How Effective Is Immersive AR Continental Food Course for Vocational Education? Analyzing Knowledge Gains and Learning Outcome Effects

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***Abstract*—Augmented Reality (AR) is one of the innovative technologies in supporting the visual presentation of materials that are close to their original form. Realistic simulation in Continental Food Course learning is one of the urgency in supporting students' understanding of concepts. This research aims to design AR products that are practical and effective in improving student's understanding of concepts in learning the Continental Food Course. This research uses the ADDIE development model, which consists of five stages: analysis, design, development, implementation, and evaluation. The instruments in this study consist of validity, practicality, and questions. Participation in this study consisted of 5 experts who played a role in validating the product and 17 students who were involved in practicality tests and effectiveness tests on learning. At the analysis stage, problems were obtained in the form of the unavailability of interactive learning media. At the design stage, a storyboard design of the AR product has been obtained. At the development stage, AR products were produced for the Continental Food Course material. At the implementation stage, it was informed that the results of the validity test of the product were 0.93 in the valid category, and the results of the practicality test were 80.53 in the practical category. At the implementation stage, information was obtained that AR products were able to effectively improve student learning outcomes at the Continental Food Course. Overall, the products developed have been valid, practical, and effective in supporting students' understanding of the Continental Food Course material. AR contributes to the learning of the Continental Food Course. Other researchers can investigate the effects of AR on the influence of 21st-century skills and students' interest in learning.**

***Keywords*—augmented reality, continental food, learning outcome, vocational education**

I. Introduction

Technology has progressed closer to reality, such as in presenting objects in everyday life. Technological advancements are developing towards digital learning and supporting virtual learning that is close to reality, known as the scope of the metaverse [1, 2]. The presence of this technology is in the form of virtual activities in the form of Augmented Reality (AR) and Virtual Reality (VR) [3, 4]. This technology has become popularly applied in education [1, 5, 6]. This condition is supported by the reliability of innovative technology in visualizing objects in a form that is close to the original. The implementation of learning in an innovative way supports student participation in learning [7]. The development of technology has an effect on various scientific fields, including vocational education.

Vocational education has undergone a significant transformation, demanding adaptation to the needs of technical skills relevant to the industry. This condition is supported by technological advances that are developing rapidly as a medium for receiving and disseminating information in supporting the explanation of learning materials [8, 9]. Technology is a crucial part that must be applied in learning to achieve optimal learning outcomes in vocational education [10].

In learning in vocational education, especially in the field of culinary arts, a number of problems arise, one of which is the low level of understanding and skills of students in the Continental Food Course. The results of collecting student graduation information data informed that as many as 75% of students did not complete the study of the material. These results indicate that students' abilities in the Continental Food Course material are low. The material is part of learning at vocational schools majoring in hospitality in culinary food subjects that require explanatory simulations to support practical learning [11, 12]. In previous learning, the implementation of media focused on delivering material through whiteboards and lecture methods. The presentation of learning materials with this method is not yet relevant to the characteristics of the material. This learning provides a one-way learning effect that has an impact on students' low understanding of the Continental Food Course material. The availability of simulation media and interactive learning media is an urgency in supporting interesting, practical and communicative explanations so that students can understand the material better [13].

The Continental Food Course deals with cooking skills. In these skills, a good understanding is needed in recognizing raw materials, food recipes, and techniques. The presentation of information explaining the material before practice and guidelines for understanding the material are needed in learning [14]. Visualization of learning presentations in the form of images and videos is one form of implementation of explaining material in culinary learning [15]. The

presentation of information with this learning has limitations in two-dimensional visualization. Visualization in two-dimensional form has limitations in representing and explaining the material and is not able to present realistic food forms like the original. AR is one of the best forms of visualization technology in this decade, and it is able to present simulations in 3D form [16]. AR provides interactivity for users to observe virtual objects as they really are. This technology is ideal for supporting presentations and material explanations in improving student learning outcomes and understanding [17].

The presence of AR as a simulation medium has characteristics that are in harmony with learning that requires visualization, such as in the Continental Food Course material. The limitations of media in learning are a gap in supporting the development of interactive media as innovative learning in Continental Food Course material. The implementation of AR in Continental Food Course learning is a new innovation that is solving the problem of media limitations in learning. The implementation of AR with Continental Food Course materials presents a new novelty in learning. AR, developed by supporting independent, practical, and interactive learning content by presenting simulations and games, offers the latest contribution to supporting learning at the Continental Food Course in improving learning outcomes. Thus, this research aims to develop AR products in Continental Food Course materials to support practical and effective learning. Therefore, this study aims to answer the following research questions:

1) What are the characteristics of the AR design and appearance of Continental Food Course materials to improve learning outcomes?
2) How is the validity and practicality of the AR material of the Continental Food Course to improve learning outcomes?
3) How effective is the AR of Continental Food Course materials to improve learning outcomes?

II. Literature Review

A. Augmented Reality (AR)

Augmented Reality (AR) has become a three-dimensional visualization technology that is increasingly popular in the world of education in the 21st century. This technology complements visualizations that were previously limited to two-dimensional images and videos, which are used to support the explanation of materials such as continental foods. With AR, users can see a three-dimensional visualization of their environment, allowing for realistic visualization of objects through computers and smartphones [18, 19] The advantage of AR lies in its efficiency in making it easier to observe the details of objects that are difficult to see directly [20]. The technology has the characteristics of three-dimensional visualization, real-time display, and representation of virtual objects in a real environment [21, 22].

AR is attracting attention in the world of education because it offers a more efficient, trendy, low-cost, and easy-to-use learning method. This technology makes it easier to explain learning materials contextually without the need for real physical objects [23]. The use of AR can also increase students' motivation, interest, and understanding in the learning process. In vocational education, AR encourages the development of 21st-century critical skills for students, especially at the vocational school level [24]. In addition, the use of AR increases time efficiency for lecturers and students because learning materials can be accessed repeatedly [25]. With organized implementation, AR supports the achievement of learning objectives effectively [26].

In general, AR technology is still undergoing development and has not been applied in various fields to support practical and effective visualization presentations. The limitations of supporting media and simulations in previous learning open a gap for AR to be developed in presenting interactive and practical learning. In explanation-oriented learning that requires simulation, there is a relevant urgency to implement AR technology. The availability of media that was previously limited in two dimensions is enhanced by the presence of AR. Thus, the presence of AR technology fills the gaps in the shortcomings that previous media were unable to present in supporting the presentation of learning materials.

B. Continental Food Course

Vocational learning is oriented towards mastering a good understanding to achieve equal results in practice. The presence of technology provides opportunities to support vocational students' understanding of the material [27]. One form of culinary vocational education is the continental food course. Previous learning was often limited to the use of instruction media in the form of flipbooks and pictures [28]. The results of previous studies showed that students' ability to learn culinary arts was in the low category [16]. Therefore, the availability of media that is suitable for continental food learning is very important to support better learning outcomes.

The results of previous studies reported that various forms of media are used to support the learning of continental food materials. The use of video as a medium to present and explain continental food materials, as well as the use of flipbooks as a supporting step [29, 30]. The results of previous research were limited to presenting a two-dimensional display that had limitations in describing food close to the original before carrying out the practice. The limitations of previous media provided a gap in supporting practical and interactive teaching with realistic visualization. The inability of previous media technology to explain information in detail clearly became a gap in learning Continental Food material.

The use of innovative AR technology can be the latest solution to improve learning media. Continental food learning materials require effective visualization to explain the process of making and serving them. AR is an innovative technology and one of the best in visualizing objects, including food, in virtual form. The appropriate characteristics of AR support the application of this technology in culinary learning, especially in continental food materials. This is because this technology has been applied in the food industry [31].

By utilizing AR, continental food materials can be visualized in a clearer and more detailed way. This technology can help students understand and practice better, as well as improve overall learning outcomes [32].

In addition, the use of AR in continental food courses also has the potential to increase student engagement in the

learning process. By providing a more interactive and immersive learning experience, AR can stimulate interest and help students better understand complex concepts in a practical way [33]. The implementation of this technology can be an important step in learning innovation, bridging the gap between theory and practice, and preparing students to face challenges in the culinary industry with better skills.

III. Methods

A. Method and Design Research

This research applies the ADDIE development model through the stages of analysis, design, development, implementation, and evaluation [34]. This approach has structured and systematic steps to ensure that the learning media produced is based on the needs of students and in accordance with the set learning objectives. The research stages through the ADDIE development model are carried out as presented in Fig. 1.

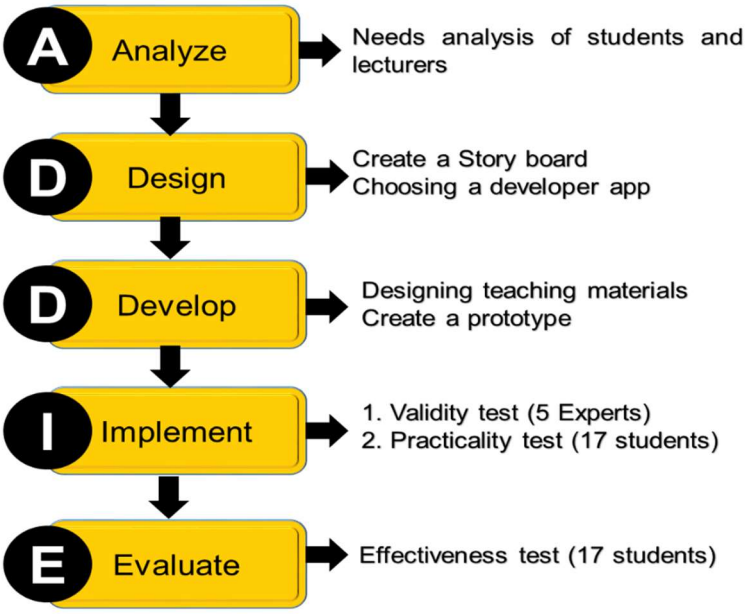

Fig. 1. Stages of research on the ADDIE development model.

Fig. 1 shows the research stage through the ADDIE development model, which begins with an analysis of the needs of students and lecturers in collecting information on learning problems. Based on these problems, the design stage was carried out. At the design stage, storyboard design is carried out by developing media that is suitable to overcome these problems. In addition, at this stage, the selection of applications used in developing the product is determined. After the storyboard is designed and the application to develop the product has been determined, it is continued at the development stage. At the development stage, material design and prototyping of AR are carried out. After the product prototype is developed, implementation is carried out by involving experts and students to test its validity and practicality.

Validity is the feasibility of a product meeting the standards of the function of the product that is developed appropriately. In contrast, practicality is the ease with which the product is used. The validity test involved 5 experts and 17 students to test the practicality of the product if implemented in learning. The experts involved in product validity testing are lecturers who have 10 years of experience in purchasing and an academic background as a doctor. Experts have the qualifications to assess media and teaching methods. Students involved in the practicality test are students in the food culinary study program who are studying Continental Food Course material.

The last stage is an evaluation to measure how effectively the product is used in improving learning outcomes. At the evaluation stage, an effectiveness test was carried out through pretest and posttest activities involving 17 students who used AR media in the learning process. Sampling is based on purposive sampling, which represents the abilities of students spread across low, medium and high abilities. Thus, the results obtained represent the actual ability.

B. Data Collections and Data Analysis Technique

The data in this study consists of the results of validity, practicality, and student learning outcomes. Data was collected using validity sheets, practicality sheets, and test instruments in the form of questions. The data obtained was analyzed using different techniques. The validity test data was processed using the V Aiken technique, the practicality test data was analyzed using the percentage technique, and the test result data was processed using a parametric statistical test. The equation used in testing the validity of the validation data results is Eq. (1).

$$V=\frac{\sum \text{Score From Expert-The Lowest Scorein Category}}{\text{Number of Category(Number of Expert-1)}} \quad (1)$$

Validity data were analyzed using the Aiken index. The standard for passing the validity test results for the prototype involves five experts with an assessment scale of one to five. The minimum score limit that must be obtained is a V value >0.80 [35]. In the practicality test, the data was

processed using a percentage technique, as described in Eq. (2).

$$N = \frac{\text{Score Student}}{\text{Maximum Score}} \times 100\% \quad (2)$$

The practicality of the product is in the range of 0 to 100 scores. The minimum standard of product criteria in the practical category is in the range of $61 \leq N \leq 80$, while the value of $81 \leq N \leq 100$ indicates that the product is in the very practical category. A score range of 61 to 100 is the standard by which a product can be used in learning.

The instrument in the student comprehension test is a multiple-choice test consisting of 15 questions about continental food material. The test aims to measure students' understanding of the material. The data of test results before and after learning were processed by parametric statistical tests. The statistical testing stage involves testing normality and homogeneity. If the value of the normality and homogeneity test (sig. 2-tailed) is greater than 0.05, then the data is considered normal. Further testing is carried out with the *t*. The hypothesis of learning outcomes before and after using AR was tested with a t-test, where the value of sig. 2-tailed >0.05, so there was no significant increase in learning outcomes by utilizing AR.

IV. Result

At the analysis stage, data was obtained from the results of student needs analysis. The data was collected through surveys and interviews with lecturers and students. Problems in learning Culinary courses. At this initial analysis stage, as many as 17 students and 3 lecturers taught culinary courses were involved. Each lecturer and student is interviewed to obtain relevant information related to the learning problems that occur.

The results of this preliminary analysis provide information about the challenges faced in the learning process of Continental Food materials at the location. The problems identified came from lecturers who taught Continental Food material and the students involved.

Learning Continental Food material faces problems related to the availability of learning media that still focuses on whiteboard and print media. This condition is contrary to the characteristics of the material, which requires simulation and representation of real objects to support a more detailed and concrete explanation of the material. Interviews with students revealed that there were difficulties in mastering the concept and practice of Continental Food. This is supported by information from lecturers who state that students' understanding of the material is still low and requires supporting media for independent learning.

Two fundamental problems in learning Continental Food material are the limitations of interactive media that support independent learning and the low understanding of students' concepts. Basic information about this problem will be used as a reference in designing media that is in accordance with the characteristics of learning and overcoming these problems.

One of the alternative solutions to overcome this problem is to design interactive learning media using innovative technology in the form of AR. AR technology is able to present a simulation of real object phenomena in the form of three-dimensional visuals, allowing students to understand the material more efficiently and effectively. By utilizing AR media, this problem can be overcome by designing AR products that are in accordance with the learning characteristics of Continental Food materials.

A. What Are the Characteristics of the AR Design and Appearance of Continental Food Course Materials to Improve Learning Outcomes?

In the design stage, the main goal is to design a solution that suits the needs of overcoming the problems that occur. The results of the preliminary analysis show that there is a need for independent learning media as a form of support in explaining Continental Food material. The designed media must be able to support independent and interactive learning for students so that they can understand the material better.

At this design stage, a storyboard design related to the planned media design is carried out. This storyboard is designed to support the understanding of concepts and achieve learning objectives. The storyboard design results of the developed product are shown in Fig. 2.

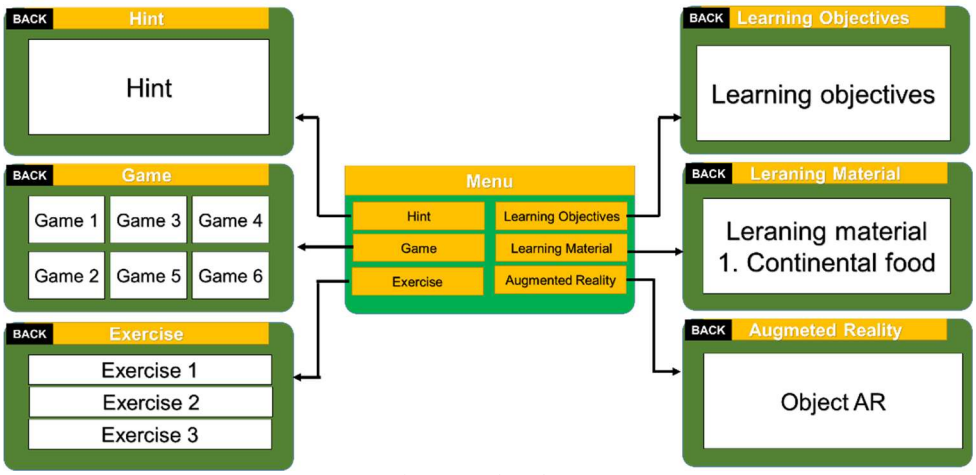

Fig. 2. Storyboard AR.

Fig. 2 displays the storyboard of the product designed according to the characteristics of the learning material. The results of this design were then developed into a prototype of AR-based learning media. The development application used

is Unity to make storyboards into real media. This application is able to produce a wide range of interactive learning media without limitations according to the developer's wishes. A storyboard is an alternative form of supporting the presentation of digital products in a more systematic manner. Alternative design presentations can be presented with flow charts to support product explanations. In this product, the storyboard was chosen as part of the design because it is able to describe the shape of the product close to the original. Products that do not go through the design stage have obstacles in the development process [36].

In addition, the technology provided by Unity supports game and AR development, enabling the creation of innovative applications. The prototype generated from this product is developed in the Unity application, with the final format being an Android Package (APK) file that can be installed on a smartphone.

Previous research presented digital teaching materials in the form of a product in the form of a website [37]. The APK format was chosen to support learning in the form of media without requiring internet access. These advantages cannot be presented in web-based media. In the development stage, execution is carried out from the design stage to produce a prototype. A prototype was developed based on a storyboard that has been designed. This product is targeted as an Android application that can be installed on smartphones. The form of product development results is presented as shown in Fig. 3.

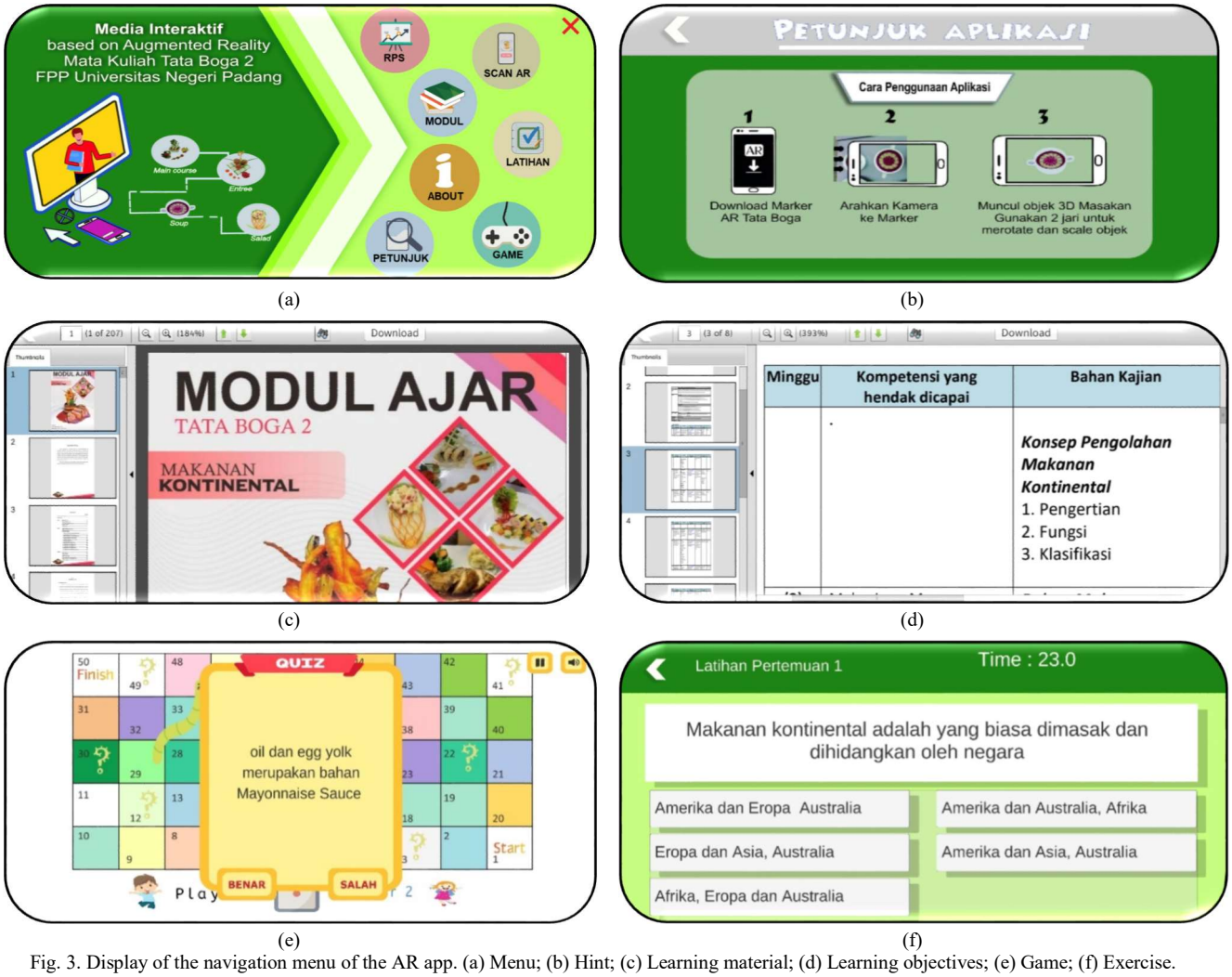

Fig. 3. Display of the navigation menu of the AR app. (a) Menu; (b) Hint; (c) Learning material; (d) Learning objectives; (e) Game; (f) Exercise.

Fig. 3 shows the shape of the development result of a prototype designed based on a storyboard. The result of the product form is a menu page display that includes navigation buttons between pages, as shown in Fig. 3(a). The navigation buttons on the display provide access to the help menu page, as shown in Fig. 3(b). The help menu contains information on how to use the media and learning steps.

The main menu display is an important part of the basic navigation of accessing media on another page [38]. Good basic navigation is presented with a simple and communicative view [39]. AR products present navigation with a design display in the form of images that represent activities on the page you want to access.

Other menu access includes learning objectives and learning materials, as shown in Fig. 3(c) and Fig. 3(d). These pages contain materials presented to guide students in independent learning. There is an interactive game page to support increased comprehension that encourages students to practice their understanding in a more engaging way related to the information presented in the lesson, as shown in Fig. 3(e). The practice page is presented to measure the ability of the able student to display the student's grades and answers after learning, as shown in Fig. 3(f). The presentation of games in previous learning was dominated by the form of quizzes [40, 41]. In the AR application developed, the game

is presented in the form of a snake and ladder that contains a punishment for every mistake made in exploring the trajectory. Snake and ladder games allow for inter-student involvement in learning while playing [42]. The integration of previous learning was developed in the form of printed snakes and ladders in the form of sheets that have limited access to use [43]. Games on AR are presented in digital form in the application developed. The combination of quizzes and games is the latest in presenting material in an attractive way to students. In addition, to support the main learning on Continental Food material, the app is equipped with AR that simulates the food-making process, as shown in Fig. 4.

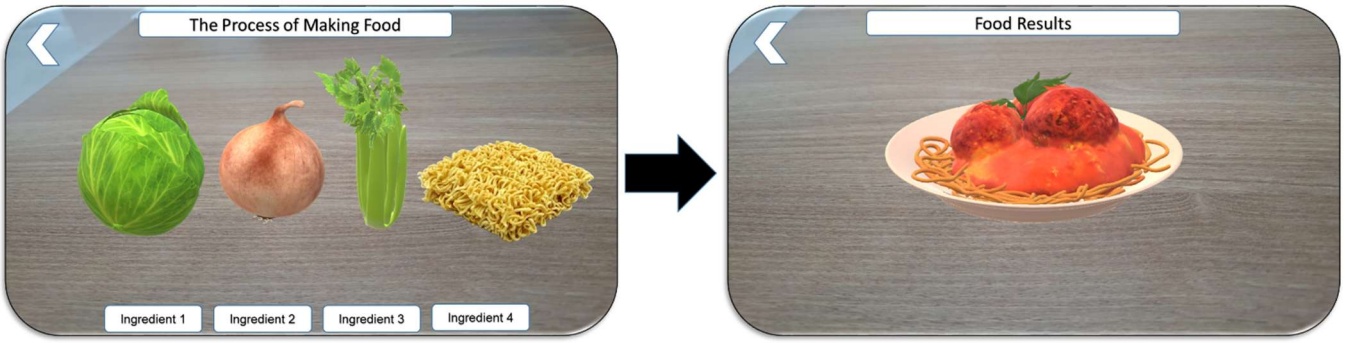

Fig. 4. AR display.

Fig. 4 shows the AR form of food, which is a core part of learning about Continental Food material. The AR objects displayed present the structure and arrangement of the ingredients needed to make the food. In addition, through this simulation, the food design system is displayed on the plate so that the food can be served aesthetically according to the presentation procedure.

This food AR object includes various forms of food serving in accordance with the achievement of learning objectives. Further testing is carried out to assess the quality of the developed product and ensure the resulting product is of high quality. In order to be accessible, the validity and practicality of the developed products published on the Play Store must be tested. Product access can be explored through the following link to install the AR application: https://play.google.com/store/apps/details?id=com.albram.Taata_BogaAR. The presentation of applications in digital form published through platforms facilitates students in accessing and operating them [38].

B. How Is the Validity and Practicality of the AR Material of the Continental Food Course to Improve Learning Outcomes?

The product that has been successfully prototyped is then tested and validated by involving five experts. The aspects assessed at this stage include ease of use, the substance of the material, learning design, and software utilization. The results of the assessment on each aspect are shown in Table 1.

Table 1. Validity results

No	Aspects	Score
1	Ease of use	0.94
2	Learning design	0.97
3	Material substance	0.98
4	Display design	0.94
5	Software utilization	0.95
	Average	0.93

Table 1 displays the results of product validation scores on the five assessment components. In the ease of use indicator, a score of 0.94 was obtained, which was categorized as valid. In the learning design indicator, a score of 0.92 was obtained, also in the valid category. For the material substance indicator, a score of 0.98 was obtained, which indicates a valid category. The display design indicator received a score of 0.94, which is included in the valid category. Meanwhile, in the software utilization indicator, a score of 0.95 was obtained, also in the valid category. Overall, the products that have been developed obtained an average score of 0.93, which is included in the valid category.

Table 2. Practicality results

No	Aspects	Score
1	Ease of use	78.5
2	Efficiency	80.6
3	Benefit	82.5
	Average	80.53

Table 2 displays the results of the product practicality score on the five assessment components. On the convenience indicator, a score of 78.5 was obtained, which is included in the practical category. In the efficiency indicator, a score of 80.6 was obtained, also in the practical category. For the benefit indicator, a score of 82.5 was obtained, which is categorized as very practical. Overall, the products that have been developed obtained an average score of 80.53, which is included in the practical category.

C. How Effective Is the AR of Continental Food Course Materials to Improve Learning Outcomes?

The products that have been developed have obtained valid and practical results and practicality. This condition shows that the product meets the standards of learning media to be implemented in the learning process and measures the effectiveness of learning through evaluation. The prototype that has been developed is used in the learning process to assess the effect of using the media in supporting students' understanding of the concept of Continental Food material. Student learning outcomes in this material are related to students' understanding of concepts in Continental Food material. The data obtained at this evaluation stage are in the form of pretest and posttest data from learning using AR. The results of the comparison of students' initial ability scores before and after learning are presented in Table 3.

Table 3. Pretest and posttest data

Test	df	Mean	Standard deviation
Pretest	16	69.52	9.65
Posttest		85	7.3

Table 3 displays the average results of Culinary student scores before and after learning. In the pretest results, students obtained a score of 69.52, which is classified as moderate. After learning was carried out using AR, a re-evaluation was carried out through a posttest, which resulted in a score of 85. The test results showed an increase in student learning outcomes before and after using AR. The data obtained were tested for normality and homogeneity, as seen in Table 4.

Table 4. Normality test and homogeneity test

Test	Normality Test			Homogeneity Test		
	Kolmogorov-Smirnova			Levene Statistic		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest	0.498	16	0.965	9.608	16	0.06
Posttest	1.030		0.965			

Table 4 displays the results of normality and homogeneity tests. The normality test showed a sig value of >0.05, which indicates that the data obtained is normally distributed. The results of the homogeneity test were carried out to check the uniformity of data in the class. The data obtained showed a Sig. score of 0.06, which is greater than 0.05, proving that the data is homogeneous.

The results of the normality and homogeneity tests as the basis for determining the advanced statistical test. The t-test is a statistical test used to see the effect of propagation. The t-test was chosen because the data was distributed normally and homogeneously. The results of the t-test are shown in Table 5.

Table 5. T-test

t	df	Sig.2-tailed
12.244	16	0.0000

Note: t_{table} : 2.02

Table 5 displays the results of the t-test of the students' pretest and posttest. The results obtained showed a t-value of 12.224 and a sig.value (2-tailed) of 0.000. Hypothesis acceptance occurs if the value of the sig.(2-tailed) < 0.05 and the value of *t* calculated > *t* of the table. The hypothesis proposed in this study states that the use of AR significantly influences student learning outcomes. The data results from the t-test showed that the t-value calculated > t_{table} and the value of the sig.(2-tailed) < 0.05. These results indicate that AR has a significant effect on improving student learning outcomes regarding Continental Food material.

Learning with AR provides better results and improves student learning outcomes. Previous research reported the implications of learning technology in driving interest and motivation in learning [44]. The implications of AR in learning report new findings about AR support being able to improve students' understanding of learning Continental Food Course material.

V. Discussion

Learning in culinary vocational education often involves explaining the material before practice. In the learning of Continental Food material, problems related to the limitations of media in explaining learning materials were found. The use of interactive multimedia is one of the solutions to support the explanation of the material and help culinary students understand the material.

Products are designed using storyboards to systematically produce products. Good product design is done with planning in accordance with the design [45]. This is in line with previous research, which shows that media development must be carried out systematically by utilizing storyboards. The product design is presented in the form of a storyboard, which has different from previous research that presents it in a flowchart [37]. The products developed are also adjusted to learning outcomes [46]. The presentation of games in teaching materials supports students' interest and attraction in exploring the material [47–49]. The AR developed is designed to present learning games to attract students to understand the material.

The product is developed in the format of an Android application. The use of Android technology in learning media as an innovative solution presents cheap and efficient interactive media [50]. The use of computer-oriented learning media and smartphones supports independent learning [30]. The prototype must go through the validation test stage by involving experts to measure the quality of the product professionally [51, 52]. Product validity shows valid results in ease of use, learning design, the substance of the material, display design, and utilization of software. The ease of use of the product allows the presentation of detailed information to the user [53, 54].

In previous studies, it was reported that the validity results were 0.82 in the valid category [55]. The results obtained showed that the treatment of valid products had a higher score, which was 0.93. In the previous study, the presentation of practicality involved 9 students who evaluated the product as practical on digital media [55]. The product developed involves more practical testing compared to previous research, which is as many as 17 students. Thus, the product developed shows a better practical effect in testing compared to previous research.

The developed product received a better ease rating than previous researchers the developed AR scored 0.93, while previous research with similar AR media scored 0.89 [56]. The assessment results indicate that AR ease of use is better than other media. In addition, the AR products developed maintain the security of privacy data because they are used offline in learning. In accessing this product application, users can scan from the playstore as a place to install applications that are guaranteed to have data security.

Simple and proportional product display provides efficiency in the use of digital products [57–59]. An attractive and easy-to-use display is one of the important aspects of AR-based learning media [60–62]. The use of software is an important part of producing products with a format that suits the characteristics of the user's device [63]. The product has been developed with Android application design with limitations at the Android Application Programming Interface (API) level 24 to 33, which provides wider access

to various versions of Android [64]. In general, the products developed have met the standards of digital product validity. Previous interactive learning media products in supporting education are limited to online viewing via the web [65, 66]. The products developed can be used offline in learning.

Interventions on learning tests on small samples were used to realize the results of the study. This result is in line with previous research that tested the effectiveness by involving 9 students in learning [55]. The AR digital product developed is also effective in learning. Interventions in the research conducted have represented a variety of student abilities, which encourages general generalizations of learning outcomes.

To support product quality, user involvement in assessing the AR that has been developed is essential. AR was developed with the target students as users went through practicality testing. The product practicality results show the practical category on the indicators of ease of use, efficiency, and benefits. The AR products developed present an easy-to-use display for students in learning. In terms of efficiency, students obtain AR cheaply, easily, and efficiently because it does not require additional costs and is easily accessible [56].

Cost efficiency is one of the important considerations in digital product development [67]. In addition, the benefits of AR support independent learning for students through the interactivity presented in the product.

Product effectiveness is an important aspect of the development of learning media. The AR developed has proven to be effective in improving the learning outcomes of culinary students on Continental Food material. This result is in line with previous research, which shows that valid and practical learning products have a positive impact on improving student learning outcomes [6].

The implication of technology in the form of digital books provides support for practical guidelines in learning [68]. AR contributes to presenting a teaching combination in the form of 3D visualization that is better than two-dimensional learning in books or other two-dimensional media Games in learning encourages students' interest and attraction in learning. The ideal digital learning product has met the standards of validity, practicality, and effectiveness in its testing. Overall, the AR products developed have proven to be valid, practical, and effective in supporting the improvement of culinary student learning outcomes.

VI. Conclusion

AR was developed based on the problems found at the analysis stage, namely the limitations of learning media in supporting Continental Food materials. Based on these problems, Augmented Reality is designed with components such as menu displays, exercises, learning objectives, learning materials, games, and AR elements that support learning outcomes. The product is developed in the form of an APK-formatted app prototype that can be installed on Android devices. Product implementation involves experts and students to test the validity and practicality of the product. Product validity includes components of Ease of Use, Learning Design, Material Substance, Display Design, and Software Utilization. The practicality of the product includes the components of Ease of Use, Efficiency, and Benefit. Overall, the products developed are valid and practical. Evaluation of the use of AR in learning shows that this product is effective in improving students' understanding of Continental Food material. This research has limitations in its application to learning. The research reviews learning about food materials in terms of interests, motivation, communication, and integration with local culture. In addition, further research can develop on products with a higher level of visualization such as utilizing virtual reality and the metaverse.

Conflict of Interest

The authors declare no conflict of interest.

Author Contributions

I.P.W: Contributes to creating research ideas and analyzing data; L.A: Responsible for collecting valid data; D.T.P.Y: Plays a role in collecting practical data; R.M: Carried out the implementation of research in the classroom; M.D: Contributed to designing and creating articles; E.M.S: Provided ideas and input in improving the article; S..K.A: Contributed to checking and processing research data. All authors approval of the manuscript submitted.

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