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Improving students understanding with teaching materials based on augmented reality video animation

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ABSTRACT

In the contemporary era marked by profound societal shifts influenced by technology, the increasing integration of digital devices into educational settings necessitates a closer examination of educators' proficiency in leveraging these resources. Despite the availability of state-of-the-art learning facilities at SDN Bunulrejo 1 Malang, the limited optimization of digital tools by teachers presents a critical gap. In contrast, students exhibit a proclivity towards enhanced learning experiences facilitated by digital devices. This study endeavors to elucidate the outcomes of research and development pertaining to augmented reality video animation (ARVA) instructional materials, a mobile-based digital teaching resource. Adhering to the Lee and Owen model encompassing assessment/analysis, design, development, implementation, and evaluation phases, this research engages 18 fourth-grade students and two expert validators (design and material experts). The design expert validation yielded a commendable score of 109 (72.6%), indicative of adequacy, while material expert validation attained a score of 103 (68.6%), similarly meeting adequacy standards. Subsequently, post-implementation, students' average learning outcomes, with a mean score of 75.27, demonstrated a commendable understanding of materials science concepts, qualifying as "good" and meeting the minimum criteria for completeness. In conclusion, the integration of ARVA into pedagogical practices emerges as a promising avenue, bridging the gap between technological resources and effective learning outcomes, as evidenced by the positive impact on students' comprehension of materials science concepts. This research contributes valuable insights into optimizing digital tools for educational purposes, offering a blueprint for future enhancements in instructional materials.

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Introduction

Major life changes have occurred, wherein humans have become influenced by and dependent on technology (Widiasanti *et al*., 2023). Rapid technological advances also stimulate

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the development of the education system, particularly in the realm of learning (Sudibjo, N., Idawati, L., & Harsanti, 2019). In the past, learning was typically conducted in a traditional classroom setting. Currently, learning can be digitally facilitated. Consequently, schools must adapt by making adjustments to accommodate these evolving developments (Sajidan *et al*., 2020). In this research, the primary subject of investigation was SDN Bunulrejo 1 Malang. The school is dedicated to continually enhancing the quality of education, with a focus on developing technology-based learning. However, a challenge arises as not all teachers can effectively utilize these technological resources. Their predominant use involves PowerPoint slides and videos from YouTube as instructional materials in the classroom. SDN Bunulrejo 1 Malang boasts sufficient learning facilities, including a computer laboratory and 48 tablets available for both teachers and students. Additionally, each classroom is equipped with projectors. All teachers possess smartphones, and students have access to similar devices under parental guidance. Failing to optimize these ample facilities would be a missed opportunity.

The presence of technology has made it possible for teachers and students to connect anytime and anywhere (Szymkowiak *et al*., 2021). The role of technology in learning encompasses infrastructure, teaching materials, learning facility aids, research information sources, consultation media, and learning media (Dzulqornain *et al.*, 2023). This condition necessitates that teachers and students must adapt to its use in learning to facilitate collaborative activities (Safitri *et al.,* 2023). Until now, investigations into the utilization of gadgets in learning have focused on two aspects. Firstly, the enhancement of using gadgets as teaching materials remains an area for improvement. Secondly, the regulations pertaining to the use of gadgets in schools exhibit limited adaptability. This article seeks to elucidate the progress in developing teaching materials that leverage gadgets. The incorporation of gadgets equipped with adaptive technology can foster engaging and collaborative learning experiences that promote meaningful educational outcomes (Gonzalez-Acevedo, 2016). Nevertheless, it is essential to emphasize that the use of gadgets in learning must be carefully regulated (Hidayatuladkia *et al*., 2021). Both teachers and parents must play a role in accompanying students (Witarsa, *et al*, 2018). The excessive use of gadgets leads to redundancies in learning, one of which is addiction (Nafaida *et al*., 2020). This research and development are expected to enhance students' understanding of material concepts. The selection of methods and strategies in technology-based learning must be carefully planned (Handoko *et al*., 2021). This aims to avoid misunderstanding of concepts among students (Wall *et al*., 2023). Therefore, teachers and researchers must be able to determine appropriate learning facilities for students (Handayani *et al*., 2022).

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This research emphasizes the development of teaching materials utilizing augmented reality video animation (ARVA) technology. The product is expected to captivate students' attention, enhance motivation and learning outcomes, and facilitate a better understanding of the material being taught. Augmented reality integrates virtual objects into the real world, providing an interactive experience in real-time through 3D animation (Azuma *et al.*, 2001). Meanwhile, animated video is an audio-visual program displayed as a moving cartoon (Sukarini & Manuaba, 2021). The positive trend regarding the development of augmented reality-based teaching materials can at least be explained as follows: (1) augmented reality teaching materials can be used independently or collaboratively in the classroom (Setyawan *et al*., 2019), (2) augmented reality has presented a new way of using gadgets for teachers and students in learning (Ozcakir & Cakiroglu, 2021), (3) interactive learning, game-based learning, collaborative learning, and experiential learning are strategies that can be integrated with augmented reality teaching materials (Hanid *et al*., 2020), (4) augmented reality-based teaching materials designed according to needs can increase learning motivation and new experiences for students (Taskiran, 2019), dan (5) when compared with traditional learning, the application of new technology in augmented reality-based learning can improve interactivity, student interest, and concept understanding (Demitriadou *et al.*, 2020).

Furthermore, ARVA in this research was applied in Ilmu Pengetahuan Alam dan Sosial (IPAS/Natural and Social Science), with the theme "*Tumbuhan, Sumber Kehidupan di Bumi*." IPAS involves learning about science and social science, including studies about nature, technology, environment, geography, history, and culture (Fatimah & Kartika, 2013; Irsan, 2021). Meanwhile, the aim of teaching plant material to students is for students to understand the material so that students can have the opportunity to develop their thinking abilities, relate the material to everyday life, the ability to work together and become independent learners (Imamah, 2012; Marín & Castañeda, 2023). The problem with IPAS is the lack of understanding of students in understanding the concept and also the boredom felt during the learning process. To create innovative learning, teachers are required to be capable of utilizing technology. conveyed that the appropriate use of technology in learning can help teachers and students achieve joint learning goals.

Method

This research and development follow the Lee and Owen (2004) model, which comprises stages in the development process: (a) assessment/analysis, (b) design, (c) development, (d) implementation, and (e) evaluation. These stages are illustrated in Fig 1.

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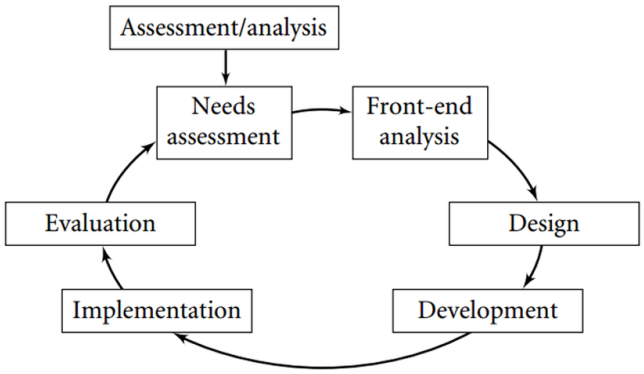

Fig 1. Lee and Owen Development Model (Aka, 2019)

This research was conducted at SDN Bunulrejo 1 Malang, selected for its ample learning facilities, which include 48 tablets, a computer laboratory, and projectors in each classroom. These resources meet the minimum requirements for facilitating learning with ARVA. The research involved students and validators as subjects, with students serving as the primary test subjects and validators assessing the suitability of the media. The participant pool consisted of 18 students from class IV and two expert validators (design and material experts). To evaluate the feasibility of the product, a product feasibility questionnaire served as the measurement instrument. Validators completed the questionnaire to assess the product's suitability for testing. Subsequently, measurements of students' comprehension levels were derived from the test results. Following the product's testing on students, they engaged in questions and assessments administered by the teacher. Students were deemed to understand the material if their scores met the minimum completeness criteria. The research encompasses two types of data: qualitative and quantitative. Qualitative data emanates from responses from validators, students, and the researchers' initial observations. Quantitative data is derived from expert validator assessments, student grades, and other numerical information. Expert validators provided evaluations based on the questionnaire, which featured five answer choices using a Likert scale: very good (5), good (4), fair (3), not good (2), and very poor (1), as outlined in Table 1.

Table.1 Rating Scale (Putra & Afrina, 2023)

Category	***Score***
Very good	5
Good	4
Fair	3
Not good	2
Very poor	1

The developer consults the eligibility criteria table (Table 2) to interpret and determine the product being tested's predicate and the level of success in student learning.

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Table.2 Product Eligibility Criteria

Category	*Percentage Rate*	*Qualification*	*Equivalent*
A	80% - 100%	Very good	Very Adequate
B	60% - 79%	Good	Adequate
C	50% - 59%	Fair	Not Adequate
D	0% - 49%	Not good	Not Adequate

Results and Discussion

1. Need Analysis

The needs analysis involves the collection of initial data, revealing the following: (1) students exhibit highly varied learning styles, (2) students express a preference for enjoyable and novel learning experiences, (3) there is a relatively high level of technology acceptance among students, as evidenced by their proficiency in using electronic devices such as smartphones, laptops, televisions, and computers, (4) a significant majority of students consistently access videos through social media platforms such as YouTube, TikTok, and Instagram, (5) more than 50% of students engage in cellphone gaming as a hobby, and (6) students exhibit a disinclination toward learning solely through reading books. Based on these preliminary findings, it is inferred that students would find electronic devices more conducive to learning than traditional methods. In this context, ARVA is considered a viable choice for teaching material. The introduction of ARVA as an engaging instructional tool is anticipated to enhance students' comprehension of material concepts. This aligns with the perspective expressed by Arianti (Arianti, 2019), who emphasized that the availability of teaching materials serves as a tool to support students' learning progress. Nonetheless, digital-based media, including ARVA, must ensure enhanced guarantees for favorable student learning outcomes. The adoption of the appropriate method/strategy remains imperative for implementation, as emphasized by Raja and Nagasubramani (Raja & Nagasubramani, 2018).

2. Design

During this stage, mapping is conducted concerning the material or content that will be developed, as highlighted by Aka (Aka, 2019). Researchers seek guidance from teachers to determine the material and learning objectives to be achieved. Subsequently, recommendations are sought for the primary sources of material that teachers typically employ in their instructional materials. Ultimately, a mapping design is obtained, as presented in Table 3. Meanwhile, the learning objectives encompass (1) identifying the body parts of plants and their functions, (2) elucidating the process by which plants obtain food and its benefits for humans, (3) comprehending plant reproduction through various means, including vegetative and generative reproduction, (4) making observations on plants and adeptly recording the results of these observations, and (5) conducting experiments on the

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photosynthesis process and meticulously recording the observed results.

Table.3 Learning Development Design

Learning Materials	***Method/Strategy***	***Learning Materials***
The subject of IPAS Chapter 1: *Tumbuhan, Sumber Kehidupan di Bumi* 4th grade students of SDN Bunulrejo 1	Collaborative learning Mini research	ARVA (picture books and animated videos integrated with augmented reality) Devices and applications: Tablet armix.apk Unity

3. Development

The development stage in this research centers on the production of teaching materials, resulting in a student book integrated with augmented reality technology. The student books were crafted using Canva (click here to view). The book comprises various sections, including the cover, developer profile page, usage instructions, learning objectives, educational content, and assessment questions for students. Within the book, several sections are integrated with ARVA. Students can scan images, following the provided instructions, using a tablet with the armix.apk installed. The animated videos are created using the Adobe Animate application. Meanwhile, the development of armix.apk involves the integration of Unity and Vuforia applications. Unity and Vuforia are two applications employed for the development of digital 3D media. Through these applications, developers can establish markers linked to animated videos (Sarosa *et al*., 2019). Teaching materials packaged in augmented reality are believed to increase student motivation and learning outcomes (Kim *et al*., 2014). To see the final media results, visit the following link https://youtu.be/JuyuS3yLKtE.

4. Implementation

Implementation activities involve conducting product trials with two expert validators. The first is a design expert validator, authorized to provide input on the appearance of ARVA products. The second is a material validator, authorized to provide input on the learning content within ARVA products. Additionally, a focus group discussion was conducted at this stage to gather more detailed suggestions for improvement. The validation results are presented in Table 4. The suggestions derived from the focus group discussion results include the following: (1) Design experts pointed out the need for clarification of several images and illustrations in the book, necessitating a rearrangement of the images. The font type and selection of animated characters are deemed captivating and are believed to capture students' attention during study. The videos that appear upon scanning by students are intriguing, but attention must be given to voice intonation and clarity to ensure students easily understand the conveyed meaning. (2) Material experts indicated that the learning content presented in the product is commendable. The content could be further enriched by adding chapters to

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make it more engaging, although considering the limitations of this research, material experts acknowledged that additional chapters could be explored in future research. The revised product underwent testing on students, following the learning flow outlined as follows: (1) the teacher initiates the lesson, (2) the teacher outlines the learning objectives, (3) a brief introduction to the material "Plants, the Source of Life on Earth" is provided, (4) students are encouraged to observe plants in the school environment, (5) teachers employ predetermined methods/strategies for teaching (observation of the surroundings, discussions, making anecdotal notes, *etc*.), (6) teachers and researchers familiarize students with ARVA for learning, (7) teachers reflect on the material studied, (8) the teacher conditions students for evaluations, and (9) the teacher acknowledges and appreciates students for their demonstrated learning motivation. The results of the student evaluation will be elaborated on in the subsequent stage.

Table.4 ARVA Product Validation Results

Evaluation	***Score***	***Category***
Design Expert	109 (72.6%)	Good/Adequate
Material Expert	103 (68.6%)	Good/Adequate
Amount	106 (70.6%)	
Final Recommendation	The media is well developed and suitable for testing on students	

5. Evaluation

The percentage of student learning outcomes reveals positive data, with only two students receiving poor grades. In contrast, 16 other students scored above the Minimum Completeness Criteria. The average overall score is 75.27, categorized as good (refer to Table 5). This suggests that ARVA teaching materials effectively facilitate students in grasping the fundamental concepts of the material "*Tumbuhan, Sumber Kehidupan di Bumi*."

Table.5 Student Learning Outcomes

Student Identity Number	***Learning Value***	***Category***
5535	50	Fair
5541	80	Very Good
5542	75	Good
5768	75	Good
5551	45	Fair
5556	80	Very Good
5559	70	Good
5563	80	Very Good
5566	75	Good
5568	80	Very Good
5687	95	Very Good
5571	80	Very Good
5685	70	Good
5585	85	Very Good
5586	75	Good
5594	80	Very Good
5596	75	Good
5599	85	Very Good
Mean	75.27	Good

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Conclusion

ARVA (Augmented Reality Video Animation) serves as a teaching material in this research, aiming to assist students in comprehending the fundamental concepts of the material "Plants, the Source of Life on Earth." Developed specifically for class IV students at SDN Bunulrejo 1 Malang (comprising 18 students), this teaching material underwent testing by two validators (design and material). The validation results affirm that ARVA media meets the criteria for suitability in student testing. Ultimately, the students' learning outcomes demonstrate positive results, meeting the minimum completeness criteria. This research suggests potential for further development, emphasizing that digital-based open materials like ARVA hold the appeal for students. The introduction of innovative teaching materials is anticipated to enhance student learning motivation. Thus, there is an optimistic expectation that ARVA products can serve as a sustainable alternative for open materials. Furthermore, there is potential for expanding the materials within the product, extending beyond a single subject.

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