility percentage of 93.1%, a student response of 90.9%, and a digital literacy n-gain score of 0.61 in the "Medium" category. It can be concluded that AREAS is very feasible to use in learning and effective enough to improve the digital literacy of class V C students of SDN 011 Samarinda Kota. The development of original interactive learning media by creating augmented reality assets themselves is recommended for future research.

Keywords: augmented reality, development, digital literacy, ecosystem

INTRODUCTION

The rapid advancement of science and technology and the swift flow of globalization have triggered a major transformation in the education system in Indonesia (Hidayat & Abdillah, 2019). The 21st century is now underway, and it is characterized by the accelerated advancement of technology and innovation, particularly in the field of education (Safitri et al., 2023). Success in 21st-century education is contingent upon digital literacy. Ideally, 21st century learning is flexible, relevant and student-centred (Rahayu et al., 2022). Along with the rapid development of science and technology in the 21st century, learning digital literacy is one of the skills that students need to learn (Budiningtyas et al., 2022). Teachers and students must possess strong digital literacy skills to effectively filter pertinent and precise information from different sources (Marhamah et al., 2024).

Observations on 19 February 2024 showed that there is a gap between the use of technology in SDN 011 Samarinda Kota and the demands of 21st century technology-based learning. At present, the majority of students are unaware of the appropriate utilization of digital devices and other digital media. Consequently, they are unaware of the hazards associated with digital media. The preliminary research questionnaire on students' digital literacy showed that only 50.3% of students met the information and data literacy aspects. Overall, the average level of digital literacy among students was 55.2%.

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One factor that contributes to students' learning difficulties in science subjects is the limited availability of learning media. Abstract concepts in ecosystems are challenging for students to comprehend when learning methods are based on memorization and complex material (Kuroru & Rahmah, 2023). To achieve learning in line with technological developments, augmented reality and Canva-based learning media are being developed, especially in the IPAS ecosystem material. AREAS has enormous potential to improve the quality of learning ecosystem materials. By using augmented reality technology, students can gain a better, deeper and more memorable understanding of the complex interactions between living things and their environment.

Numerous studies have been conducted to enhance students' comprehension of learning through the development of technology-enhanced learning media. For instance, research conducted by Fajari & Meilisa (2022) found that AR media was quite effective in improving critical thinking skills and digital literacy of primary school students. In this study, the augmented reality (AR) learning media developed required students to download the application before using it. This can be a challenge, particularly for students who are unfamiliar with the application installation process, have limited device storage, or lack internet access. In addition, research conducted by Asy et al. (2023) concluded that students' cognitive scores were altered as a result of the use of hands-on augmented reality technology to enhance their digital literacy skills. This research is still restricted to high school students, as primary school students necessitate a distinct approach due to their distinct cognitive requirements and learning patterns. AREAS (Augmented Reality Ecosystem) has been devised in the form of a link as a solution. This enables AREAS to be accessed using a browser without the necessity of downloading any additional applications. Students can access the learning media directly from any device connected to the Internet by clicking on the link provided by the teacher with AREAS.

AREAS is a new breakthrough that integrates interactive learning design with augmented reality technology. Simple hyperlinks enable students to access a variety of engaging educational resources. AREAS enables students to acquire knowledge at any time and in any location. Students will enhance their digital literacy skills through the use of augmented reality on AREAS. Therefore, this study aims to determine the feasibility of AREAS, to determine students' responses to AREAS, and to determine students' digital literacy skills after using AREAS.

METHOD

This study is a research and development (R&D) that refers to the ADDIE model with the stages of analyse, design, develop, implement and evaluate. The ADDIE model is particularly well-suited for product development due to its ability to be customized to suit a variety of circumstances (Branch, 2009).

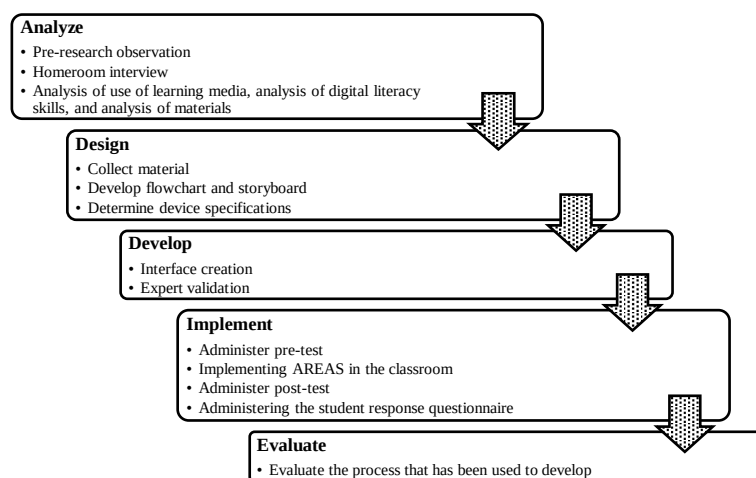


Figure 1. ADDIE Model Schematic

The analysis phase encompassed pre-research observations, interviews with classroom teachers, assessment of students' digital literacy skills, analysis of the materials to be used in the media, and analysis of students' use of learning media. The results of the observation indicated that the teachers did not implement interactive learning media, interactive questions, or elements that encourage active engagement to increase student participation. The class teacher also said that the use of digital technology in the classroom was not optimised.

Material was collected during the design phase to guarantee that the content to be presented was both informative and pertinent. In addition, a flowchart and storyboard were developed to illustrate the sequence of slides, appearance, text to be displayed, object placement, and location of supporting media. The hardware specifications necessary to operate AREAS.

In the develop phase, product realisation was carried out based on the design created, including preparation and input of materials, creation of interactive learning media interfaces and input of supporting media. The validation testing was conducted by media and materials experts after the product creation process is complete. AREAS is revised to integrate feedback following an expert evaluation.

The AREAS design that had been devised was implemented in the classroom during the implement stage. The implementation procedure commenced with the administration of a digital literacy questionnaire as a pre-test, followed by the implementation of AREAS, which included a post-test questionnaire and a questionnaire on students' responses to the developed AREAS.

The evaluation stage is the final stage in the ADDIE model. The purpose of the evaluation is to assess whether AREAS has met the needs and initial objectives of the development, and whether the development has been successful in improving students' digital literacy skills.

Data collection in this study included observation, interviews and questionnaires. The instruments utilized in this study were observation sheets, interview sheets, student media needs analysis questionnaires, learning media needs analysis questionnaires, media expert validation questionnaires, material experts, pretest and posttest questionnaires, and student response questionnaires. The subjects in this study were experts as validators and students of class V C SDN 011 Samarinda Kota as many as 21 students while the object in this study was AREAS (Augmented Reality Ecosystem).

The instruments in this research were the media expert validation questionnaire, the materials expert validation questionnaire, the student response questionnaire and the digital literacy test assessment. The digital literacy framework encompasses four components: information and data literacy, security, communication and collaboration, and technological skills. The four aspects are derived from the report "Status of Indonesian Digital Literacy" by Katadata Insight Center (2020) which refers to "A Global Framework of Reference on Digital Literacy Skills".

Quantitative data analysis was implemented to evaluate the feasibility of media, material, and student responses to AREAS. The descriptive percentage technique was implemented to conduct the analysis. The analysis questionnaire was distributed to two material experts, two media experts and V C students with the criteria listed in Table 1.

Table 1. Scoring guidelines

Score	Criteria
5	Excellent
4	Good
3	Fair
2	Poor
1	Very Poor

(Sugiyono, 2019)

The results of the questionnaire were analysed using the formula:

$$\text{Percentage (\%)} = \frac{\text{sum of scores obtained}}{\text{maximum Score}} \times 100\%$$

(Sugiyono, 2019)

The results of the formula calculation were compared with the eligibility criteria in Table 2.

Table 2. Criteria interpretation scale

Percentage (%)	Criteria
81%-100%	Very Feasible
61%-80%	Feasible
41%-60%	Fairly Feasible
21%-40%	Unfeasible
<20%	Very unfeasible

(Arikunto, 1999)

An n-gain analysis was conducted to assess the improvement in students' digital literacy skills by comparing the pre-test and post-test scores. The formula for n-gain is as follows:

$$<g> = \frac{(\%<posttest> - \%<pretest>)}{100 - \%<pretest>}$$

(Hake, 1999)

After the n-gain value has been obtained, it is subsequently classified in accordance with the criteria outlined in Table 3.

Table 3. n-gain Category

n-gain Value	Criteria
$g > 0,7$	High
$0,7 > g > 0,3$	Medium
$g < 0,3$	Low

(Hake, 1999)

The criteria for categorising the improvement in students' skills from the n-gain results based on percentages are listed in Table 4.

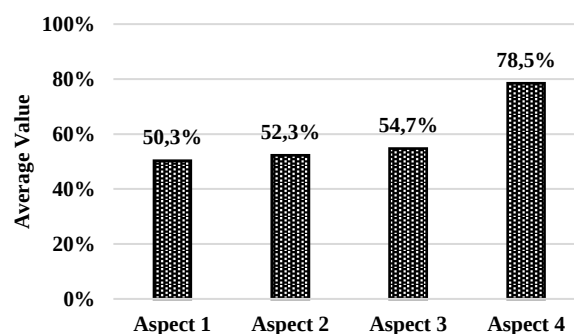
Table 4. Effectiveness n-gain category

Percentage (%)	Category
> 40	Not Effective
40-55	Less Effective
56-75	Moderately Effective
> 76	Effective

(Arikunto, 1999)

RESULTS AND DISCUSSION

The first stage in the development of the ADDIE model is analyzing. Observations on 19 February 2024 showed that conventional learning models were still dominant, the use of interactive media was still minimal, and student participation was still deficient. Interviews with classroom teachers on 19 February 2024 confirmed that the integration of digital technology, particularly Canva and AR, was still limited. The school's utilization of technology facilities is not optimal, despite the fact that they are adequate. Furthermore, a questionnaire was implemented to evaluate the students' initial competencies in digital literacy. The results of the analysis are illustrated in Figure 2.

**Figure 2. Graph of analysis of students' digital literacy skills**

Description: Aspect 1 = Information and Data Literacy
 Aspect 2 = Communication and Collaboration
 Aspect 3 = Security
 Aspect 4 = Technological Skills

The questionnaire filled in by the students of class V C showed that 55.2% of the students on average had fulfilled four aspects of digital literacy, namely information and data literacy, communication and collaboration, security and technological skills. Based on the questionnaire distributed to students to analyse the use of learning media, the majority of students prefer and feel benefited by learning

with technology-based media and desire new digital learning resources. This indicates a gap between the potential of current technology and conventional learning practices.

The subsequent phase was the design phase, which followed the analyze phase. This design phase involves the collection of material, the creation of flowcharts, storyboards, and equipment specifications. The content utilized is from Chapter II of the IPAS course. This chapter continues the study of ecosystems in Class 3. Students are expected to comprehend the connection between food and the necessity for living organisms to acquire energy, and to articulate this relationship in the form of a food chain (Ghaniem et al., 2021). To facilitate user interaction with AREAS, the researchers developed flowcharts and storyboards to determine the sequence of slides, visual appearance, and placement of text and supporting media on each slide. To ensure that AREAS functions optimally, the researchers developed device specifications for accessing it. The minimum device specification is 4GB of RAM, 200MB of storage capacity, and Android 8.0 or iOS 13.0. It is also advisable to have a reliable internet connection in order to access AREAS without any issues. A visual display that is both seamless and uninterrupted is the outcome of a high-quality internet connection, which ensures that the message is effectively communicated (Sulistriono et al., 2021).

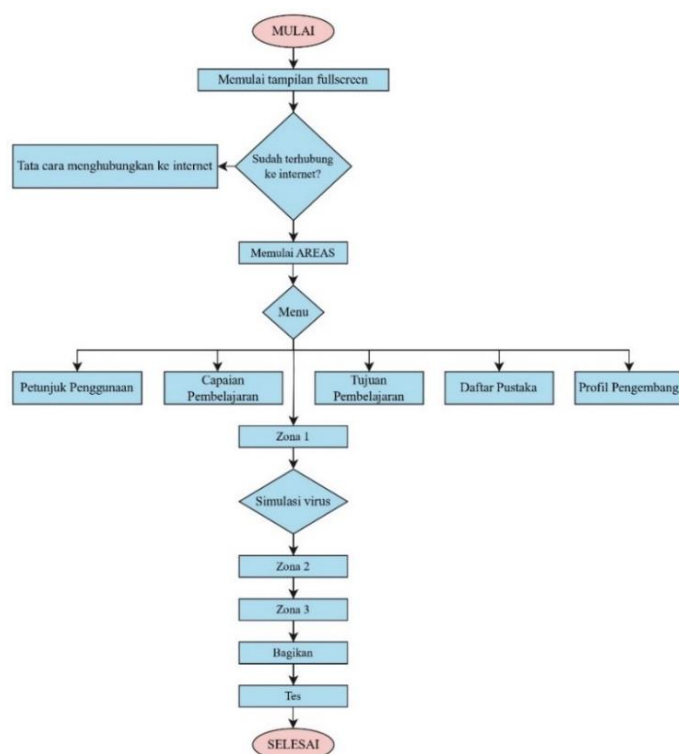


Figure 3. AREAS flowchart

The develop stage of AREAS includes the production process based on the design that has been created. This production process involved the use of hardware such as laptops, mouse, and devices, as well as design software such as Canva and Assemblr EDU. The creation of visual media should guarantee that all visual elements displayed in the learning media are clear and relevant representations of the concepts being conveyed, thereby facilitating students' comprehension of the material

(Asnawati, 2019). AREAS can be accessed at the following URL: <https://bit.ly/AREAS2024>.



Figure 4. AREAS interface

The ecosystem material included in AREAS is Chapter II Topic A: Eating and Being Eaten with the theme of food chains and two learning objectives per level. This topic introduces students to the concept of food chains.



Figure 5. Ecosystem material interface

AREAS is designed to enhance students' digital literacy skills by incorporating digital technologies such as AR and Canva, in addition to ecosystem materials. To improve students' skills in the first aspect of digital literacy, students were given the opportunity to use the internet and their digital devices to access AREAS. To support the improvement of the second aspect, students were asked to share media from their browsers to WhatsApp after completing 4 zones in AREAS. In the security aspect, AREAS provides a simulation scenario when a student's device is attacked by a virus, so students can try to overcome the attack by choosing the most appropriate solution. In the fourth aspect namely technological skills, students must be able to recognise and use their devices to connect them to the Internet.



Figure 6. Simulation of security aspects of the digital literacy interface

AREAS was validated by two material experts and two media experts after the development of the product was concluded to ensure that it is suitable as a learning medium. In line with the study by Suhartini et al. (2017), the product was validated by two validators to obtain their input and notes so that it can be applied in research. A product is considered valid if it satisfies all of the criteria that have been established and assessed by the validator (Nirmala et al., 2023). The example can be seen in the media expert validation criteria in Table 5.

Table 5. Media expert validation

No.	Aspect	V1	V2	Percentage	Criteria
1	Usability Aspects	15	13	93,33%	Very Feasible
2	Functionality Aspect	10	10	100%	Very Feasible
3	Text Quality Aspects	10	10	100%	Very Feasible
4	Image/Video Quality Aspects	5	4	90%	Very Feasible
5	Color Quality Aspects	5	4	90%	Very Feasible
6	Design Quality Aspects	10	9	95%	Very Feasible
7	Word and Language Usage	5	5	100%	Very Feasible

The results of the validation carried out by media experts indicated that AREAS was of good overall quality, especially in functionality aspect, text quality aspects, and word and language usage. The improvement notes from the media validators are described in Table 6.

Table 6. Media expert revision

Advice	Before	After
Add identity to the main page of the learning media.		

Add a bibliography to the menu page.		
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The validator highlighted the necessity of including a bibliography and an identity on the main page to ensure that the developer's name and the class description of the media created are clearly visible. This is in line with the research of Suhartini & Haerani (2022), that assert that plagiarism can be prevented by including a bibliography as a reference source.

Furthermore, validation was carried out by two material experts by assessing three aspects, namely learning design, material content and language and communication. The results of the validation by material experts are described in Table 7.

Table 7. Material expert validation

No.	Aspect	V1	V2	Persentase	Criteria
1	Learning Design	13	15	93,33%	Very Feasible
2	Material Content	12	14	86,66%	Very Feasible
3	Language and Communication	4	4	80%	Feasible

The results of the validation carried out by the material experts indicated that AREAS was rated overall as "Very Feasible" with an average percentage of 88.57%. Clarity of the module, relevance, and conciseness of the material were the most highly rated learning design components. Table 8 provides recommendations for enhancements from the material validators.

Table 8. Material expert revision

Advice	Before	After
Remove the exclamation mark from the title on the main page		

Convert foreign words to Indonesian



It is imperative to enhance writing skills and translate foreign-language terms into Indonesian within the aspect of language and communication according to PUEBI. Research by Sutrisno et al. (2023) found that students would comprehend the lessons more rapidly if they were delivered in Indonesian, as Indonesian is their primary language. Additionally, they would be able to comprehend the information more readily.

The implementation of AREAS for students in Class V C was carried out in several stages. First, a digital literacy pre-test was conducted to measure the students' initial skills. The results of this pre-test became a reference to see the development of the students' skills after using AREAS. Then, AREAS was implemented in the classroom. Operation of AREAS was granted to each student via their respective devices, as illustrated in Figure 7.



Figure 7. Students use the AREAS

The implementation process was successful, despite the presence of a few technical issues, such as unstable network connections. To overcome these obstacles, the researchers provided hotspots with better network quality. During the learning process, students were enthusiastic about exploring the different features of AREAS. After using AREAS, students accessed a post-test to measure the improvement of their digital literacy skills. A questionnaire was also given to the students to find out their opinion on the effectiveness of AREAS as a learning tool. Figure 8 shows the students filling in the questionnaire.



Figure 8. Students fill in student response questionnaires

The ADDIE model research procedure concludes with the evaluation stage. The objective of the evaluation is to determine whether the developed medium aligns with the initial requirements and objectives. The feasibility of the developed AREAS showed very satisfactory results. Material and media experts considered AREAS to be very feasible to use with an average score of 93.1% as can be seen in Table 9.

Table 9. Expert validation results

No	Aspect	Total Score	Percentage	Categori
1	Media Expert	115	95,8%	Very Feasible
2	Material Expert	62	88,5%	Very Feasible

Student responses to AREAS were also very positive. An average of 90.9% of the student responses to the questionnaire included the 'very feasible' criteria as depicted in Table 10.

Table 10. Students' responses results

No.	Aspect	Obtained Score	Maximum Score	Percentage	Criteria
1	Learning Motivation	469	525	89,3%	Very Feasible
2	Media Effectiveness	480	525	91,4%	Very Feasible
3	Language and Communication	292	315	92,6%	Very Feasible

The reason for the limited student response in the learning motivation aspect is that certain students find it challenging to access AREAS. Typing blunders are frequent, as they are required to manually input the URL. Research by Marhamah *et al.* (2023) found that user interaction with digital devices can affect user interest in using applications and websites. The achievement of the media effectiveness aspect is in line with the function of using learning media in teaching and learning activities according to Azhari (2015), namely, clarifying the presentation of learning materials and facilitating the limited experience gained by students. Regarding the language and communication aspect, some students stated that they can operate the interactive learning independently, and the instructions and text can be read clearly and well. The students' response on this aspect is in line with the media expert's assessment on the aspect of functionality and text quality, which received 100%. Similarly, the media and materials experts' evaluation of the language aspect is that the writing must be consistent with the students' level of mastery. This positive response from students is an indicator that AREAS has been well-received by users.

The n-gain analysis showed that AREAS was effective in improving students' digital literacy skills. Based on the data from the pre-test and post-test scores, the average student pre-test score was 56%, while the average student post-test score was 81.9%. The results of the n-gain analysis are shown in Table 11.

Table 11. Results of n-gain analysis

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
N-gain	21	.38	.97	.6168	.18394
N-gain percentage	21	38.18	96.55	61.6763	18.39450
Valid N (listwise)	21				

The n-gain analysis indicates a moderate increase in students' digital literacy skills, with a value of 0.61. The n-gain is classified as 'high' if it exceeds 0.7, 'medium' if it falls between 0.3 and 0.7, and 'low' if it is less than 0.3 (Hake, 1999). The

information and data literacy aspect received an average n-gain of 0.57. It is evident that certain students continue to encounter challenges when independently accessing the AREAS website. This is the result of a deficiency in the ability to navigate the internet and type URLs. According to the competencies of the information and literacy aspect in N. Law et al. (2018), technology users must possess essential skills, including the ability to search for and locate the appropriate information, evaluate the credibility of information sources, and utilize information wisely. The communication and collaboration aspect received an average n-gain score of 0.53. Some students reported that they encountered difficulty in locating the "share" button on their device's browser. One method to address browser display differences and encourage student collaboration is to optimize the use of the same browser when accessing learning media to establish a consistent digital learning environment regardless of the device used (Mustofa & Budiwati, 2019). The security aspect received an n-gain score of 0.63. AREAS provides a simulated scenario where a student's device is attacked by a virus. The digital security aspect can be improved by providing cybersecurity education in an interactive form. The technological literacy aspect received an n-gain score of 0.63. Students need to be able to recognise and use their devices to connect to the Internet. This is in line with one of the principles of digital literacy, namely the need for skills and knowledge to access and use different hardware and software applications (Silalahi et al., 2022).

CONCLUSION

The learning media namely AREAS (Augmented Reality Ecosystem) on ecosystem material is developed to improve the digital literacy of primary school students. This learning media is presented to students in the form of a URL, which is subsequently accessed through the browser of their device. Experts in media and materials have validated AREAS. The findings indicate that AREAS is very feasible for use as a learning resource. Class V C students gave a very positive response to the use of AREAS in their learning. They felt that AREAS significantly facilitated their comprehension of the material. The use of AREAS is quite effective in improving the digital literacy skills of class V C students.

It is advisable to consider the possibility of supporting applications that are readily accessible with limited Internet when developing similar interactive learning media, as AREAS still has a weakness that requires a stable internet network. Furthermore, it is strongly advised to create self-made augmented reality in order to enhance the AR display's originality by incorporating a variety of harmonious assets. In order to enhance students' digital literacy skills, researchers should provide application specifications for accessing learning media sites.

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