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An Augmented Reality-Based Interactive Learning Application for Teaching Food Chains in Elementary Schools

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Abstract

Augmented Reality (AR) media is considered important due to its ability to engage elementary school students. The purpose of this study was to develop an AR-based application for teaching food chains in elementary schools. This research followed the Research and Development (R&D) model proposed by Borg & Gall. Data were collected through assessment sheets completed by expert validators, and data analysis involved both quantitative and qualitative methods. The results showed that: 1) the media received a feasibility score of 4.71; 2) the material received a score of 4.11; 3) practitioners rated the media highly, with a score of 4.83; and 4) in the limited trial, 8 out of 10 students scored above the Minimum Mastery Criteria in quizzes. Therefore, it can be concluded that the AR-based food chain application is highly feasible for use in elementary schools. Through AR, students can observe in real time how plants, herbivores, carnivores, and decomposers interact within an ecosystem.

INTRODUCTION

Background of the Study

Intellectual development continues over time, and curriculum changes are necessary to support this ongoing growth and adapt to societal transformations (Prasetyo & Sutama, 2022). The learning process, particularly in basic education, also evolves over time, including changes in learning models, approaches, and strategies (Ernawanto et al., 2022). This evolution is closely linked to the objectives of learning, one of which is the teaching of biology in elementary schools.

The intellectual demands of the 21st century are increasing rapidly, necessitating continuous development in knowledge-building processes (Sundari et al., 2022). Therefore, teachers must implement learning methods that help students meet these intellectual challenges (Diana & Turmudi, 2021). Students are expected to actively seek new knowledge and utilize their full potential (Zhang et al., 2020). Similarly, students are required to be more proactive in acquiring knowledge (Ülkü Kan & Murat, 2018). To achieve this, the development of digital-based learning media is recommended (Qorimah et al., 2022). Previous studies have shown that digital-based learning can enhance the effectiveness and efficiency of the learning process (Qorimah & Sutama, 2022).

Problem of The Study

An effective and efficient learning process should include interactive, fun, challenging, and motivating elements, and provide students with opportunities to develop their creativity and independence based on their interests and talents (Mustaqim, 2017). Conventional learning is often limited by insufficient media and resources, such as a lack of laboratory facilities, and teachers tend to use traditional teaching methods. As a result, students find science subjects uninteresting (Swargiary, 2023). Although teachers act as facilitators and students are expected to be more active, teachers must create an encouraging learning environment that stimulates student engagement (Bahçeci & Yaratan, 2020). Fun learning activities are influenced by various factors, one of which is the selection of learning media, which should be attractive and interactive without compromising the integrity of the content (Priyadi, 2022). The use of learning media in the teaching process can enhance students' motivation and help them better understand concepts (Qorimah et al., 2022). Based on previous literature, many learning media have been shown to improve student participation, but Vidak et al. (2022) recommend the use of augmented reality (AR)-based digital media. Augmented reality is a technology that combines the real world with virtual elements in two- or three-dimensional forms, projected within a real environment (Mustaqim, 2017). In simple terms, it merges virtual objects with real ones through a computerized process, making them appear as if they are physically present (Sesa, 2022). Research findings from Yuliono et al. (2019), Amdani et al. (2022), and Tuta & Luić (2024) indicate that the use of augmented reality in learning has a significant impact on students' cognitive abilities.

Research's State of the Art

The concept of the food chain refers to the transfer of energy between organisms at different trophic levels through the process of predation and consumption in a specific sequence (Rustamaji, 2022). The study of food chain concepts has significant implications not only for science and technology but also for everyday life. Furthermore, food chain-related topics frequently appear in elementary school examinations (Prastya & Widiarini, 2022). Based on this, the food chain was selected as the subject of study, as it has the potential to stimulate students' higher-order thinking (Guerrero et al., 2018; Subran & Mahmud, 2024).

Augmented reality (AR) is based on three key principles: first, the integration of the real and virtual worlds; second, real-time interactivity; and third, the three-dimensional integration of virtual objects into the real environment. In simpler terms, augmented reality involves adding virtual elements to a real-world setting. The combination of real and virtual components is made possible through appropriate display technologies, while interactivity is achieved through input devices such as sensors or touchscreens. Augmented reality can be considered a variation of virtual environments, often referred to as virtual reality (Supriyanto et al., 2023). This technology enables the insertion of digital information into the real world, which is then displayed using devices such as webcams, computers, smartphones, or specialized glasses (Qorimah & Sutama, 2022). The primary goal of

augmented reality is to enhance human understanding by building upon the real world through the integration of virtual elements and contextual data, such as audio commentary, location-based information, historical context, or other relevant forms. Today, augmented reality is widely applied across various fields, including medicine, military, manufacturing, entertainment, museums, educational games, and formal education.

One rapidly developing technology is augmented reality. AR involves the overlay of virtual elements—such as text, images, and animations—onto the real world, enabling users to engage with their surroundings in a more attractive and interactive manner (Prastya & Widiarini, 2022). The application of AR technology in the design of learning media offers an engaging alternative for introducing the concept of the food chain. This paper explores how to develop 3D augmented reality-based learning media for teaching the food chain, with the aim of increasing interest among younger learners.

Gap Study & Objective

Presenting the food chain in animals must be done in a more engaging and interactive way, as this is essential for stimulating and fostering students' interest in the subject. Observations at Nuril Elementary School, Class V, regarding the teaching of food chain concepts showed unsatisfactory results, as most students did not understand the material explained by the teacher. This may be due to the abstract nature of the content, which is not fully grasped by all students. Therefore, a technology-based approach is needed to transform abstract concepts into tangible representations through animation.

Augmented Reality (AR) media has been studied using qualitative, quantitative, classroom action research, and Research and Development (R&D) methods. Korenova et al. (2019) and Yilmaz (2021) conducted qualitative studies that described the use of AR. Aripin and Suryaningsih (2019), Bakar (2024), and Cahyaningrum et al. (2024) carried out quantitative research to examine the effect of AR media on students' interest in science education. Du et al. (2023) conducted classroom action research using AR media to improve the vocabulary of autistic students through sports videos. Swan and Gabbard (2014) and Wang (2024) performed R&D studies to develop AR-based learning materials on solar system topics.

As a result, although AR media has been used as an educational tool, there is no existing research focused on the development of AR-based applications specifically for food chain materials. Therefore, further research is needed on the development of augmented reality-based learning media for the food chain.

METHOD

Type and Design

This study is a Research and Development (RnD). The purpose of this study is to develop or produce a product. The development in this study used the Borg & Gall research procedure which was modified by Sugiono (2017) with steps including needs analysis, problem identification and data collection, product design, design validation, design revision, and product effectiveness, in this research will be discussed in starting from needs analysis to testing product effectiveness.

Data and Data Sources

This study utilised two types of data: primary data, which included interview responses from two teachers and ten fifth-grade students at a private elementary school in East Java, and secondary data, consisting of photographic documentation and interview transcripts obtained from the same group of teachers and students. The data sources comprised ten fifth-grade students, one lecturer functioning as a material validator, one lecturer serving as a media validator, and one teacher acting as a practitioner. The study was conducted at a private elementary school in East Java.

Data Collection Technique

This study utilised a data collection method in which the validator completed an assessment sheet. The data analysis approach for the product trial included both quantitative and qualitative assessments. Quantitative data was obtained from assessment sheets completed by material experts, media experts, and practitioners to evaluate the viability of the developed media. An assessment sheet was used as a validation tool to assess the feasibility of the augmented reality-based food chain application. The instrument was validated by the validator prior to use. The questionnaire was completed by a lecturer acting as a media and material expert validator, and by a fifth-grade teacher from the observed school, who served as a practitioner validator. Qualitative data was collected and later quantified using validation sheets distributed to material experts, media experts, and practitioner experts. This phase involved expert testing and product evaluation to determine the viability of the developed product for students.

Data Analysis

In this study, data analysis techniques were carried out qualitatively and quantitatively. Qualitative data analysis techniques were carried out using an interactive model that includes data reduction, data presentation, and data verification. Meanwhile, qualitative data is obtained from the value of the assessment sheet which is converted into quantitative data and also the results of observations of students. For quantitative data analysis carried out on the questionnaire, quantitative descriptive statistics were used, as explained in the data conversion guide. The data results are then converted into qualitative values as a reference for category assessment based on the value conversion table (see Table 1 in below).

Table 1. Validation Criteria

Validation Criteria	level of validity
4.01 – 5.0	Very Valid
3.01 – 4.0	Quite Valid
2.01 – 3.0	Less Valid
0.01 – 2.0	Invalid

RESULTS

In this study, the researchers employed a research and development (R&D) model based on the framework developed by Borg and Gall, which was adapted by Sugiyono (2017) into six stages: needs analysis, problem identification and data collection, product design, design validation, design revision, and evaluation of product effectiveness. The following section outlines the findings of the research process.

During the needs analysis phase, the researchers conducted a literature review, classroom observations, and interviews with class teachers. Two key findings emerged. The first was related to the analysis of learning materials. This was carried out through a review of thematic textbooks for fifth-grade elementary students, specifically Theme 5, Sub-theme 2, Learning 1, which contains content on natural science, including information on food chains. The core competencies addressed in the science curriculum are: 3.5, which involves analysing the relationship between ecosystem components and food webs in the surrounding environment; and 4.5, which focuses on creating work that demonstrates the concept of food webs within an ecosystem.

A concept analysis was then performed, categorising concepts into various types: concrete concepts, abstract concepts without observable examples, abstract concepts with concrete examples, concepts based on principles, concepts involving symbols, concepts describing processes, concepts naming attributes, and concepts describing size attributes. This classification aimed to identify suitable concepts for the development of Augmented Reality (AR) media. It was determined that materials

primarily consisting of abstract concepts were more appropriate for AR-based learning, as such concepts can be more effectively visualised and understood through this technology.

The second finding in the research relates to the analysis of teachers' and students' needs. To identify the need for developing augmented reality media, an initial analysis was conducted through the distribution of questionnaires to assess the classroom environment and available facilities. With regard to teacher needs, it was found that the current learning media used in class consists of pictures drawn by the teacher on the blackboard. Digital media has not been used as a teaching tool. While these teacher-drawn pictures are clear in explaining the material, they lack colour, which reduces student interest. Furthermore, teachers face challenges in developing learning media due to limited funding and a lack of student creativity. Teachers also expressed the need to improve the use of learning media, suggesting that augmented reality media could serve as a suitable solution. This medium would make learning more engaging and enjoyable, as it is based on games and technology that can be accessed via students' mobile phones. As this type of media has never been implemented before, teachers believe it could enhance students' interest in learning activities.

The problem identification stage was obtained from a literature review and data collection was obtained from pre-research during the needs analysis. In theory, some theories support the feasibility and function of Augmented Reality media as learning media. Based on the literature review, Augmented Reality can shift the learning paradigm from being teacher-centered to student-centered and the teacher is only a facilitator so that students become active in learning, no longer relying on the teacher as the sole source. The advantage of Augmented Reality is being able to accommodate a variety of learning styles because Augmented Reality is programmed to display visual, audio, and animated media. The Augmented Reality application program is also a unique media because it contains a form of presentation that is very different from the presentation in general.

Pre-research or field observations were conducted to identify the needs of teachers and students regarding augmented reality (AR) learning media. These observations involved interviews with teachers, principals, and students. The interview questions focused on educators' skills in using and developing learning media, the curriculum in use, teaching approaches adopted in schools, and student responses to AR-based learning media. The findings from the pre-research or field observations indicated a clear need for the use and development of augmented reality learning media. Based on the pre-research data or field observations, the product to be developed is an augmented reality-based learning media. This media will be in the form of an application for Android smartphones. The content of the application includes food chain material suitable for fifth-grade elementary students. Therefore, it aligns with the elementary school curriculum. The media is named "Augmented Reality-Based Food Chain Application Media," as it presents the material in a way that makes the objects in the content appear realistic. The application also includes a quiz on the food chain. The following section outlines the design of the augmented reality-based food chain application:

Main Menu Page

This page includes several feature options, namely application instructions, terrestrial ecosystems, marine ecosystems, and rice field ecosystems (see Figure 1 below).

Figure 1. Main Menu Page

Application Instructions Page

This page will appear when the user selects this feature. On this page, there are instructions for operating the augmented reality-based food chain application (see Figure 2 below).

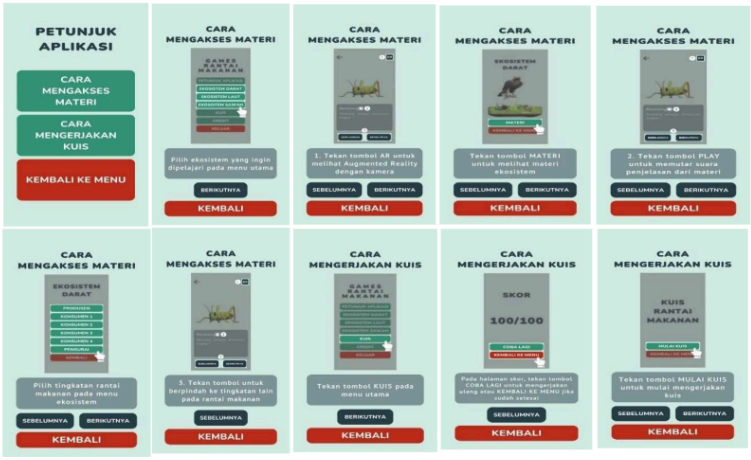
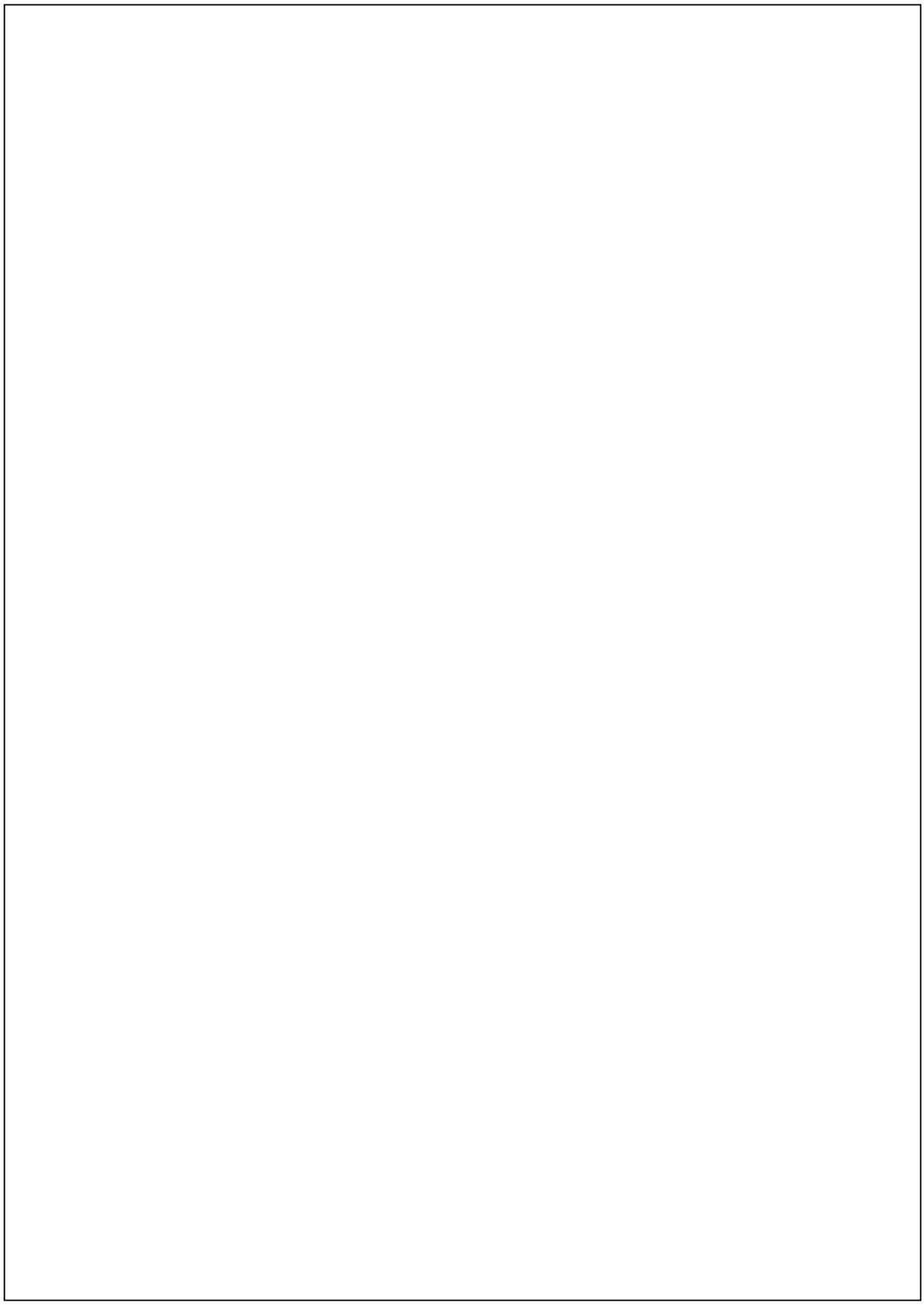


Figure 2. Application Instructions Page

Land of Ecosystem Page

This page outlines the food chain in terrestrial ecosystems, including producers (grasses), primary consumers (grasshoppers), secondary consumers (frogs), tertiary consumers (snakes), quaternary consumers (birds), and decomposers. A play icon is located next to the name of each producer or consumer. When clicked, the icon provides an audio explanation of the selected feature (producer or consumer). In the upper right corner, a box labelled "AR" appears after selecting a producer or consumer. If selected, the corresponding augmented reality object is displayed (see Figure 3 below).

Figure 3. Marine Ecosystem Page



Marine Ecosystem Page

This page outlines the food chain in terrestrial ecosystems, comprising producers (phytoplankton), primary consumers (zooplankton), secondary consumers (small fish), tertiary consumers (large fish), quaternary consumers (toothed whales), and bacteria acting as decomposers. A play icon is positioned next to the name of each producer or consumer. When clicked, this icon provides an audio explanation of the selected feature (producer or consumer). Subsequently, in the upper right corner, a box labelled "AR" appears when the producer or consumer is selected; if activated, the corresponding AR object is displayed (see Figure 4 below).

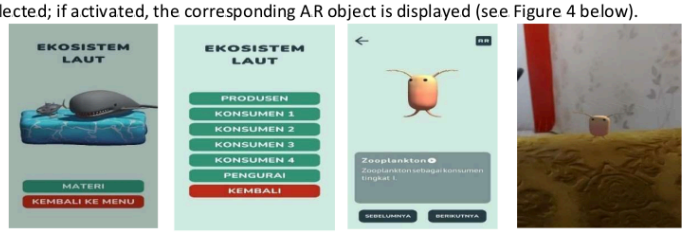


Figure 4. Marine Ecosystem

Rice Field Ecosystem

This page contains the food chain in terrestrial ecosystems which includes producers (rice), consumers I (rats), consumers II (snakes), consumers III (eagles), and fungi as decomposers. On this page there is also a play icon next to the name of the producer or consumer, the icon when clicked will play an explanation sound about the selected feature (producer or consumer).

Then, in the upper right corner, after selecting the producer or consumer feature a box will appear that says AR, if selected, the AR object will appear (see Figure 5 in below).

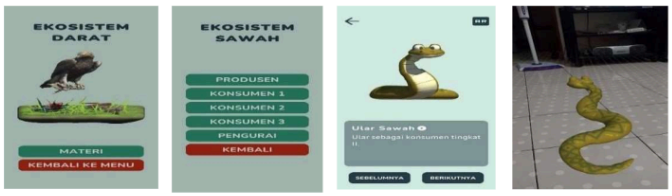


Figure 5. Rice Field Ecosystem

Quiz Page

On this page, five questions or questions related to the food chain material in the three ecosystems that have been studied by users will appear (see Figure 6 in below).

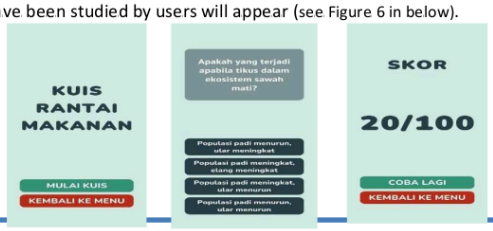


Figure 6. Quiz Page

Credit Page

Figure 7. Credit Page

Figure 7 shows a vertically-oriented Credit Page from an application with a clean, minimal design and a soft green background. The content is neatly organized with clear headings and attribution details. After the product has been successfully developed, the next step is to test the eligibility of the media through product validation. Design or product validation is carried out after the initial product creation. There are two types of validation, namely material expert validation and media expert validation. The validation sheet was provided by material experts and media experts as validators (see Table 2 in below).

Table 2. Assessment by Material Experts

Aspect	Indicator	Score				
		1	2	3	4	5
Content suitability	1. Compliance of indicators with Core Competencies					√
	2. Conformity of learning objectives with indicators				√	
	3. Suitability of learning activities with objectives					√
	4. Suitability of learning activities with material					√
Material accuracy	5. Accuracy of facts with material.				√	
	6. Accuracy of examples in the material				√	
	7. Accuracy of images and illustrations	√				
Material presentation	8. The material presented is coherent				√	
	9. The material presented is interesting and meaningful					√
Total Score						37

The validation of the augmented reality-based food chain application was carried out by media expert MA, a lecturer in the learning media development course within the Elementary School Teacher Education programme at Universitas Muhammadiyah Surakarta. The evaluation results from the media experts are as follows:

The authorship component, which comprises three indicators—readability of writing, accuracy of font size, and appropriate font selection—each received a score of 5. The second component, media display, which includes colour accuracy, image composition, and media dimensions, also each received a score of 5. The media quality dimension, which includes media durability and accuracy of size, each received a score of 5. The media capability dimension, which refers to the media's function as a learning reference, was assigned a score of 5. However, the media's effectiveness as an educational tool for play and its ability to engage students' interest in learning were rated a score of 2.

The media efficiency component, which relates to time efficiency, was assigned a score of 4. Cost efficiency and power efficiency each received a score of 5. The sixth aspect concerns the use of the augmented reality-based food chain application, which received a score of 3 for its ability to enhance student engagement, a score of 4 for its effectiveness in explaining food chain concepts, and a score of 5 for the ease of access to the media. The first round of validation conducted by media experts resulted in a total score of 70, corresponding to an average score of 4.11. This conversion to qualitative data indicates that the media is considered highly effective.

The validation of the augmented reality-based food chain application was conducted by a material expert, AD, a lecturer in the basic science concept course within the Elementary School Teacher Education programme at Universitas Muhammadiyah Surakarta. The evaluation results from the subject matter experts are as follows:

The content feasibility aspect, which includes the appropriateness of indicators with fundamental competencies, the alignment of learning activities with objectives, and the relevance of learning activities to each topic, received a score of 5. The alignment of learning objectives with indicators received a score of 4. The accuracy of the content, which includes the precision of facts and examples related to the material, received a score of 4. The accuracy of images and illustrations received a score of 1. The material presentation aspect, which includes the coherence of the content, received a score of 4, while the interest and meaningfulness of the material received a score of 5.

The total score from this validation was 37, resulting in an average score of 4.11. When converted into qualitative data, the media is considered highly effective. In this second validation, no criticisms or recommendations were provided, so the media was deemed suitable for use without modification.

After product validation by both the material expert and the media expert, suggestions were provided by the validator. These suggestions were used as input for revising the initial product design. The revisions made by the media experts include: 1) The application is titled "Food Chain Games," but it lacks any gaming elements; 2) There is no information about the designer or creator of the application; 3) The application does not include quizzes, assessments, or questions to assess users' cognitive understanding; 4) It offers no challenging activities or feedback mechanisms, making the experience one-sided.

No criticisms or suggestions were received from the material experts; therefore, the media was considered suitable for use without further revisions. Following the successful revision of the augmented reality-based food chain educational media, an effectiveness test was conducted in the field. The trials included a small group trial and a field trial. During the learning process, the augmented reality media was used, and after the lesson, each student was asked to complete a feedback questionnaire.

The small group trial took place on 12 October 2022, in a fifth-grade classroom with ten students.

The students were provided with a mobile application focused on the food chain, which utilised augmented reality technology. They were allowed to review the instructions before using the

application. Subsequently, they examined each menu within the application. After that, they engaged with and used the augmented reality features within the application.

Following the limited trial, an evaluation was conducted in which students completed a media feasibility assessment questionnaire administered by expert practitioners, specifically Mrs. EI, the homeroom teacher for fifth grade, who facilitated the administration of the questionnaire during the trial.

The results indicated that all aspects—clarity of instructions for using the media, ease of use, comprehensible language, appropriateness of the media for elementary school children, accuracy in colour selection, attractiveness of the media design, engaging presentation of the material, use of the media as a medium for delivering content, relevance of the material to the basic competencies (KD), and alignment with the developmental level of elementary students—received a score of 5.

In addition, students were asked to complete a validation questionnaire that had been provided. The overall eligibility percentage across all aspects was 80%.

Field trials were conducted at a private elementary school in East Java. The purpose of the trial was to obtain the effectiveness of the Augmented Reality learning media for fifth-grade students in Learning 1, Sub-theme 2, Theme 5, and food chain material. The first step taken by the author is to display Augmented Reality learning media in Learning 1 Sub-theme 2 Theme 5 with the help of an LCD projector. Then the writer explained the material about the food chain to students. The last activity is giving quizzes to evaluate students' understanding of the material taught through Augmented Reality media. This quiz is used as a pretest and posttest in this large group test. After the data was obtained, to test the effectiveness of Augmented Reality learning media on food chain material, a paired sample t-test was used with a significance level of 5%. The test criteria used are if the resulting significance value is less than 0.05, then Augmented Reality learning media is significantly effective in learning about student learning outcomes in food chain material. Using the help of SPSS software version 20.0, the effectiveness test output results are obtained which are presented in the Table 3 in below.

Table 3. Results of Testing the Effectiveness of Augmented Reality Learning Media

df	**19**
Sig. (2-tailed)	0.000

Based on the output in the table above, it can be seen that the sig. = 0.000 <0.05 then Ho is rejected and Ha is accepted, which means that Augmented Reality learning media is significantly used in learning on student learning outcomes in food chain material.

DISCUSSIONS

Augmented reality integrates the virtual realm with tangible objects through a computational process, creating an illusion of realism for the user. This technology incorporates three-dimensional virtual objects into a real-world environment and presents them in real time (Zulkifly et al., 2022). It enables users to perceive the real world augmented with virtual elements, demonstrating significant potential for development, particularly within the field of education. This suggests the possibility of creating educational media that simulates materials or events as if they were directly present (Hapsari & Zulherman, 2021). This indicates that augmented reality media for food chain education integrates 3D virtual elements with the real world in real time, adapting to actual conditions. It is compatible with mobile devices, facilitating students' rapid recognition and understanding of the content presented by the teacher.

Augmented reality technology possesses three key characteristics: the integration of the physical and virtual worlds, the provision of interactive and real-time data, and the ability to present information in three dimensions. It has been applied across various domains, including education.

Android smartphones were selected for the presentation of augmented reality technology due to their widespread use among students, with approximately 65% owning such devices. The accessibility of these devices facilitates student engagement. Markers are used to display 3D objects when the smartphone camera is directed at them, ensuring practicality and versatility across different locations.

Research by Nirwanto et al. (2021) highlights the application of augmented reality learning media, which was driven by the limited diversity of learning resources available to teachers in science education. This led to students having insufficient access to tools for independent learning. The study concluded that augmented reality media is suitable for use in elementary schools, particularly in science education, due to its appealing design, digitally encapsulated narratives featuring 5M learning experiences aligned with the scientific approach, and the practicality and accessibility of digital media. This study begins with an examination of the curriculum, available resources, and educational objectives related to the use of digital augmented reality media. In the context of 21st-century learning, the implementation of digital-based augmented reality media requires careful consideration of story topic selection to effectively communicate messages and achieve educational goals (Wicaksono et al., 2021). A previous study by Wicaksono et al. (2022) highlighted the benefits of digital media in improving reading literacy within 21st-century education.

Teachers argue that the evolution of technology and information media—including 3D images, animations, and interactive mobile internet devices—is essential for fostering student interest in learning. Moreover, mobile-based learning media plays a crucial role in enhancing the practicality of student learning by utilising all available information.

Hapsari and Zulherman (2021) demonstrated that the application of augmented reality media in biology education, particularly in teaching the food chain concept, significantly improves students' understanding of the material. Aripin and Suryaningsih (2019) argue that one factor contributing to students' engagement with food chain content via augmented reality is the inclusion of 3D animation, which provides a visual representation of complex structures, such as the nervous system, thereby simplifying its explanation.

Zulherman et al. (2021) state that visual representations in biology can take various forms, including photographs, illustrations, tables, charts, and diagrams. The use of augmented reality media, which offers three-dimensional visual representations, has the potential to significantly enhance students' comprehension of abstract concepts. The implementation of 3D visualisation through augmented reality will streamline the presentation process, making teachers' explanations more effective and aiding students in better understanding the material.

Animation is a learning media that is arranged in such a way from a collection of motion pictures and equipped with audio so that it feels alive and improves students' understanding 3D animation is used for learning to focus students' attention on real objects or events, therefore researchers develop learning media in the form of technological applications. Augmented reality and animation as well as the material developed is a food chain to make it easier for students to understand the material. Smartphones were chosen in the presentation of augmented reality technology because smartphones are owned by all students and are often used every day, making it easier for students to operate the media, and practical to use. From the observations of the researchers, the students looked very interested and enthusiastic about this augmented reality-based food chain application,

so they felt

happy and did not get bored easily with the lesson. This is in line with what was stated Yovan & Kholiq (2021) that learning activities through the help of augmented reality media are fun because the media used is interactive and makes it easier for children to understand lessons. In addition, Bakri et al (2019) revealed that implementing learning through augmented reality media will increase student achievement.

Kanti et al. (2022) found that augmented reality (AR) learning materials used in fifth-grade science classes can improve students' concentration and understanding of the content, while also catering to the learning preferences of the digital generation, consistent with previous research.

According to Ritonga et al. (2022), the use of AR-based learning can enhance students' cognitive outcomes in relation to the animal life cycle. Animation is an effective method for presenting educational content. It refers to multimedia that integrates text, images, audio, animation, and video. Efendi et al. (2022) conducted a study demonstrating that fifth-grade students who were taught science using AR-based learning materials achieved higher academic performance compared to those who did not use such resources. Students were more engaged and enthusiastic during the learning process.

Sunami and Aslam (2021) also explored the application of AR media in their prior research. They argued that the use of animation-based AR media for teaching the water cycle can improve learning outcomes and student engagement, while also enabling easy access and sharing at any time. Digital animation has the potential to engage students, enhance their understanding of complex concepts, and encourage them to develop new skills and explore innovative ideas (Ilma et al., 2022).

CONCLUSION

The developed product is an application that utilises augmented reality (AR) media to deliver content on food chain concepts, and it is accessible on Android devices. This research introduces food chain material across multiple ecosystems, specifically terrestrial, marine, and rice field environments. Each ecosystem includes an audio icon for concise explanations and an AR icon for visualising abstract elements of the food chain. In addition, a quiz feature is included to assess students' understanding of food chain concepts. The study aimed to ensure that students gain a comprehensive understanding of the subject matter, particularly the food chain, while also making the learning process accessible at any time and place. The limitations of this research, which was conducted solely during the feasibility testing phase, were validated by media experts, material experts, and practitioner experts. The media feasibility assessment indicated that the AR-based food chain application is highly effective and appropriate for teaching food chain concepts to fifth-grade students. Similarly, the material and practitioner feasibility tests confirmed that the application is highly effective and suitable for use without modification. Therefore, further research is required to evaluate the effectiveness of the media in field trials.

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