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Development of Card View Media Based on Augmented Reality Technology for Natural Resource Materials

Shellyna Febri Cahyaningrum[1*], Kurniana Bektiningsih[1]

[1] Elementary School Teacher Education, Universitas Negeri Semarang. Semarang, Indonesia.

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Corresponding Author:
Shellyna Febri Cahyaningrum
shellynafebri4@gmail.com

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Abstract: This research aims to develop an augmented reality-based Card View learning media on natural resource materials for 5th-grade elementary education. The study was conducted at SDN Bintoro 07 Demak involving 19 fifth-grade students as research subjects. The research method used was Research and Development (R&D) applying the ADDIE model. This research produced an augmented reality Card View created with an application called Assemblr Edu. The product underwent expert validation testing, resulting in a 85% validation rate from media experts and a 92.64% validation rate from subject matter experts. Student response to the media was 96.05%. Normality test results showed significance values (sig.) of pretest: 0.64 and post-test: 0.54. Paired Sample T-Test results indicated a significance value of 0.00. The N-Gain test produced a figure of 61%, interpreted as quite effective. From this research, it can be concluded that augmented reality-based learning media can be used as excellent quality supporting media for teaching natural resource materials.

Keywords: Augmented Reality; Card View; Instructional Media

Introduction

History shows that media development always follows technological advances. The development of technology and information in the 21st century has had an impact on various aspects of life, including education (Mardhiyah et al., 2021). Formal education must adapt and develop to equip students with competencies or skills that are relevant to the 21st century. 21st-century competencies are the skills students need to support the learning process, adapt to change, and face 21st-century challenges, problems, and careers (Ongardwanich et al., 2015; Redhana, 2019).

Education in Indonesia has only focused on the development of logical thinking skills. One of the factors that greatly influences the learning process and learning outcomes is the learning environment (Fajri et al., 2024). However, currently education has shifted towards creative, analytical, and innovative development (Wati & Sari, 2023). In the current learning process, learning media plays a very important role in helping to inspire students. Gagne and Briggs (Hamid, 2020) explain that learning media is a tool used to convey material content that is able to stimulate students when participating in learning. Purba (2020) also explains that media are components that exist in the environment of learners.

Apart from that, the use of augmented reality technology can also increase student involvement in the learning process. The ability to interact with content directly and in an attractive visual manner will help maintain students' interest in the material being studied. Thus, card view augmented reality not only helps bring SDA concepts into a more concrete form but also increases the overall effectiveness of learning. By using this approach, grade 5 students will be better prepared to understand the importance of preserving and utilizing natural resources in a sustainable manner, as well as to play an active role in protecting the environment and natural resources in the future.

Furthermore, the use of augmented reality technology can also enhance student engagement in the learning process. The ability to interact with content

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directly and in an engaging visual manner can help maintain students' interest in the material being studied. Thus, augmented reality card view not only helps to bring SDA concepts into a more concrete form but also enhances overall learning effectiveness. By employing this approach, 5th-grade students will be better prepared to understand the importance of conserving and sustainably utilizing natural resources, as well as to play an active role in protecting the environment and natural resources in the future.

For Indonesia itself, the world of education has just released its newest curriculum, namely the independent learning curriculum. Where the independent curriculum concept prioritizes learning approaches that provide opportunities for students to learn in a relaxed, relaxed manner, without pressure and stress, so they can explore their natural talents. The principle of the independent learning curriculum focuses on students' freedom of thought and creativity. Creative thinking is a thinking process that leads to the emergence of new ideas, perspectives, approaches, and methods for understanding something (Setiawan et al., 2019). Armed with creative thinking skills, students can overcome problems through various problem solving methods (Wanelly & Fauzan, 2020). In general, indicators of creative thinking ability consist of fluency, flexibility, originality, and elaboration (Aulia, 2023). However, the Indonesian Ministry of Education has specifically outlined the elements of creative thinking that Indonesian students must have, which are different at each stage. Fifth-grade elementary school students are included in Stage B, the elements of creative thinking that must be possessed include: generating original ideas, creating original works and actions, and having flexible thinking in finding alternative solutions. to problems (Kemendikbud, 2022).

Learning natural resources in social studies meta-lessons in elementary schools provides students with knowledge of the various natural resources that exist in Indonesia. Through learning about Natural Resources, students can know, utilize and conserve Indonesia's natural resources from an early age. Learning about natural resources in elementary schools is found in Semester 2 Sciences subjects which use the Merdeka Curriculum (Ghaniem et al., 2021).

The learning process at SDN Bintoro 07 Demak uses lecture method learning media and material in textbooks as learning media. Students' understanding is based on memorizing the material listed in the textbook and has not used interactive multimedia learning media. When learning natural resources material, students' understanding cannot only rely on memorization but must be done with good visualization so that students can easily understand the material given. Meanwhile, some students don't like reading. Using interactive learning media to help clarify concepts and processes that are difficult to understand, such as maps of the distribution of natural resources

Augmented Reality (AR) is a technology that enhances the real world by integrating virtual objects, creating interactive and dynamic user experiences (Adji et al., 2023). AR aims to match the concrete (real) environment with the virtual environment, enabling users to interact with physical and digital objects (Frasnyaigu et al., 2023). AR Learning Media provides experiences through 3D objects that will guide students to be able to imagine and understand objects (Vari et al., 2023). AR media is still considered a new technology, similar to multimedia, which plays a crucial role in supporting the learning process (Wilsa et al., 2023). Effective learning and training are essential in both education and business, resulting in more effective, interactive, and participatory learning (Kharisma et al., 2023).

There is a wealth of research demonstrating the significant benefits of AR as a valuable medium in educational contexts. Maulana et al. (2019) stated that AR has tremendous potential to increase student interaction and involvement in the learning process. One of the main benefits of AR in education is its ability to visualize abstract or complex concepts (Ewais & Troyer, 2019). By using digital elements integrated into the real world, AR allows students to view, manipulate, and interact with virtual objects directly. This can help students understand difficult concepts in a more real and concrete way (Aripin & Suryaningsih, 2019). AR also promotes experiential learning, where students can learn through hands-on, hands-on activities. By actively involving students in the learning process, AR helps increase student motivation (Liono et al., 2021).

Understanding Natural Resources (SDA) is an important aspect in the education curriculum for grade 5 students. Natural Resources include various elements such as air, water, land, forests, energy and biodiversity which provide vital support for human life and the ecosystem around us. It is important for students to understand how natural resources work, how to use them sustainably, and how to protect them from damage. However, the concepts related to natural resources are often quite abstract and difficult for young students to understand. Therefore, the use of learning media that can bring these concepts into a more concrete context is very important. This is where card view augmented reality becomes a very effective tool.

By using card view augmented reality, students can see real images of various aspects of natural resources, such as forests, oceans, or biodiversity, in a controlled environment in their classroom. They can directly interact with the content, rotating, zooming, or changing its viewpoint to suit their needs. This helps students to

visualize concepts that were previously difficult to understand more clearly and concretely.

Augmented reality was chosen because of its advantages in describing a building object in real 3 dimensions (3D). This is expected to foster the habit of planning, monitoring, and evaluating the learning process. In addition, many studies show that Augmented Reality is categorized as quite effective in influencing students' critical and creative thinking abilities (Jumanto et al., 2024). Has a positive influence on the material provided in the form of AR media (Widiasih et al., 2023). The use of AR media has a positive effect so that it is visually attractive and easy to learn (Limbong et al., 2023). AR-based learning improves students' literacy skills in the context of science subjects (Tetep et al., 2023).

The difference between previous research and this research lies in the selection of material used in the application and the school level used as a sample. Researchers took the initiative to use an augmented reality-based application called Assemblr Edu. Based on previous research, the way it works is to load virtual objects such as 3D models that can appear in a real environment to give users the feeling that virtual objects are in their environment. The material visualized using augmented reality is a science subject for natural resources material. Different from previous applications, this application visualizes various types of natural resources based on their groupings which include forestry, marine, and mining combined with 3D animations that present each of these sectors. Other features include explanatory videos, fun facts, discussion material, and quizzes for reflection.

Based on this background, researchers will conduct research on the influence of developing card view media based on Augmented Reality technology for natural resource materials.

Method

This research is research and development that uses the ADDIE (Analyze, Design, Develop, Implement, and Evaluate) model (Dick et al., 2015). The ADDIE model was chosen because it is in accordance with the research objectives, namely to develop card view media based on AR technology for science lesson content. The development will produce a product in the form of augmented reality card view learning media on natural resources material in fifth-grade. The research was carried out at SDN Bintoro 07 Demak in the 2023/2024 academic year with 19 students.

The analysis phase was conducted in four ways: conducting interviews with one 5th grade elementary school teacher, administering tests of critical and creative thinking abilities to 19 5th grade elementary school students, reviewing the curriculum documents applicable in Indonesia known as the "Merdeka Curriculum," and analyzing the developmental aspects of the participants selected as research samples. In the Design phase, a systematic and specific teaching material design was created, considering the suitability of content, language, presentation, as well as the models and learning strategies used. The Development phase included the development of media products, validation of media and materials, followed by limited testing. The Implementation phase involved implementing media for one class, collecting data on the effectiveness of the developed media. The final stage, Evaluation, was conducted to evaluate the developed media products based on student responses and field notes.

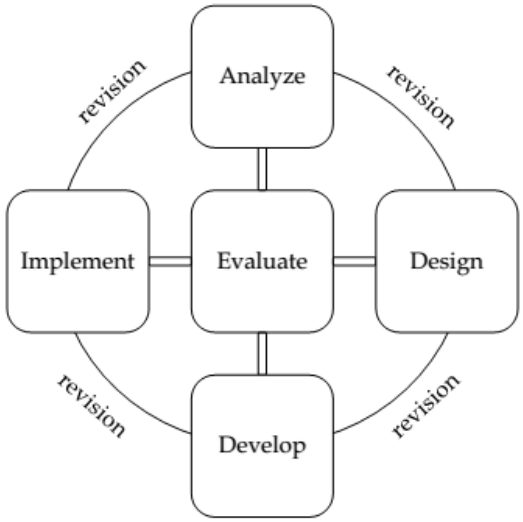

Figure 1. The ADDIE concept (Branch, 2009)

This research employs three data collection techniques. The interview technique is used to obtain data during the needs analysis and development stages. The questionnaire technique is utilized to gather expert validation data on the developed products and the effectiveness level of the products. The test technique is employed to acquire initial data on student comprehension abilities and to measure product effectiveness through pretests and posttests.

Data collection utilizes several instruments including: interview guidelines for conducting instructional media development interviews, evaluation questionnaires tested by media experts, evaluation questionnaires tested by subject matter experts, and student response questionnaires to gauge student feedback on the media. Data is analyzed both qualitatively and quantitatively. Qualitative analysis is conducted to process data from interview guidelines and questionnaire sheets, summarizing the data into descriptive information. Quantitative analysis is performed to process data from questionnaires and tests

to determine the quality, practicality, and effectiveness of the developed products.

The techniques used in data analysis include Normality Test, Paired Sample T-Test, and N-Gain Test. Normality Test is employed to verify that the data follows a normal distribution. Paired Sample T-Test is applied to assess the differences in students' interest and understanding of science before and after the implementation of the AR card view media. Additionally, the N-Gain Test is conducted to evaluate the effectiveness of the AR card view media in enhancing students' interest and understanding of Science.

The analysis of the results of the media suitability instrument test by experts and the distribution of student response questionnaires are interpreted using the following criteria:

Table 1. Interpretation of Expert Eligibility Criteria

Percentage	Criteria
86%-100%	Very worthy
76%-85%	Worthy
60%-75%	Decent enough
55%-59%	Not worthy
<54%	Not feasible

Result and Discussion

Product development and research is an augmented reality-based learning media called Card View. This product contains material on natural resources for fifth-grade elementary school, even semester. The product was created with the aim of being a learning resource for students in visualizing and introducing the concept of natural resources. Augmented reality is a form of technology that combines the real world (real word) and the virtual world (virtual word) into a real environment and then projects virtual objects into reality. The use of augmented reality-based learning media can help students in learning activities in the presence or absence of educators because the nature of augmented reality can be used anywhere and at any time (Mustaqim & Kurniawan, 2017).

The development of augmented reality card view media on the topic "Natural Resources" for fifth-grade science and science learning involves research and development stages that have been designed according to the ADDIE model. This product development process involves five steps which refer to steps in research and development strategies that have been proven effective. These stages include needs analysis, design, validation by experts, response testing by students, and evaluation of the products that have been created.

The first stage is analysis. This stage was carried out at SDN Bintoro 07 Demak which included: an analysis of the facilities and infrastructure at the school, especially the VA classroom, an analysis of the learning activity process, and analysis of the use of learning media during the learning process in the VA class. The entire analysis process aims to determine students educational needs and find solutions to increase learning effectiveness by developing media that suits their needs.

After the analysis stage, researchers continued to the second phase, namely design to develop augmented reality learning media. This process begins with the collection of all essential data needed to design the media, including the specified materials, the selection of appropriate applications, and the initial media creation concept. To visualize the development process, a flowchart was created that depicts the card view augmented reality media development workflow with symbols that explain each step visually, facilitating understanding and implementation of the project. Next, researchers prepared design sketches for augmented reality card media, integrating design ideas with targeted learning materials to simplify the design process. The creation of research instrument grids was also carried out to adapt to research needs and assessment specifications from various assessors, including material and media experts as well as educators and students. Finally, the researcher developed research instruments such as validation sheets and observation sheets as well as interview guidelines which not only aimed to assess the suitability of the media but also to collect responses from users regarding the effectiveness and acceptability of augmented reality learning media in the context of natural resource material in fifth grade science learning.

Next, in the development stage, the product begins to be made based on predetermined design specifications. Once the initial product is developed, it undergoes a refinement process that considers the specific needs and on-the-ground conditions of the students. The product then undergoes validation and testing process by material and media experts. After receiving validation, the product is refined again before being tested on students.

This learning media is designed using the Assemblr Edu application to integrate augmented reality technology into learning. The media is in the form of a physical card equipped with a marker image in the form of a barcode and instructions for its use. When the marker is scanned or aimed at, a 3D visual representation of the object will appear. After the scanning process, users will be directed to the Assemblr Edu page. This application is compatible with Android devices starting from version 10 (Android Q) to the latest version, Android 14 (Upside Down Cake). For users of devices with Android versions below 10, downloading

an additional application is required to be able to process scan results.

This development research produces card view augmented reality learning media products on natural resource material in fifth-grade elementary school. This media was created with an application called Assemblr Edu. The learning materials contained in this media are: learning objectives, understanding of natural resources, grouping of natural resources, benefits of natural resources, impact of using natural resources, and efforts to preserve natural resources, as well as additional slides showing visualization of conditions natural resources in forestry, marine, and mining which are equipped with special buttons that display fun facts related to these fields, as well as a quiz menu on the home page. The following displays the media that has been developed

Figure 2. Card View media display when scanned

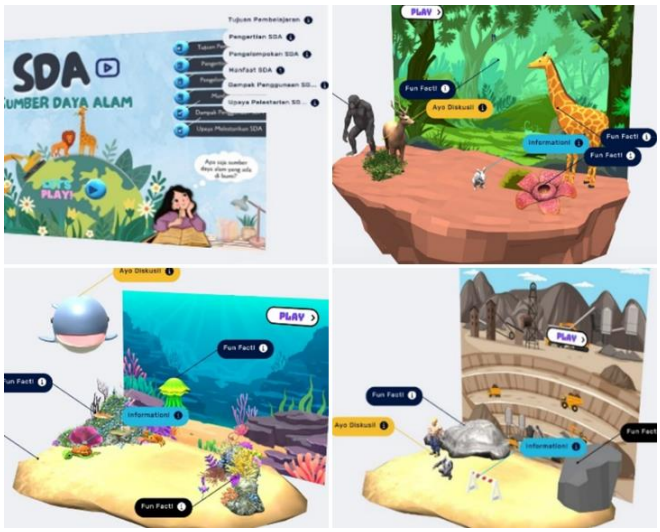

Figure 3. Home on the card view menu after scanning

Card view learning media based on augmented reality was assessed for its suitability by media experts and material experts. The validation results are presented as follows.

Table 2. Media expert validation

Assessment aspects	Score
Relevance to the topic	11
Media display design	20
Media use	10
Advantages of media	10
Total score	51
Number of instrument items	15
Maximum total score	60
Percentage	85%
Eligibility categories	Worthy

From the media validation results in Table 2, it can be concluded that the Augmented Reality-based Card View learning media received the "Worthy" category.

Table 3. Material expert validation

Assessment aspects	Score
Suitability of IPAS material	18
Material suitability	29
Language compatibility	16
Total score	63
Number of instrument items	17
Maximum total score	68
Percentage	92.64%
Eligibility categories	Very worthy

From the results of material validation in Table 3, it can be concluded that the material presented in the augmented reality-based Card View learning media received the "Very Worthy" category.

The results of Table 3 state that the highest average score obtained from validation results by material experts was 92.64%. This can be concluded that the learning media presents appropriate material, namely natural resource material. These results are relevant to the criteria for selecting learning media according to Kustandi & Darmawan (2020) one of which is choosing media that suits the material and can support the lesson content.

Based on the validation results carried out by experts (media experts and material experts), the following scores were obtained.

Table 4. Expert Validation Mean

Validation results	Percentage	Category
Members of the Media	85%	Worthy
Materials expert	92.64%	Very worthy
Rates	88.82%	Very worthy

Next is the implementation stage. Sugihartini et al. (2018) stated that at the implementation stage validation can be carried out with experts to determine the suitability of the media that has been developed. This stage includes the application and testing of products that have been developed in learning activities to assess

their effectiveness and attractiveness for students. This product trial was carried out by teaching staff involving 19 students in the VA class at SDN Bintoro 07 Demak, but only 10 of them were respondents. After conducting product trials, researchers continued to apply the Card View Augmented Reality learning media on a larger scale to 19 VA class students. Before carrying out learning activities with this media, students will fill out a pre-test question sheet. After that, students will also fill out a post-test sheet which is distributed after the learning process using Card View media to determine the level of students' understanding of natural resource material with the help of Card View media.

Table 5. Pre-test and Post-test Results

	Results	
	Pre-test	Post-test
Number of questions	20	20
Lowest value	30	60
The highest score	75	100
Average value	50.26	79.73

The findings from both the pre-test and post-test indicate a noticeable improvement in student learning outcomes following the utilization of Augmented Reality-based Card View media.

In the final stage, namely product development evaluation, the results of all the processes that have been carried out will provide an assessment of the quality of the product being developed. Researchers will evaluate the suitability of the product and make necessary improvements to ensure that the product is ready to be used in the learning process. From this activity, researchers collected data which was then analyzed to get feedback and suggestions for using the media being developed. During the implementation stage, students will fill out a questionnaire containing questions about the use of augmented reality (AR) card view media. This questionnaire is designed to assess the feasibility and effectiveness of AR media in supporting the learning process for fifth-grade science subjects.

Table 6. Results of Student Responses

		Indicator
	Media	Material
Total	109	55
Number of questions	6	3
Maximum total score	114	57
Percentage	95.61%	96.49%
Rates		96.05%
Category		Very good

The results of student responses in Table 6 can be concluded that augmented reality-based learning media received a "Very good" response.

To evaluate the efficacy of the developed Card View learning media, a knowledge assessment was conducted involving a pre-test and post-test administered to 19 students. The evaluation process employed the Normality test, Paired Sample T-Test, and NGain test. Below are the results obtained from the data analysis.

Table 7. Normality Test

			Shapiro-Wilk
	Statistic	Df	Sig.
Pre test	.96	19	.64
Post test	.95	19	.54

Data from both the pre-test and post-test of students regarding IPAS demonstrate normal distribution, as evident from the Shapiro-Wilk test results in Table 7, with significance values (sig.) greater than 0.05 (pretest: 0.64; post-test: 0.54).

Table 8. Paired Sample T-Test

				Paired differences		
	Mean	Std. Deviation	Std. Error mean	t	df	Sig. (2-tailed)
Pretest-Posttest	-29.47	4.37	1.00	-29.35	18	.00

On the other hand, the results from the Paired Sample T-Test revealed noteworthy outcomes, indicating a substantial disparity in IPAS learning outcomes prior to and following the utilization of AR card view media. The significance value (sig.) of 0.00, being less than 0.05, suggests a positive impact of AR card view media on learning outcomes.

Table 9. NGain Test

	N	Mean	Std. Deviation
NGain	19	.61	.13

N-Gain analysis shows the effectiveness of AR card view media in improving student learning outcomes towards IPAS. The N-Gain value of 0.61 is in the medium category ($0.3 \leq g \leq 0.7$) or can be interpreted as 61% with the interpretation being quite effective (56-75). So the use of Card View learning media has proven to be quite effective.

Abidin et al. (2020) support that augmented reality learning media can make learning not boring. Learning media with augmented reality also provides a significant increase in learning motivation (Shariff, 2024) which is proven based on validation test results from experts (media experts and material experts) showing that the average percentage of validation test results is 88.82%. Based on these findings, it is evident that the

development of augmented reality learning media has met the assessment criteria and can be classified as highly suitable for enhancing science education, particularly in instructing fifth-grade students on natural resource materials in elementary schools.

The feedback from 19 fifth-grade students at SDN Bintoro 07 Demak regarding the augmented reality-based Card View learning media for natural resources also demonstrated an average satisfaction rate of 96.05%, classified as highly satisfactory. This affirms that the media has garnered positive reactions from students, reflecting their enthusiasm for using it in learning. Students express delight in utilizing this learning tool as it offers them a new learning experience. Android-based mobile learning media has succeeded in improving learning outcomes (Ardiansyah & Nana, 2020). In line with that, Mandailina et al. (2021) based on the results of their research, explain that learning from various online learning sources is able to increase student motivation and learning outcomes by 70%, which is in the strong category.

Augmented Reality (AR) technology promises a revolution in education by providing a more immersive and engaging learning experience (Akçayır & Akçayır, 2017; Nijholt, 2023). This technology immerses students in various visualizations, audios, and simulations, enhancing their interest in the subject matter (Al-Ansi et al., 2023). Additionally, AR helps to clarify abstract concepts, making them easier to understand in a real-world context (Al-Azawi & Shakkah, 2018). The development of this learning technology opens up new opportunities to explore different pedagogical methods in an interactive environment (Beck, 2019). As we enter a new era of digitalized education, it is crucial for academics, educators, and teachers to prepare and integrate this innovation into the curriculum (Kamińska et al., 2019; López-Belmonte et al., 2023). With a focus on creating educational materials that effectively support the educational system (Criollo-C et al., 2021). AR is not just a trend but an essential tool that will continue to be evaluated for its effectiveness in improving learning outcomes (Nguyen et al., 2019).

The outcomes of the NGain test concerning the utilization of Card View learning media have verified its effectiveness. In addition, the existence of learning media using smartphones allows students to play and learn simultaneously, which facilitates exploration in understanding the concept of natural resource material. As stated by Mayke (Rifa'i, 2020), learning while playing provides students with the opportunity to discover for themselves, repeat, manipulate, and gain immeasurable understanding so that a more effective learning process occurs. Thus, the integration of smartphone-based learning media with a play approach can increase learning effectiveness and broaden students' understanding of learning material.

Conclusion

From the discussion provided, it can be concluded that the utilization of Card View Augmented Reality (AR) learning media offers a modern and engaging solution for implementation in the context of school education. AR technology allows users to interact directly and swiftly with virtual content, enhancing student participation in the learning process. Research findings also indicate that AR has proven effective in improving learning outcomes and elucidating abstract concepts. Thus, augmented reality-based Card View media can be used as excellent quality supporting media for teaching natural resource materials.

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Author Contributions
Designing the research, conducting the research, curating the data, and writing the research article, SFC; reviewing the original draft and providing feedback, KB.

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The authors declare no conflict of interest.

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