

User Experience Design of Augmented Reality-based Mobile Learning Media for English Subjects through User-Centered Design Approach

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Abstract—Learning during the COVID-19 pandemic has changed and adapted to existing conditions in new ways. To maintain the existence of learning, the integration of ICT in learning is necessary. The integration of learning with ICT that is applied properly can increase the effectiveness of learning and make learning more fun. This study aims to design the user experience of learning media based on Mobile Learning with Augmented Reality technology to increase the motivation of high school students in learning English called ARCALIS. The approach used the User-Centered Design (UCD) approach. The UCD approach is an approach that uses human factors, knowledge, usability techniques, and an interactive approach to developing systems in system design and development. The resulting then tested with the assessment of learning media experts covering 3 aspects, namely Education, Program Display, and Technical Quality. The media validation assessment obtained an average value of 80% with a valid feasibility level without revision, which means that ARCALIS media is good to implement. In the future, ARCALIS can be developed in terms of material content, multimedia content, and learning evaluation with high-order thinking skills.

Keywords—mobile learning, augmented reality, user-centered design, user experience, learning media

I. INTRODUCTION

The Covid-19 pandemic has an impact on the entire community in various fields such as education, economy, society, and tourism. The negative impact is felt by the community, one of which is in the field of education. According to the Instruction of the Minister of Home Affairs Number 14th at 2021, learning from home is applied to the red zone and orange zone [1]. This instruction was applied because Java and Bali are included in the red and even black zones, learning is still carried out online. This instruction was applied because Java and Bali are included in the red and even black zones, learning is still carried out online.

Online learning is learning that can connect teachers and students remotely with the help of electronic media. Internet connection is at the heart of online learning during a pandemic. Various learning applications such as GoogleClass, Edmodo, Moodle, Quizizz, Zoom, and Whatsapp Group can be used as distance learning media. The integration of learning with appropriate ICT in the application can trigger students to think more critically, be able to work together, collaborate, be more creative and innovative, improve communication skills, solve problems, manage information, and make learning more fun [2]. The fun learning process can make it easier for students to capture and remember what they learn because it gives them a special impression. Therefore, Being an educator is required to be more active and creative in equipping students under the demands of the times (21st century) [3]. With the advancement of digital technology, educators can use mobile devices such as smartphones as learning media to increase learning effectiveness [4].

Nowadays, the Indonesian population, especially teenagers, are accustomed to using information and communication technology, especially gadgets or mobiles. The use of mobile in the world of education is often referred to as mobile learning. Learning that uses mobile as a learning medium is more exciting, not limited by the environment, time, space, or cost [5]. Mobile learning can serve as both a source and a medium. Serves as a source because the application can contain various learning resources in the form of text, images, sounds, or animations [6]. Furthermore, it functions as a medium because the mobile application uses a smartphone device with its operating system.

The use of mobile learning combined with Augmented Reality (AR) technology will be one of the interactive and interesting educational media. Augmented Reality (AR) is a combination of 2D or 3D virtual objects that are projected in real-time [7]. AR technology can visualize the shape of the

object being studied and can provide a direct explanation of the learning material from the object being observed [8]. AR can be a supporter of the birth of interactive education in various fields of science as well as a solution for learning from home during the Covid-19 pandemic.

One of the subjects that require more effort to be able to understand the material is English subjects. The English language subject is a complex subject at the elementary school level and is a compulsory subject in middle or high school [9]. Problems that often occur when learning English, especially during a pandemic, are writing grammar, pronunciation, listening, and reading. In addition, many teachers in public and private schools do not take advantage of facilities such as laptops, earbuds, and mobile phones as learning media. These facilities can facilitate the process of teaching and learning English subjects. Mobile learning media combined with Augmented Reality can make English lessons that were originally a scourge turn into fun lessons and motivate children to learn English [10]. Moreover, AR can visualize virtual images in real-time. This is a challenge for researchers.

To answer these challenges, it is necessary to design a user experience to create media that has functions and can be used easily by users. User experience is the user experience when using a product/software/system. There are several user experience design methods including design thinking, user-centered design, card sorting, heuristic evaluation, and others. In this study, the researcher chose the user-centered design method. The user-centered design (UCD) method is a method using human factors, knowledge, usability techniques, and is a method that is interrelated with the aim of system design and development [11]. For this reason, this model is considered appropriate for media development.

II. LITERATURE REVIEW

A. User Experience

User experience (UX) is useful for aligning the understanding of the developer with the user about the system of the product to be developed. Experiences from users can be in the form of positive or negative opinions so that developers can find out whether the product is easy to use and understandable to users [12]. Figure 1 shows how the user experience will be implemented. Good user experience has elements involved, what and how users do both from the appearance of the system to its behavior on a system [13].

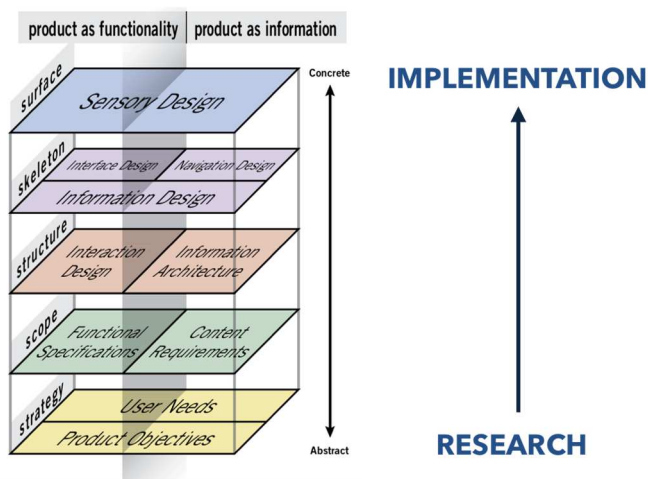


Fig. 1. User experience elements

B. Mobile Learning

Mobile learning is a term that refers to the use of information technology tools in the teaching and learning process. In general, mobile learning is learning that is carried out based on mobility, which utilizes mobile devices such as smartphones and tablets. Mobile learning is an attractive technology for the millennial generation, this is because smartphones and internet media are getting better and better, and cannot be separated from the hands of millennials. Based on the Global Attitudes Survey Q45 & Q46 Spring 2018 it was identified that Indonesia was ranked 24th out of 27 countries in terms of smartphone ownership [14]. The conclusion from these data is that most of the Indonesian population already owns a smartphone and uses internet services, this is a good potential to be developed in using Mobile as a learning medium. Mobile learning as taking place when the learner is not at a fixed, predetermined location, or when the learner takes advantage of the learning opportunities offered by mobile technologies [15]. Online learning during the pandemic makes students must study independently at home with teacher guidance through distance. Mobile learning is very helpful for students in accessing learning materials, taking quizzes easily by anyone, anywhere, and anytime.

C. Augmented Reality

Augmented reality (AR) is a technology that incorporates 2D or 3D virtual objects in real-time. AR allows users to interact in real [16]. Augmented reality is a technology that can simplify the process of visualizing objects that are usually only in the form of abstract images that are easier to see and understand because objects will be displayed in a real form in 3D and can interact with the surrounding environment through devices that support camera systems and screens such as smartphones/ mobile. In the media application that will be developed, augmented reality technology can be used to visualize objects that are learning English. Such as examples of conversations about asking suggestions, giving suggestions, accepting the suggestion, rejecting the suggestion. In addition, the media that will be developed also displays information related to objects that are displayed in 3D and can interact with the user's gadget screen [17].

D. English Learning

English is one of the compulsory subjects in high school. English is an adaptive subject that is taught to improve student's language skills in spoken and written form. English is also a tool to develop science, technology, information, and student culture. English subjects must prepare students as early as possible in facing the nation's competitiveness in a global or international society [18]. Before curriculum changed in Indonesia, English was required since elementary school, but now it's only as a local content subject where every elementary school has the freedom to include or omit English from the list of lessons. Therefore, English in secondary schools is required so that students as the nation's successors can face international competitiveness. The focus of the development of learning English in the developed media is on suggestion material. Sub-chapters of suggestion are the expression of offers, expression of suggestions, accepting and declining offers, and the response of

suggestions (accepting and refusing) [19]. Visualizing the material using optimal learning media can help students easily understand the suggestion material.

E. User-Centered Design (UCD)

User-centered design (UCD) is a method of designing and developing interactive systems. The stages and design activities at UCD originate in humans in each cycle [20]. The stages of the UCD include 4 stages as follows.

- *Understand and define user context.* The initial stage includes analysis and gathering of information related to the user context that will be applied to the system being built.
- *Specify user requirements.* The next step is to determine the functional requirements of the system and identify user needs. The user requirements that have been determined can be a guide in designing a design solution at a later stage.
- *Build design solutions according to user requirements.* The next stage is to create a design solution that fits the user's needs. The creation of a detailed design solution that has passed the testing stage can clarify user requirements.
- *Conduct design evaluations based on user requirements.* The last stage is to evaluate the design solution to find out the advantages and disadvantages at the design solution stage and ensure that user needs and user requirements have been met or not.

III. METHOD

The method used in developing mobile-based English learning media with Augmented Reality technology is the UCD Approach. Furthermore, UCD was chosen because it is suitable for the development of user experience design on learning media. In a series of research, the user experience development stage is included in the initial research stage before the trial process in the field. The goal is to find a user experience design that best fits the needs of potential users. UCD focuses on finding the characteristics of learning media that are suitable for potential users who in this study are high school students in learning English. The research process with the UCD approach consists of determining the user context, specifying user goals, developing design solutions, and testing.

The evaluation stage is carried out by validating the ARCALIS media prototype carried out by media and application experts referring to 3 criteria for learning media aspects as follows.

- Education includes covering the relevance of learning materials to the curriculum such as content, interaction, feedback, and error handling.
- Program display includes including coloring, use of words and language, on-screen display, graphics, animation, sound, menu commands, and design displays.
- Technical quality includes covering program operation, usage reactions, program safety, and supporting or additional facilities.

The instrument was distributed to experts in the form of a questionnaire given via google form with a rating scale of 1 to 4 ranging. The table of categories of feasibility levels is shown in Table 1. The average valid percentage is at least 76, meaning that the media can be used for classroom learning.

TABLE I. ASSESSMENT CRITERIA

Percentage (%)	Feasibility Level	Informations
76% - 100%	valid	no revision needed
51% - 75%	enough	revision needed
26% - 50%	less	revision needed
< 26%	invalid	revision needed

IV. RESULT

A. System Overview

The ARCALIS application was created based on an analysis of the evaluation of English learning during the pandemic, where many students had difficulty understanding the material Suggestion and lack of interest in learning English because the learning media used is less attractive. The material raised in this application is an English subject for 11th-grade high school, the selected basic competency is KD. 3.1. Applying social functions, text structure, and linguistic elements of spoken and written transactional interaction texts that involve the act of giving and asking for information related to suggestions and offers, according to the context of their use", that was chosen because it is one of the important materials that will always be needed and become provisions in everyday life. Suggestion material discusses the expression of offers until the response of suggestions.

ARCALIS based application Mobile Learning with 1 user, namely students. Students can see and listen to the learning material in each topic. Students can also enjoy AR mode which is interesting for students so that students can easily understand the material and feel more comfortable learning English. In addition, students can also take quizzes to measure abilities after using ARCALIS learning media. When students finish working on the quiz, students can save the quiz scores so that students can conclude for themselves the abilities and knowledge that have been obtained.

B. User Context Analysis

1) Identification Stakeholders and Users

This stage is carried out by interviewing stakeholders and users to find out the needs of the system created. The result of the interview is that there is 1 application user, namely students. Learners are users who can enjoy all the services of the application, starting from studying all the topics available, learning with AR, and doing quizzes where the assessment is immediately available.

2) User Character Identification

The next stage is carried out to know the characteristics of each user of the system. Special characteristics of users (students) are viewing material from various topics, enjoying AR in presenting material, doing quizzes, and getting quiz results, and being able to store quiz results.

3) Identification of Purpose and Authority

The purpose of designing ARCALIS is as a learning media based on Mobile with a combination of AR to make it easier

for students to understand English material Suggestion, especially during a pandemic. With ARCALIS, students are expected to be more interested, enjoy, and enjoy learning English and can measure their abilities before and after using ARCALIS. So that students are more confident in communicating using English both orally and in writing.

4) System Environment Identification

At this stage, it is carried out to explain the specifications of the device and other equipment so that ARCALIS can be used properly according to user needs. 3 types of environment in the system will be created, namely hardware (including smartphones), software (including OS android), and completeness of the system (including the internet network to access ARCALIS).

5) User Needs Analysis

The user needs analysis stage is based on the results of interviews and identification in the previous stage. This stage is carried out to identify user needs for the system to be built. The results of the needs analysis are verified by stakeholders, then the results are converted into features to be developed in ARCALIS. At this stage, a list of user requirements and a list of ARCALIS features is also carried out.

6) Identification of User's Functional Needs

Functional requirements are requirements that include system services, the relationship between the system and inputs, and certain conditions that must be provided by the system. The user's functional requirement in ARCALIS is that the system can display AR mode in presenting material and storing quiz results.

7) Identify User's Non-Functional Needs

Non-functional requirements are the functions and service limits of the system. Non-functional requirements can be standardization, time constraints, service limitations. In this system, the user's non-functional requirements include the system being able to run on the OS android, the system has a user-friendly interface, and the system has a pleasant UX.

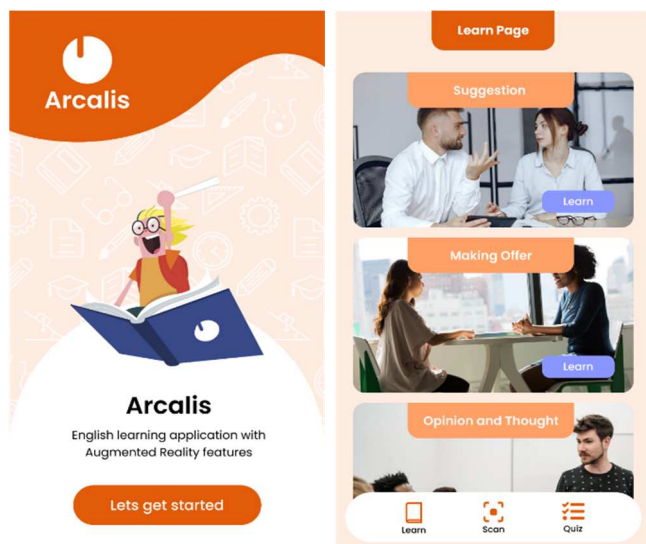


Fig. 2. Splash screen (right) and learn page (left)

8) Identify Feature List

Identification is done to find out the list of features needed by the user when using the system. The following list of features is presented in Table 2.

TABLE II. FEATURE LIST

Feature List	Description
1. Splash Screen	The start page to start logging into the application and contains brief information related to ARCALIS
2. Learn Page	Pages that display topics from the material contained in ARCALIS
3. Learn	The section that is used to open the topic that the user wants for further reading
4. Scan Page	Page to bring up AR components
5. How to scan	Section to find out how to scan/scan
6. Activate AR mode	Section to start opening scan mode
7. Toggle zoom	Section used to enlarge objects
8. Rotate	The section that functions to rotate objects
9. Quiz Page	Page to display quiz questions
10. Play	The section used to start working on the quiz
11. Save	Section for storing quiz scores

9) User Interface (UI)/User Experience (UX) Design

To clarify and make it easier to understand the flow of the ARCALIS system, the following user interface (UI) in ARCALIS.

The splash screen in Figure 2 is a loading page that displays the logo and brief information from ARCALIS. The learn page menu in Figure 2 contains a series of English learning materials. Swipe down or up to see all topics. Press the "Learn" button to start learning the related topic.

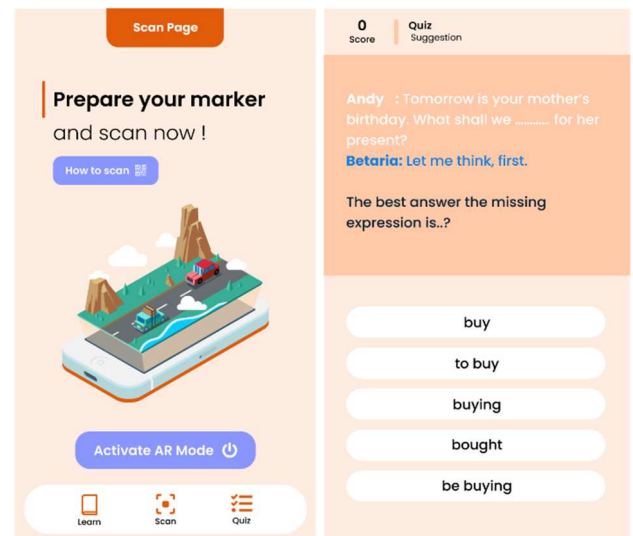


Fig. 3. Scan menu (right) and quiz menu (left)

The scan page menu in Figure 3 is used to display AR components with scan markers. To find out how to scan markers, users simply press the "how to scan" button. While the "activate AR mode" button is used to start entering scan mode. Then point the camera at the marker until the AR object appears. Slide the zoom toggle to enlarge the object and the rotate button to rotate the object. The quiz page menu in Figure 2 contains English questions that the user can do directly by pressing the "Play" button, then when finished working on the quiz press the "Save" button to save the quiz scores. There are 10 questions in each quiz and each question has five answer choices, and there is only one correct answer choice.

10) Evaluation and Discussion

The evaluation phase is an important element of the User-Centered Design approach. The process of assessing user experience with the system using an online questionnaire (google form). In this expert trial, there are 40 questions to determine the results of expert judgment, namely English teachers to assess the validity of the media.

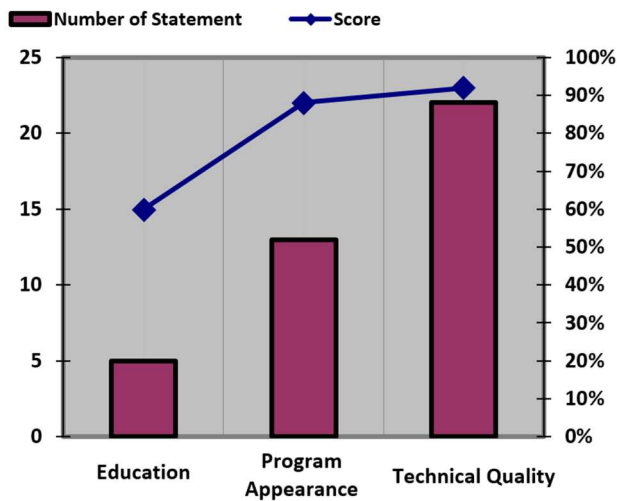


Fig. 4. Media assessment results from expert judgment

Based on the test results ARCALIS is a valid media and can be used for learning. Figure 4 shows the result of the ARCALIS application validation assessment in every aspect which includes the educational aspect with a score of 60%, the program display aspect with a score of 88%, and the technical quality aspect with a score of 92%. From these three aspects, an average score of 80% was obtained with a valid no revision needed level. The results of the assessment can be concluded that the ARCALIS application is good for high school students in 11th grade, but improvements need to be made for the material. The relevance of the material with the curriculum is felt to be lacking so that the value obtained is not yet valid.

V. DISCUSSION

Innovation can be done in various ways in responding to learning needs during this pandemic. Learning must still be pursued to run effectively and efficiently. On the other hand, limited conditions must also consider the interests and ease of student learning [9]. In this study, it is shown how ARCALIS is designed in such a way for learning English. In line with the results of the needs analysis, learning English is a challenge for students considering its position as a second language, maybe even the majority of the third and fourth languages for multicultural Indonesian students [10], [19]. This media should be developed to attract students' interest in learning English with mobile learning and the sophistication of augmented reality.

Learning in a way that students like is certainly more attractive to them, especially if it offers the latest technology such as mobile and augmented reality-based. This innovation must bridge the existence of problems and learning needs that are expected to have a positive impact on student responses [21]. Furthermore, the development of ARCALIS can also make a positive contribution to digital technology-based learning. Innovative media provide a more up-to-date learning experience for students, especially in this digital era [22].

It is the student's learning experience in using technology that we want to build here. Mobile design allows students to be actively involved in learning according to research results which show that the use of mobile learning is the best solution that can attract students [6], [23]. Moreover, in ARCALIS, the media is designed for one user so that the learning process can be more intensive. The features provided help students to learn more easily in reading and listening to the material, especially the suggestion material so that it becomes a medium that students can use to practice independently in communicating in English orally and in writing.

In more detail, it can be observed that in fact students today cannot be separated from various kinds of gadgets. In line with the majority of the selection of various gadgets by Indonesian students, from the positive side, this is an opportunity for teachers and the development of learning products to carry out various real innovations in learning [24]. Especially during the pandemic which limits the direct interaction of students and teachers in learning. Discussing learning during the pandemic itself has become a common thing how many problems have to be faced by teachers and education practitioners in general in Indonesia [25]. Network and device limitations are the main obstacles that are widely mentioned.

Every product development must be based on the results of the needs analysis as in this study the media development process is carried out systematically starting from the needs analysis to the evaluation stage. Requirements analysis is used in developing the features in ARCALIS to the presentation of its visualization. The features referred to in ARCALIS itself are designed to be easily operated by students, especially in displaying material, switching to AR mode, and taking quizzes. In the application, the user experience will be explored. The evaluation results from the media results also show that the product is feasible to use in terms of the display program and the technical quality aspect. This stage plays an important role in confirming the feasibility of the product developed based on predetermined criteria referring to the UCD used [13], [17]. The results are used to ensure that the results of the needs analysis have been answered.

VI. CONCLUSION

System requirements analysis begins with interviews with several high school English teachers and literature studies by reading papers, journals, and research related to system development to obtain information. Then identify user characteristics, objectives, user authority, and system environment to be designed. The next stage is to analyze user requirements which include identification of functional requirements and non-functional requirements of users, as well as making a list of features of the designed system. Based on the analysis of system requirements and analysis of user requirements that have been obtained previously, a design solution is made. The steps taken in the design of the design solution are to create a user interface (UI). UI creation to describe the design in more detail and make it easier for users to understand the flow of the ARCALIS feature.

Furthermore, an evaluation of the design solution resulting from user experience in using ARCALIS was carried out using a media expert validation assessment involving 1 respondent as an expert judgment. Testing is done online by google form. The assessment covers 3 aspects includes education, program appearance, and technical quality. From

the media validation assessment, an average value of 80% was obtained with a valid feasibility level without revision, which means that ARCALIS is good to implement. Based on the results of this research, in the future, the development of ARCALIS media will be carried out by taking into account several notes obtained from the testing results, such as the need to develop appropriate material content, multimedia and evaluate learning with high order thinking skills.

ACKNOWLEDGMENT

Great gratitude and appreciation for LP2M Universitas Negeri Malang which has supported this research activity through the 2021 PNPB research grant.

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