International Journal of Evaluation and Research in Education (IJERE)
Vol. 14, No. 1, February 2025, pp. 406~414
ISSN: 2252-8822, DOI: 10.11591/ijere.v14i1.29702

iFoodAR: augmented reality for high school food design technology

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Article Info

Article history:

Received Dec 26, 2023
Revised Aug 6, 2024
Accepted Aug 11, 2024

Keywords:

ADDIE
AR application
Augmented reality
Cognitive theory
Food design technology

ABSTRACT

Technology is advancing with the times. Augmented reality (AR) received great attention in education because it focuses on technology that connects the real and virtual worlds in real-time. The blending of AR technology and educational content aims to generate innovative thinking that can improve the effectiveness of teaching and learning for students in real-life scenarios. This study aimed to develop an AR module and application (apps.) for high school students to learn about food technology. Five phases of the analysis, design, development, implementation, and evaluation (ADDIE) model were used to develop food technology applications in the classroom based on AR technology. An interview was conducted to obtain the usability of the AR module from the selected expert. The results showed that iFoodAR fulfilled the requirement in line with the standard curriculum and assessment document (DSKP) of the Malaysian Ministry of Education and gained positive feedback on using AR in the classroom from the expert teachers. It is concluded that iFoodAR apps have the potential to cater the diversity learning styles, leading to a shift in teaching methods incorporating more interactive and visually stimulating learning experiences.

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1. INTRODUCTION

Teachers play an essential role in helping students solve problems in school and thus prepare them for their future careers [1]. Teachers can be the deciding factor when it comes to teaching students' thinking styles in the classroom. In this new era, teachers must change their teaching methods to accommodate the newest generation and maintain their interest in learning in the classroom. Technological advancement has also changed the way people learn [2]. Moreover, the learning process has transcended the physical boundaries of the classroom and is global and lifelong. The globe is in the digital age, where the source of knowledge is the heart and backbone of a nation's prosperity, especially in education [3]. As a result, traditional teaching methods must also be modernized. The latest system hardware modules and software programs for electronics, microprocessors and microelectronics are now being used in classrooms and laboratories to provide an effective and efficient method for teaching design and technology subjects [4]. ICT technology includes all technologies that help disseminate information, such as radio, television, cell phones, computers, and the internet [5]. It has influenced education, and its influence can be divided into three

phases: replacement, transition and transformation [6]. Teachers in the replacement phase use it as a tool for teaching and learning sessions without changing teaching methods, but teachers in the transition phase use ICT to drive change to new teaching methods. Learning media are materials and tools or a mixture of software and hardware used in the learning process [7].

Augmented reality (AR) is a new technology that can be combined into a single narrative. According to Ismail *et al.* [8], AR is the direct or indirect engagement with the physical environment and the real world, the elements of which are augmented by computer-generated sensory input such as sound, video, graphics, or GPS data. AR is currently one of the technologies with great educational potential, especially for describing concepts [9]. Previous study [10] described that when you show the current state of something on your phone, it may look like it has suddenly appeared, but that is just your imagination and the illusion of an actual image of a static object. The mobile augmented reality (MAR) variant of AR technology has recently gained traction for training and learning purposes [11]. The appeal of MAR for educators stems from its mobility, as learning applications can be accessed via ubiquitous mobile devices, namely smartphones. Learners can now access learning materials and content anytime and anywhere [12].

It is argued that this technology's mobility will change how students learn in the new millennium. The technology acts as the most powerful tool for teachers [13]. Rather than relying on the teacher as the only source of knowledge, students can access multimedia learning that delivers learning content interactively and animatedly to arouse interest, capture attention, and motivate students. Furthermore, since AR utilizes 3D registration of virtual and real objects, users have the potential to view learning content from a 3D perspective. Learning sessions do not end when they leave the classroom because students can access teachers, resources, and assignments via the AR module anytime, anywhere.

2. METHOD

The present study employed the ADDIE model as a framework for systematically developing the mobile application created in this research. The abbreviation ADDIE, representing the sequential stages of analysis, design, development, implementation, and evaluation, encompasses the essential divisions and procedures necessary for the successful execution of a project [14]. The selection of this model was based on its emphasis on phase repetition, wherein each phase is interrelated. Consequently, the lack of successful execution of a specific phase led to the iteration of such a phase until its intended goal is achieved [15]. The sequential progression of the ADDIE paradigm can be observed in Figure 1.

The development process of the mobile application for the study was organized by the ADDIE methodology [16]. Consequently, there existed five discrete periods. The initial stage, known as analysis, constituted the analytical phase. The subsequent stage, the design phase, featured the creation and development of educational resources [17]. In the project's third phase, the focus was on the production of learning materials and the creation of activity plans. The learning materials and activities were carried out during the fourth step, known as implementation. During the concluding stage, the completed module underwent testing and evaluation.

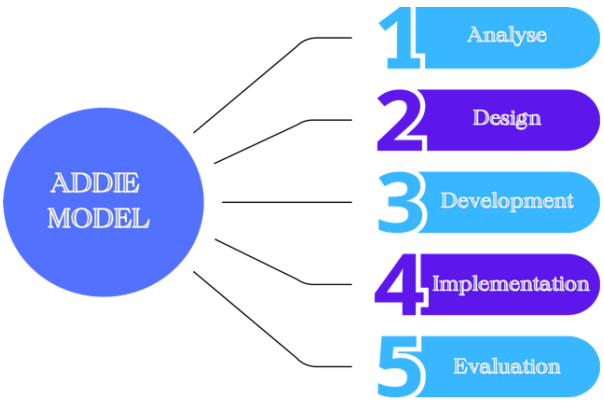


Figure 1. The flow process of the ADDIE model

2.1. Phase of analysis

The analysis phase is about finding out what the problems are. To find out the issues associated with the study, the researcher interviewed the requirements of two selected the subject of design and technology

(RBT) teachers. They raised some issues that must be considered when designing the lunch meal. One of the issues raised is how challenging the subject of food design technology can be. Next, they talked about how difficult it was for the students to understand the concept of food design. The problem includes where students have difficulty accurately relating kitchen appliance use to the food preparation process. In addition, the syllabus in the textbook is not engaging for student understanding due to fewer examples provided and more to long [18]. Due to this issue, students experience challenges to understand the topic well. Moreover, students have limited creativity in arranging food on the dining table and the plate [19]. Last but not least, the students found it difficult to answer the exam questions appropriately due to limited knowledge and exposure to this subject [20].

With the existence of this iFoodAR module, students are provided with various examples and styles of food preparation. Students can customize the listing of tools and food styles according to their preferences. This module can also help teachers interpret and integrate the learning content from the textbook into an actual form of visualization using the AR application. iFoodAR makes it easier for students to master all the critical elements in the food design syllabus, such as the selection of appropriate equipment, the use of tools, the layout of food, and the design of menu preparation more effectively. Then, the learning session will be more exciting and positively impact students.

2.2. Phase of design

In this phase of the research process, the researcher will develop the right E-modules to fit the food design theme. This phase is of great importance as it involves strategic planning for creating the software and determining strategies to achieve the objectives of the e-module [21]. In this phase, the researcher will plan how to create the application. To make this module, the researcher used the appropriate software. Canva and Adobe Illustrator CC were the two programs that the researcher used to design the visuals. Next, the researcher used a program called PowToon to create the movie. The researcher used the software Blippar to combine all components, including images, video, and text.

In addition, iFoodAR also includes assessments for students to measure their understanding of the course material, improving users' learning effectiveness and efficiency. At this stage, it was also determined that the mobile application should include appropriate text, music, video images and other multimedia elements. According to Nasir and Mohamed [22], using new technologies is a remarkable thing teachers must emphasize in their teaching. Figure 2 shows the movement of the module transition navigation represented by the arrows in the figure. Figure 3 shows the poster design that needs to be scanned with a cell phone. After it is scanned, the iFoodAR module appears on the cell phone screen.

2.3. Phase of development

The next phase is the development phase. In this phase, the actual systems are built using appropriate media and technological components tailored to the research objectives [23]. Blippar was used as the leading software to combine all the elements. Blippar allows both IOS and Android users to utilize this feature. In addition, users need to use a QR scanner to scan the QR code before scanning the marker-based barcode. Unlike other software, no coding is used to create the iFoodAR module. Figure 4 shows the display of the Blippar Hub, which developers use to create the content of the iFoodAR module.

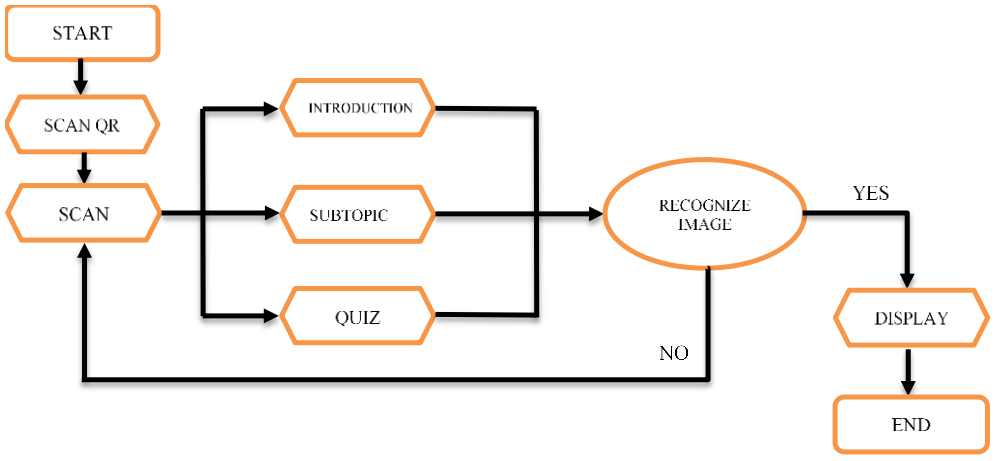


Figure 2. The flowchart of application of the iFoodAR module

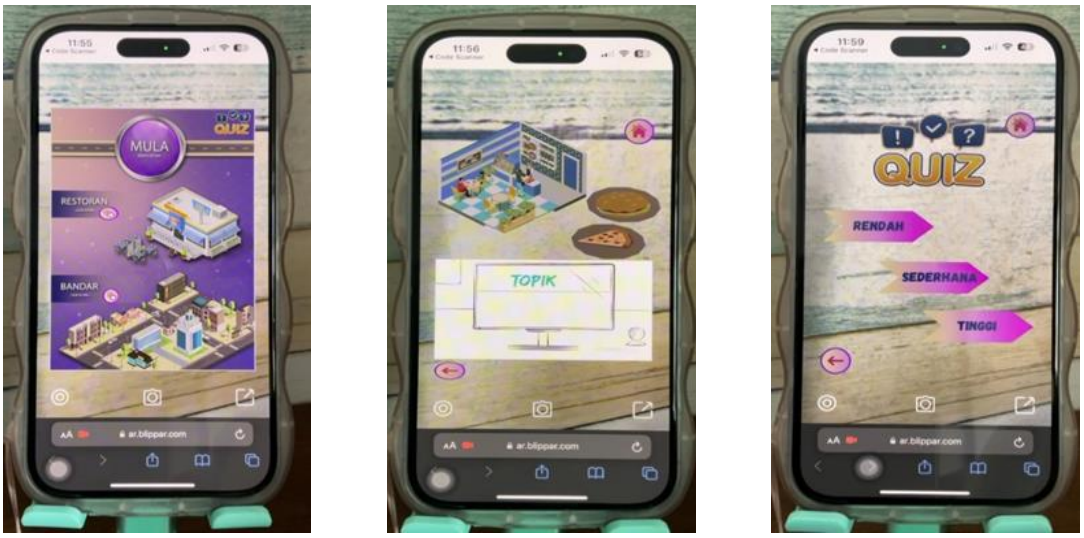
Figure 3. The poster design for the iFoodAR module

Figure 4. The guidelines and marker based of iFoodAR module

2.4. Phase of implementation

In the implementation phase, the previously created software and teaching materials are used and evaluated in their actual form [24]. The software or learning modules are used in a practical, real-life environment in this phase. The implementation phase is essential for identifying errors during software development [25]. This platform allows researchers to identify and correct errors before the user fully uses the software.

According to Figure 5, the module of iFoodAR is divided into three parts. Figure 5 (a) indicates the first marker-based which contains the words “MULA”. The content appears on the phone's display as shown in label a as interface of iFoodAR content. The content comprises a video introduction to the module and instructions for use. Figure 5 (b) shows a second marker-based system, which represents the restaurant vector. After scanning this image, the Topic is displayed as second interface for note page and note content. There are a total of six subthemes. Users can access the descriptions of the subtopics in the form of videos and graphics by clicking on the button associated with the respective subtopic. Lastly, Figure 5 (c) shows the tag-based activity called as Quiz. Users need to click on the button with the word “Quiz”. After clicking the image, the content will appear as interface for Mind Test. The question level is based on Bloom’s Taxonomy and includes three levels of learning which are low, intermediate, and high levels. The purpose of this section to obtain the user’s understanding after using this module “iFoodAR”.



(a) (b) (c)

Figure 5. Interphase of iFoodAR application through the mobile for (a) interface of iFood content, (b) interface for note page and note content, and (c) interface for mind test

2.5. Phase of evaluation

In this phase, the reviewer examines the modules before being tested and evaluated by experts from the field, two RBT teachers, and three experienced experts from their respective fields. Qualitative research is used to evaluate the module developed in this study. The questions in the interview form are related to the design, multimedia features, interactivity, and content, and an interview form is used to measure the responses. The interview questions consist of five parts: demographic information of the interviewee, content, functionality, design of the iFoodAR module, comments, and suggestions.

3. RESULTS AND DISCUSSION

The data collected for this study was verified for reliability through interviews with three professionals from the selected fields and two teachers certified in RBT. The professionals had a comprehensive understanding of the subject of design and technology and the field of food and services, as well as expertise in developing and evaluating multimedia teaching tools. A list of questions was developed to conduct the interviews, which included five different sections: demographics of the interviewees, content, functionality, design of the iFoodAR module, commentary, and recommendation. The experts were presented with nineteen questions on iFoodAR to evaluate the effectiveness of the developed e-module. A thematic analysis was carried out to aid in the data processing process. The interview transcripts served as the basis for creating codes [26].

3.1. Experts' background

Section A gathered information on the experts' background including their personal details, educational qualifications, and professional experience, particularly in the field of design and technology. The experts selected for this study have substantial experience, ensuring that their insights are grounded in both theoretical knowledge and practical application. As shown in Table 1, the experts come from a diverse range of educational institutions and professional environments. Their experience spans various sub-disciplines, such as culinary arts, family and consumer sciences, and design technology, with their professional tenures ranging from 5 to 16 years. This wide breadth of experience ensures that the evaluation of the iFoodAR module is thorough and reflective of current educational and technical practices.

3.2. iFoodAR module's content

Part B enquired the content of the iFoodAR module by posing six targeted questions to the experts, as detailed in Table 2. These questions were designed to assess various aspects of the module, such as its pedagogical value, the appropriateness of its content for the Food Design curriculum, and its ability to engage students through the use of interactive elements. The iFoodAR module incorporates multimedia, such as

images and videos, to create an immersive learning experience. According to expert feedback, these features significantly enhance the module's attractiveness, making it more likely to capture and retain student interest. Furthermore, the interactive nature of the content encourages active learning, which is a key factor in modern educational technology.

Table 1. Background of experts

Respondent	Gender	Background	Experience
R1	M	A lecturer affiliated with the Family and Consumer Science Department at the Faculty of Technical and Vocational, UPSI. Possesses extensive experience and specialized knowledge in culinary arts.	13 years
R2	F	A lecturer from the Family and Consumer Science Department at the Faculty of Technical and Vocational, UPSI, who has experience and expertise in food and service.	12 years
R3	M	A chef instructor with 5 years of field experience and now serving at the Faculty of Technical and Vocational, UPSI.	12 years
R4	F	A teacher of design and technology (RBT) subject.	12 years
R5	F	A teacher of design and technology (RBT) subject.	16 years

Table 2. Information regarding the iFoodAR content

No	Question	Expert views
1	Based on your observations, what is your opinion on the AR module's content for the Food Design topic?	This excellent and interactive module includes images and videos that can attract students to learn.
2	Does the content in this module correspond to the topic of Food Design?	All panels agree that the content contained in this module corresponds with the topic of food design, as each subtopic has its description.
3	Based on the observations, does this AR module comply with the standard curriculum and assessment document (DSKP) content that the Ministry of Education has set on Food Design?	iFoodAR has content that coincides with the standard curriculum and assessment document (DSKP) set by the Ministry of Education on Food Design.
4	Are reinforcement exercises provided according to the levels of Bloom's Taxonomy?	The exercises provided at the end of the module are suitable according to the levels of Bloom's Taxonomy because they contain three different levels of questions to assess student comprehension of the topic of Food Design.
5	In your opinion, are students able to apply food design knowledge easily based on the developed AR module?	The developed module was able to assist students in studying concerning their surroundings. This would help students feel the real experience through learning as it relates to their surroundings.
6	In your opinion, what recommendations may be made to enhance the application content?	The panels have proposed several suggestions. 1. Include the learning objective at the start of the module. 2. Every note includes graphic elements consistently. 3. Set up buttons or numbers accordingly to make sure the application runs smoothly.

3.3. iFoodAR module's functionality

Part C concentrated on the developed module's functionality. This component had six questions about the functionality of iFoodAR towards students, which included text, images, videos, animation, and color. Table 3 depicts the researcher's queries and the five experts' responses in Part C.

The advancement of technology has resulted in the creation of mobile applications [27]. This is also common in the educational system. The current study used the ADDIE methodology to create a mobile learning application called iFoodAR. The ADDIE paradigm is divided into five stages: analysis, design, development, implementation, and evaluation [28]. As a result, the iFoodAR development process had five stages, beginning with analysis and progressing to creating learning materials, developing learning materials and organizing activities, and finally, testing and assessing the complete application. Problems were discovered during the first phase of analysis. Students considered the Food Design topic of the Design and Technology class challenging to score. This was consistent with past research in which students thought some subjects in the curriculum were too memorized, making the topic difficult and failing to foster critical thinking [29].

The second part entailed creating learning materials and developing the application. Notes, application details, additional content, and a test were all included in iFoodAR. This app not only provided information for the Food Design topic, but it also used users surrounding and environment related to food that was common in this country's society. Students could measure their learning through the test questions [30]. Furthermore, iFoodAR used all media, mixing photographs and text meaningfully to attract them rather than just a simple text. iFoodAR was tested during the fourth phase.

The final testing for the iFoodAR application was tested by the reviewer and shown to typical student users. While exploring the application's functionality, they were asked for feedback and thoughts [31]. This stage successfully exposed problematic application components that occur or might occur. The

final stage involved expert review and the launch of the mobile application. The reviewers generally agreed that iFoodAR's content was appropriate for students. The material, visual appeal, and color visuals were also explicit and entertaining. Nonetheless, it was suggested that the application be made could be used at school using a tablet so that it can be used as a teaching aid for teachers at school [32].

Table 3. Information regarding the iFoodAR functionality questions

No	Question	Expert views
1	Are these modules suitable for use by secondary school students?	The modules are suitable for the students to use as gadgets nowadays are compulsory in life.
2	Can this AR module help students improve their understanding of the topic of Food Design?	Students will be able to envision in this engaging and interactive module, which will facilitate their knowledge.
3	Does the use of this AR module can ease the students' learning process on the topic of food design?	Teachers can assess their students ' comprehension levels with the help of the video notes, pictures, and quizzes included in this module.
4	Based on your observations, what are your views regarding the module design in terms of: i) graphics/video/animation, ii) writing, iii) color.	The application has an appealing and appropriate design based on favorable feedback from all five panels.
5	Based on your observations, will this module affect students regarding internet usage?	It should be because a reliable internet connection is needed for this AR module to run smoothly.
6	In your opinion, what recommendations may be made to enhance the functionality of the AR module?	The suggestions given by all panels: i) improve the module's functionality, as it can only be used at home or school; ii) the usage of batteries might be a bit higher; iii) limit Internet usage as it can be a cost to the student; iv) define the difference between the usage of this module compared to textbook.

4. CONCLUSION

As a result, the current technology, which is based on industrial revolution (IR) 4.0 being utilized by this module. Education is viewed as a teaching and learning skill that can be adapted to individual learning styles and strategies due to the impact of IR 4.0. However, it is hoped that this module will significantly impact students' ability to understand the topic better and meet the learning outcomes standards based on DSKP provided by the Ministry of Education. The development of this augmented reality application has accomplished its intended goal of creating an AR application that facilitates and intensifies the learning process for the subject of food design technology. The evaluation item that needs, such as the content and the functionality of the augmented reality module on the topic of food design technology for high school students, shows that the feedback from professionals has been positive. This demonstrates very clearly that the requirements of the AR modules are suitable for the current technology and that the technology is best suited for use in any circumstance because it can be easily accessed anywhere. In the meantime, concerning the development of modules, it has been validated by specialists that it makes use of the appropriate content and refers to DSKP. Next, based on the opinions of specialists, it has been determined that students can utilize this module as it is simple, appealing, and user-friendly to learn as it includes graphics. Videos indicate a better understanding and real-life experience about the subject.

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