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Augmented reality of food plants as a biodiversity learning media for 10th grade high school: A feasibility analysis

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ABSTRACT

Submission of material that only uses printed books, printed pictures, and power points as well as limited infrastructure hinders student learning experiences. Augmented reality (AR) interactive media is one of the innovations to make it easier to guide material to make it more interesting and interactive. So this study aims to describe the feasibility of interactive multimedia augmented reality of food plants as a support for learning biodiversity in 10th grade of senior high school. The augmented reality system was created using Vuforia and Unity 3D software, and involved curriculum analysis, storyboard design, data collection, marker creation, and 2D object design of food plants, followed by AR media creation. This research used a quantitative descriptive method, data collection is carried out using validation instruments of material experts and media experts. Validators consist of 3 material experts and 3 media experts. The validation obtained an average total validation (RTVtk) of material experts at 3.83 and media experts at 3.80. This assessment is considered valid because it meets the validity standard, namely 3≤mRTVtk≤4. Thus, interactive multimedia augmented reality is suitable to be used as a learning medium in the sub-material of utilizing biodiversity as food plants in 10th grade of high school.

INTRODUCTION

The learning process in the era of growing technology can be supported by the availability of technology-based learning media. Learning media is needed in the continuity of the teaching and learning process. Various types of technology that can be used to facilitate learning, one of which is android. Android provides easier and faster access to users so that learning can be delivered properly.

According to Talizaro (2018) learning media is a teaching aid for teachers to convey material, increase creativity and student attention in the teaching and learning process. With the existence of learning media, students will be more assisted and motivated in learning. So that the learning process will be more effective and efficient (Puspitarini & Hanif, 2019).

Based on the results of observations made by researchers at Senior High School 2 Sekayam, Sanggau Regency, West Kalimantan, Indonesia by conducting interviews with biology teachers regarding learning on the sub-matter of biodiversity utilization, it was found that the process of delivering material was only based on printed books, power points, printed out pictures and field practicums on plants around the school environment. The plants introduced to students are also still general in nature. Thus, students do not know many other plants that can be utilized as food. The utilization of ICT-based media is still rarely used due to the limited number of infocus/projectors and the availability of signals that are difficult to obtain so that it becomes an obstacle for students to obtain additional information apart from printed books. To overcome these problems, there needs to be innovation regarding the learning media used, one of which is augmented reality (AR).

Augmented reality is a technology that displays 2D or 3D images that can visualize objects as if they were real (Kurniawan & Witjaksono, 2018). The delivery of abstract concepts in biology learning can be helped by using augmented reality media (Celik et al., 2020). According to Tomaschko & Hohenwarter (2019) augmented reality allows users to move and observe the model displayed from various sides. So that students can feel or get a picture of plants in real, concrete and according to reality without having to guess or go to the location where the plants are located (Arici et al., 2019). Such a learning experience will create a long-term impression or effect in remembering learning material (Chin & Wang, 2021). The easy operation of augmented reality, which does not require special devices and without the use of internet networks, can make it easier for students to access and operate this media at school and at home (Kiryakova et al., 2018).

Based on research by Wulandari et al. (2019) development of augmented reality android version as learning media, augmented reality media can be used as learning media. This study obtained a good average score in expert validation, small group evaluation and field test. In addition, based on Fitria (2023), the application of augmented reality as a learning media for the digestive system in humans in biology subjects, AR media obtained good results and can be applied as a learning media. This is seen from the application compatibility test that has been carried out.

From the research that has been done before, it can be concluded that augmented reality can be used as learning media and will provide benefits in the form of information and increase knowledge about food plants in Raut Muara Village, Sanggau Regency, West Kalimantan to the community and students. Based on what has been described, this study aims to analyze the feasibility of augmented reality learning media for food plants as a support for learning biodiversity in grade-10. Thus, through this research it is expected to produce learning media that is feasible to use.

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METHODS

Quantitative descriptive method was used in this research. The research was conducted in two stages, namely: making interactive multimedia augmented reality food plants and validating interactive multimedia augmented reality food plants. The process of making multimedia follows Wijayatno & Samodra (2021) with the development of the process carried out by researchers. Starting with (a) analyzing the 2013 curriculum, namely KD 3.2 analyzing observation data on various levels of biodiversity (genes, species and ecosystems) in Indonesia, in this case the 2013 Curriculum is used, (b) designing storyboards, (c) collecting data on 28 plant species from 88 types of food plants obtained based on research in Raut Muara Village, Sanggau Regency, some of which are bemat/bemban (*Donax canniformis K.. Schum*.), tumep leaves (*Smilax tamnoides L*.), peluntan (*Artocarpus sericicarpus F.M.Jarret*), tampuy (*Baccaurea macrocarpa* (*Miq.) Mull. Arg*.), and tipu' (*Etlingera linguiformis (Roxb.) R.M.Sm*); voice dubbing; and material to be added, (d) marker creation using photoshop software and the Vuforia platform which will then be created in .pdf format, (e) 2D virtual object design using Unity software, (f) augmented reality creation process using Unity and Vuforia SDK tools.

Furthermore, the interactive multimedia augmented reality food plants that have been made are validated by 3 material expert validators and 3 media expert validators. The validation process carried out is useful for assessing the feasibility of learning media as an alternative media that can be used by teachers to support the presentation of material in the teaching and learning process. The 3 media expert validators came from 1 Universitas Tanjungpura's Biology Education lecturer, 1 biology teacher of Senior High School 2 Sekayam, and 1 biology teacher of Senior High School Mujahidin Pontianak. 3 media expert validators came from 1 lecturer of Biology Education of Tanjungpura University, 1 biology teacher of Senior High School Santun Untan Pontianak, and 1 ICT teacher of Senior High School Santun Untan Pontianak.

This study used 2 types of validation instruments, namely: material expert validation instruments and media experts. Then the data was analyzed using the following analysis techniques:

a. Finding the average of each criterion.

$$Ki = \frac{\sum_{i}^{n} \quad = 1\ Vhi}{n}$$

Description:

Ki = average of the i-th criteria
Vhi = h-th validator's assessment score for the i-th criterion
i = criteria
h = validator
n = number of validators

b. Finding the average of the three aspects.

$$Ki = \frac{\sum_{i}^{n} \quad = 1\ Kij}{n}$$

Description:

Ai = average of the i-th aspect
Kij = average for the i-th aspect of the j-th criteria

c. Finding the average total validation of the three aspects.

$$RTVtk = \frac{\sum_{i}^{n} \quad = 1\ Ai}{n}$$

Description:

RTV*tk* = average total validity
Ai = average of the i-th aspect

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d. Match the total average with the following criteria.
   3≤ RTVtk≤4 = valid
   2≤ RTVtk≤3 = moderately valid
   1≤ RTVtk≤2 = invalid

RESULTS AND DISCUSSION

Augmented reality interactive multimedia that has been produced in the form of an application with .apk format that can be installed on an android smartphone with markers that have been provided in the form of .pdf which can then be printed by the user. Augmented reality made contains the main menu which contains instructions, material, sampling sites, competencies, evaluations and creator profiles, the display is presented in (Figure 1).

Figure 1. AR media displays

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There are three characteristics of food plant AR media made, namely, combining the real world and the virtual world that presents projections of food plant images into the real world in 2D, interactive in real time, and in the form of 2D images that have a better resolution level. The results of 2D projections of food plants are equipped with explanations in the form of voice dubbing that describes local names, scientific names, families, parts that are utilized and processing methods. The results of the material marker scan and the marker used are presented in (Figure 2).

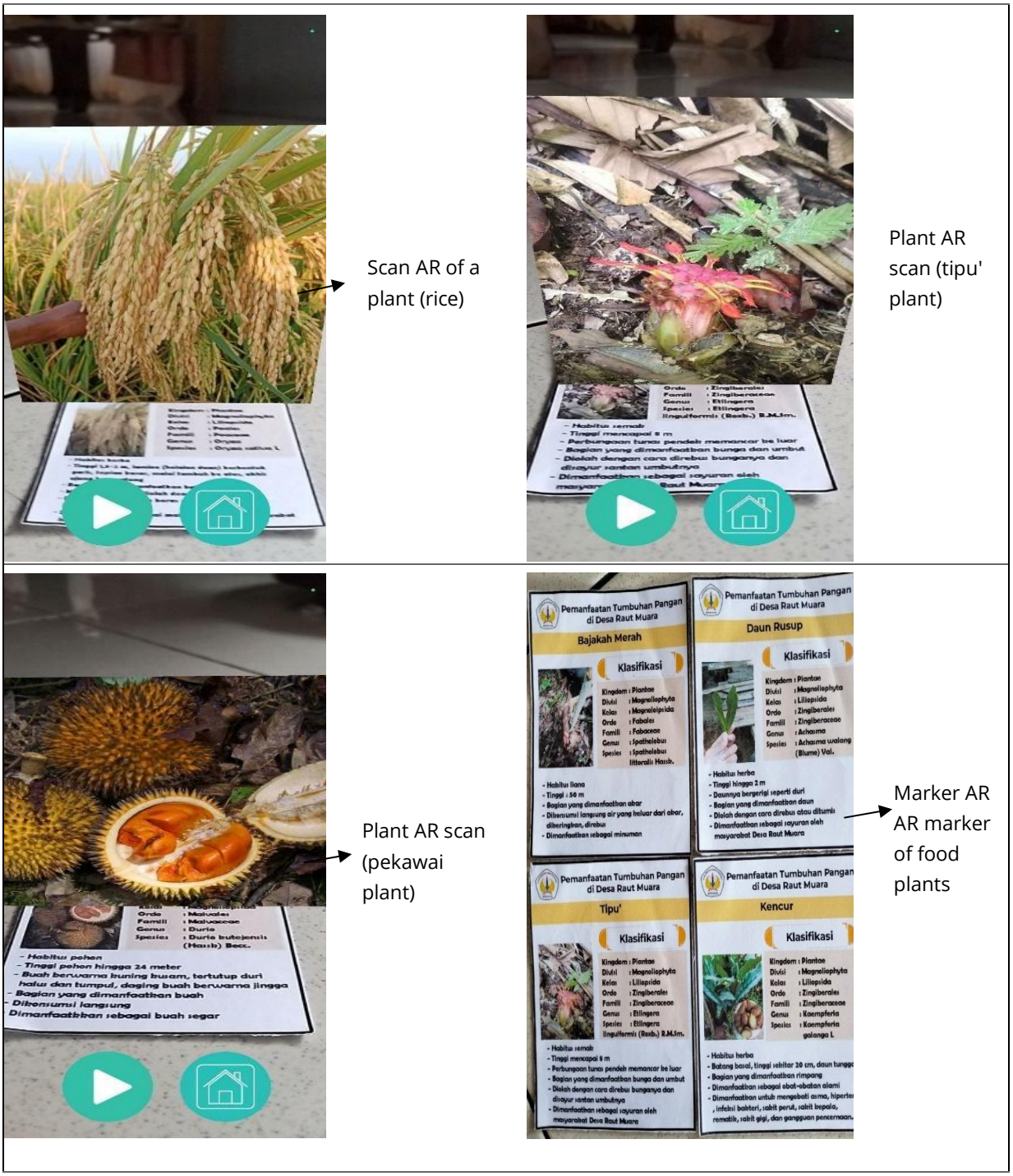

Figure 2. AR plant scans and markers used

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Feasibility testing was carried out after the interactive multimedia was completed, which was carried out by 6 validators (three material experts and three media experts). The validity test was conducted by expert validators consisting of 2 lecturers of Biology Education of Tanjungpura University, a biology teacher of Senior High School 2 Sekayam, a biology teacher of Senior High School Mujahidin Pontianak, a biology teacher and an ICT teacher of Senior High School Santun Untan Pontianak. The results of validation by material experts are presented in Table 1.

Based on Table 1, the media that has been developed is classified as valid because it has an RTVtk value of 3.83. This value is in accordance with the predetermined criteria. There are three aspects measured, namely the format aspect, content aspect and language aspect. The format aspect scored 3.78 (valid), the content aspect scored 3.89 which is classified as valid and the language aspect scored 3.83 (valid). The criteria for each aspect are described as follow.

Aspects of format

The format aspect consists of three assessment criteria, with the components of clarity of instructions for using multimedia and the suitability of colors, images and writing on learning media with android smartphone programs. The score obtained in the format aspect is 3.78 which is classified as valid (Table 1). Clarity of instructions and balanced use of colors, images and writing can support students to understand concepts to make them more visible. This is in line with the opinion of Utami et al. (2021), which states that the use of learning multimedia can motivate students and increase interest in learning. In addition, with the use of multimedia, students can understand lessons easily (Septiani & Rejekiningsih, 2020).

Aspects of content

In the content aspect, there are 6 assessment criteria assessed by the validator. The score obtained in the content aspect is 3.89 which is classified as valid (Table 1). Based on the assessment, it has been proven that the content of the material in the learning tools that have been made is in line with the 2013 curriculum syllabus, theories, and explanations that are shared not only in the package book or worksheet and relate existing information to everyday reality. The suitability of evaluation questions, image formats, questions and answer keys is in line with the submaterial presented in augmented reality interactive multimedia so that it can facilitate the learning process (Putro et al., 2021). This is in line with the statement of Abdulrahaman et al. (2016) which describes if the media is a place of learning material to be conveyed to support teaching and learning.

Aspects of language

There are 2 criteria measured in this aspect, with a score of 3.83 (valid) (Table 1). This proves that the language applied to augmented reality interactive multimedia is standardized, communicative, easy to understand and in accordance with the Indonesian Spelling Guidelines (PUEBI). The characteristics of ease of use of the media are simple language and easy to understand (Susilana and Riyana, 2009). The use of beautiful, short, concise and clear language can make it easier for students to master the learning presented in the media.

The multimedia was also validated by media experts presented in Table 2. Based on Table 2, the RTVtk (average total validation) of augmented reality interactive multimedia of food plants obtained a score of 3.80. There are 6 aspects evaluated by validators, namely aspects of simplicity, integration, emphasis, balance, shape and color. The simplicity aspect obtained a score of 3.83 (valid), the integration aspect obtained a score of 3.66 (valid), the emphasis aspect obtained a score of 4.00 (valid), the balance aspect obtained a score of 3.50 (valid), the shape aspect obtained a score of 3.83 (valid) and the color aspect obtained a score of 4.00 (valid). The criteria for each aspect are described as follows.

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Table 1. Data analysis of media validation results by material experts

No.	Aspects	Criteria	Validator 1	Validator 2	Validator 3	Ki	Ai
1.	Format	1. The instructions for using AR are clear, complete and easy to understand.	4	4	4	4,00	3,78
		2. Harmony of background color, writing and image display in interactive multimedia AR with android smartphone program.	3	4	4	3,67	
		3. AR interactive multimedia is suitable as a learning media in the classroom and at home, innovative, and easy to run on android smartphone devices.	3	4	4	3,67	
2.	Contents	4. The formulation of the submaterial presented in the AR interactive multimedia is in accordance with the KD, indicators of competency achievement and learning objectives in the 2013 Curriculum syllabus.	4	4	4	4,00	3,89
		5. The suitability of text content, 2D image display in AR interactive multimedia with theory.	4	4	4	4,00	
		6. The suitability of evaluation questions in AR with basic competencies, indicators of competency achievement and learning objectives in the 2013 Curriculum syllabus.	3	4	4	3,67	
		7. AR interactive multimedia conveys information completely, clearly and easily understood.	4	4	4	4,00	
		8. The information conveyed in the AR interactive multimedia is not only listed in the textbook, connecting the material with everyday life and adding insight or knowledge of students.	4	4	4	4,00	
		9. The suitability of the image display, the form of questions and answer keys in the AR interactive multimedia with the submaterial presented.	3	4	4	3,67	
3.	Language	10. The language used in AR interactive multimedia is standard, communicative and easy for students to understand.	3	4	4	3,67	3,83
		11. The language used in the AR interactive multimedia is in accordance with the Indonesian Spelling Guidelines (PUEBI), using capital letters at the beginning of sentences and using italicized letters to indicate foreign words / scientific names.	4	4	4	4,00	
		RTVtk					**3,83**

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Aspects of simplicity

The aspect of simplicity consists of 2 assessment criteria. The score obtained on this criterion is 3.83 (Table 2) which means that the media is declared valid. Based on the validator's assessment, that augmented reality interactive multimedia is easy to install, easy to move and works well on android smartphone devices and the use of sentences that are straightforward and easy to understand, the selection of text is not too diverse in one display format. According to Utami et al. (2022) media is said to be simple if it can be obtained easily. Thus, making and using so that it can support the achievement of goals in the teaching and learning process (Sudarsana et al., 2019).

Aspects of integrity

The aspect of integration has four assessment criteria. The score obtained by this criterion is 3.66 (Table 2), which means that the instructions for use, the order of each page, the navigation buttons and the scan marker display are complete, clear, systematic and function well. According to Shi (2023) interactive media for teaching is a combination of components that are synergistic and related and can benefit media users.

Aspects of emphasis

The score obtained on this criterion is 4.00, which means that the aspect of emphasis in augmented reality media is already in the category worthy of being used as a container for delivering teaching materials. According to Kumar et al. (2018) emphasis is one of the elements that will be the center of attention of students.

Aspects of balance

The aspect of balance has 4 criteria assessed by validators with a score of 3.50 (Table 2). In this aspect, it can be concluded that the placement of images, text, and 2D scan projections is balanced. The display of images and 2D projections is appropriate, attractive and clear. Dubbing sounds and back-sound use intonations that are interesting, easy to understand and do not disturb students. According to Utami et al. (2022) the use of animation, image layout and writing on each appropriate display can support the delivery of material clearly and not disturb the concentration of students. Thus augmented reality learning media can be used as learning media (Marini et al., 2022).

Aspects of shape

The aspect of shape contains two criteria that are assessed, namely the clarity and consistency of the shape of navigation buttons, menus, backgrounds, colors and objects displayed (Table 2). According to Bicen & Kocakoyun (2018), the clear delivery of the content of the material presented and the ease of the user in operating the program are caused by the selection of colors and background shapes that are in harmony. Based on the validation test that has been carried out on 2 criteria of the form aspect, a score of 3.83 is obtained, which means that the augmented reality learning media is declared valid and adequate to be applied as a learning platform.

Aspects of color

The aspect of color includes only one assessment criteria, namely, determining the color degradation of each page in augmented reality interactive multimedia in harmony with the color of the text, background and navigation buttons. The color aspect obtained a score of 4.00 which was declared valid (Table 2). Color is a very strong part of the scheme. The selection of harmonious colors can add to the effectiveness of a learning container (Serrano et al., 2019).

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Table 2. Data analysis of media validation results by media experts

No.	Aspects	Criteria	Validator			Ki	Ai
			1	2	3		
1.	Simplicity	1. The operation of AR interactive multimedia uses a special player that is easily installed on android smartphone devices.	4	4	4	4,00	3,83
		2. AR interactive multimedia uses simple sentences, easy to understand and the fonts used are not too diverse on one display.	4	4	3	3,67	
2.	Integrity	3. Instructions for use / work in interactive multimedia AR complete, clear and easy to understand.	3	3	4	3,33	3,66
		4. The sequence of each AR interactive multimedia page is neatly arranged, systematic and in accordance with learning activities.	4	3	4	3,67	
		5. Navigation buttons in AR interactive multimedia are attractive, clear and work well on android smartphones.	4	4	3	3,67	
		6. Scan markers to display 2D images of plants in AR interactive multimedia are clear, precise and easy to operate on android smartphones.	4	4	4	4,00	
3.	Emphasis	7. AR interactive multimedia communicates information briefly, clearly and completely.	4	4	4	4,00	4,00
4.	Balance	8. The placement of the layout of text, images and 2D scan projections of food plants in AR interactive multimedia is balanced.	4	3	4	3,67	3,50
		9. The display of 2D images and projections in AR interactive multimedia is appropriate, attractive and clear.	4	4	3	3,67	
		10. The voice dubbing on the explanation of the material in the interactive multimedia AR is clear, the intonation of the voice is interesting and easy to understand.	4	3	3	3,33	
		11. The suitability of back-sound, sound dubbing and animation in AR interactive multimedia does not disturb learners.	3	3	4	3,33	
5.	Shape	12. Navigation buttons and menus in AR interactive multimedia have an attractive shape, placed in a consistent and clearly visible position.	4	4	4	4,00	3,83
		13. The shape of back-sound design in AR interactive multimedia is interesting, the division of each column / button according to the color is not brighter than the contents of the text / object displayed.	4	4	3	3,67	
6.	Color	14. The selection of color degradation for each page in the AR interactive multimedia is in accordance with the color of the text, background color and color of the navigation buttons.	4	4	3	3,67	4,00
		RTVtk					**3,80**

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A learning container can be said to be practical if it has little or no revisions (Williams, 2020). Based on the validation conducted by three material experts and three media experts, there are several revisions/improvements that must be made, including adding instructions on how to scan and position the marker correctly, reducing the volume of the back-sound, adding images to the explanation of plant utilization material and evaluation questions, on evaluation questions negative questions (which are not) are replaced with positive sentences, and adding instructions for working on questions. The revision/improvement process is carried out with the aim that augmented reality learning media for food plants is suitable for use in the teaching and learning process.

AR media that has been improved can then be used in the learning process as a supporting media for learning resources. In the process of learning Biology sub-material utilization of plant biodiversity, teachers can form study groups to observe plants that can be utilized as food sources virtually through AR media. Students can work on worksheet which is equipped with different markers in each group, which then the worksheet will be presented in front of the class. Individual assessment can be done by asking students to do evaluation questions on AR media that have been equipped with scoring, so that students can immediately mention the score they get. AR media can also be used as an independent learning resource at home, because this media does not require an internet connection and other devices in running it, the markers used can also be accessed easily for anyone.

Interactive media augmented reality food plants will contribute to the ease of carrying out learning so that it has an impact on the effectiveness of the teaching and learning process and improve student learning outcomes. The application of interactive learning media requires students to be ready to carry out learning with new media independently, so that it not only maximizes learning outcomes but can also develop student creativity in understanding the subject matter.

CONCLUSION

Overall, it can be concluded that augmented reality interactive multimedia is feasible to use as learning media for the utilization of food plant biodiversity in 10th grade of senior high school with an RTVtk value by material experts of 3.83 and an RTVtk value by media experts of 3.80.

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