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Design and Development of the Didik BacaAR Application Utilizing Buildbox Classic to Support Early Literacy Acquisition among Students

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Abstract

Augmented Reality (AR) is an advanced technology that enhances student engagement and comprehension during the learning process. AR facilitates the integration of interactive visual components into complex subjects, thereby making learning more engaging, efficient, and authentic. However, research on the application of AR technology in Malay language education in contemporary schools is limited. The primary objective of this study is to develop a storyboard creation process using the Buildbox Classic platform, employing the Design and Development Research (DDR) methodology while incorporating elements of Malay syllables to create educational applications. The storyboard serves as a crucial planning tool in designing and developing AR applications. This process involves scriptwriting, organizing visual recordings, and arranging interactive elements, all of which are essential for constructing a well-structured AR application for educational purposes. Analysis indicates that the use of applications in reading instruction can assist students in learning more effectively. Data were collected and analyzed using frequency and percentage values derived from a checklist. Findings suggest that the combination of AR technology with storyboard applications addresses challenges in creating interactive and accessible educational tools, thereby enhancing student learning outcomes.

Keywords: Augmented Reality Technology, Education, Technology, Malay Language Applications

Introduction

Augmented Reality (AR) technology has seen significant advancements over time, with a wide range of software and hardware now available for its implementation across multiple sectors, including archaeology, architecture, commerce, advertising, construction, industrial design, healthcare, entertainment, sports, tourism, and the military. However, AR in education has also evolved in tandem with Industry 4.0 technology. Several tools and displays are necessary for interacting with AR systems. According to Syberfeldt et al. (2016), AR systems generally require three categories of devices: i) head-mounted displays (HMD) and

goggles, ii) mobile devices such as smartphones, tablets, and iPads, and iii) holographic display systems and projectors.

Regarding AR types, Lavingia & Tawar (2020), categorize AR into four primary types: i) marker-based AR, ii) markerless AR, iii) projection-based AR, and iv) superimposition-based AR. Marker-based AR relies on specific markers or labels, like QR codes, to position 3D virtual objects in real-world settings. Image recognition systems then generate corresponding 3D images that can be rotated for better visualization from different angles. Markerless AR, as noted by Yih & Chun (2019), represents a newer development where sensors in mobile devices, along with GPS, are used to detect real-world elements like locations or points of interest, allowing users to position virtual objects in real environments without relying on markers.

Two additional AR types are emission-based and superimposition-based AR. Emission-based AR projects artificial light onto real-world surfaces, allowing users to interact with these surfaces, with human interaction detected through changes in expected radiation patterns. Plasma laser technology can be used to create 3D interactive holograms in this type of AR. Superimposition-based AR replaces an object's original view with an augmented one, dependent on accurate image recognition, and is commonly applied in medical fields for tasks such as overlaying X-rays onto a patient's body.

Advancements in AR technology offer new opportunities for diverse sectors, particularly education, where teachers can explore its potential in enhancing student learning (Batulmalai & Siti Mistima, 2020). As Bacca et al (2014), note, the most commonly employed AR types in education are marker-based (59.38%), location-based (21.88%), and markerless AR (12.5%). Mobile devices, frequently used by students, are ideal hardware for AR in education, providing an engaging way to present information through graphics, animations, and text (Akçayır & Akçayır, 2017). These devices are not only accessible and cost-effective but also support multi-sensory learning materials, facilitating a deeper understanding of educational content (Chang et al., 2014; Akçayır & Akçayır, 2017). Therefore, this study was conducted to:

i. Designing an Didik BacaAR application to help students learn to read
ii. Develop the Didik BacaAR application to help students learn to read.
iii. Testing the functionality of Didik BacaAR applications in helping students read from the aspects of content design, interaction, and interface.

This research centers on the development of the Didik BacaAR application aimed at supporting students in their learning journey. The study primarily evaluates the level of expert acceptance of the Didik BacaAR application, particularly from the perspectives of content design, user interaction, and interface quality. This initiative seeks to enhance the learning process. Furthermore, it is expected that the Didik BacaAR application will indirectly foster a deeper understanding among students by increasing their engagement with syllable reading through the innovative use of the application.

Methodology

The development of storyboards utilizing the BuildBox Classic application and Augmented Reality (AR) technology encompasses several key phases. Initially, BuildBox Classic acts as an interactive platform for planning, designing, and managing storyboards. In the AR development process, these storyboards outline the visual narrative of the application and

the intended user interaction, such as the placement of 3D objects and animations. After completing the storyboard, the 3D objects are integrated into the AR environment through specialized plugins, like those used in Unity software. This integration ensures that every component within the AR application aligns with the storyboard to deliver a cohesive and immersive user experience. The entire process involves rigorous system testing, such as BlackBox testing, to confirm the application's full functionality and its ability to meet user requirements. This research adopts the Design and Development Research (DDR) approach, which focuses on the iterative development of applications in educational contexts. The study follows a quantitative methodology, using a checklist for expert feedback (Saedah Siraj et al., 2020), and the DDR approach consists of three essential phases, as outlined in Table 1.

Table 1
Main Phases of DDR

Fasa	Kaedah
Phases 1: Need Analysis	Literature Review
Phases 2: Design and Development Research	Checklist
Phases 3: App Functionality	Questionnaire

Sampling

In the design phase, the researcher selected 3 experts for the item validity of the application content checklist to obtain an expert consensus view of what should be in the application design. Apart from the selection of the number of experts, the researcher ensures that the selected experts have a background or experience in the field related to the study being conducted, this selection can support their opinion to the needs of the study and can revise their initial judgment to reach a consensus among experts (Pill, 1971). This is because according to Saaty & Özdemir (2014), adding more inexperienced experts can weaken the accuracy of the results. The selected expert must meet the following criteria:

i. Knowledgeable in the field of study, at least a Master's Degree in the field of education, educational technology or a field related to design thinking.
ii. Experienced in the field studied and have at least five years of experience in a related field.
iii. Can fully commit until the study is completed.
iv. Have no personal interest to avoid the study biased.

Therefore, the researcher took into account all the factors and criteria according to Saaty & Özdemir (2014) in choosing the 3 experts involved.

Data Analysis

In this study, data collection and analysis were conducted using frequency and percentage values derived from a distributed checklist. To streamline the analysis, each item was grouped, and its frequency was calculated as a percentage. Microsoft Excel was utilized to classify the percentage values, determining the levels of agreement concerning the Didik BacaAR application. Descriptive statistics were then applied to analyze the data, revealing the percentage of expert agreement across the various questions, as presented in Table 2.

Table 2
Determination Level Table

Assessment	Determination Level Indicator
High	80-100
Moderate	40-79
Low	0-39

The checklist form was distributed to experts who possess significant expertise and extensive experience in their respective fields. The evaluation of the Didik BacaAR application by these experts aimed to obtain validation for the development of the application. The evaluation process included groups of expert lecturers specializing in areas such as language, educational technology, and Malay language education, providing professional feedback to enhance quality and ensure the prototype development objectives are met. Expert validation was also conducted to ensure that all content aligns with the intended learning objectives before the application is implemented with the actual sample (Peterson, 2003).

In this research, three experts were engaged to provide input on determining the necessary items for application development. Table 3 presents the demographic details of these experts, along with their respective areas of specialization relevant to the evaluation of the application.

Table 3
Expert Demographics and Areas of Expertise

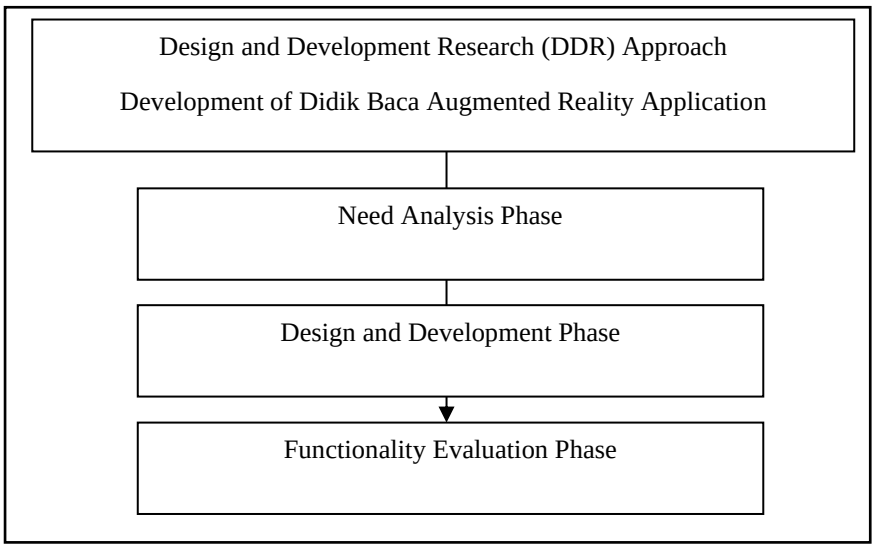
Expert	Position	Institution	Options/Fields of Expertise	Expertise Experience (Year)
1.	Senior Lecturer, Prof. Dr.	IPTA	Malay Language Education	25 years
2.	Senior Lecturer, Prof. Madya Dr.	IPTA	Technical and Vocational Education and Training (TVET) *Augmented Reality*	13 years
3.	Senior Lecturer, Ts. Dr.	IPTS	Animation Design and Application Creation	12 years

The checklist questionnaire instrument contains 22 items that are divided into seven constructs, which were assessed by experts in areas such as (i) content design, (ii) interaction design, and (iii) interface design. The agreement level was measured using a percentage-based approach with a binary scale (Yes/No), ranging from 0% to 100%. This scale was selected by the researcher due to its simplicity in data collection and its ability to accurately reflect the experts' feedback.

Product Design

To ensure high-quality research outcomes, the process must be carefully planned and systematically executed to meet the study's objectives. Proper planning helps to minimize or eliminate unexpected errors. In the product development phase, the application was designed using a pedagogical approach combined with the Design and Development Research

(DDR) methodology, which integrates a structured and systematic process. Each step serves as a guide for the development of the Didik BacaAR application, as illustrated in Figure 1.



Need Analysis Phase

At this stage, the researcher evaluates the application's content alongside three primary research objectives: designing and developing the Didik BacaAR application, as well as testing its functionality for educational purposes. The analysis phase is the initial step in the DDR approach, where the researcher identifies the target audience, emerging issues, and existing challenges, along with strategies to address them. During this phase, the study's scope and objectives are determined based on the gathered, assessed, and analyzed data. Table 4 outlines the five key criteria reviewed during the analysis process prior to the development of the Didik BacaAR application.

Table 4
Didik BacaAR Application Analysis Phase Process

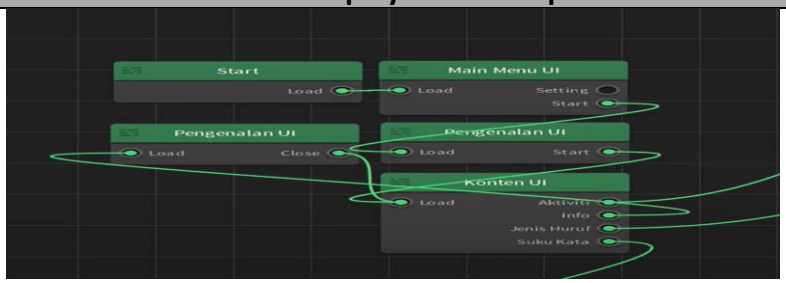
Kriteria	Penjelasan
Functionality	The application's design must be appropriate and align with the study's scope.
Controllability	Users should operate the application according to the provided manual to ensure clear and effective system functionality.
Design	The application must be compatible with the functions and methodologies used for teaching and learning purposes.
Endurance	The selection should align with the application's function to ensure its optimal use.
Economy	The utilization of web pages in application development should be considered due to their appropriateness and user-friendly nature for this purpose.

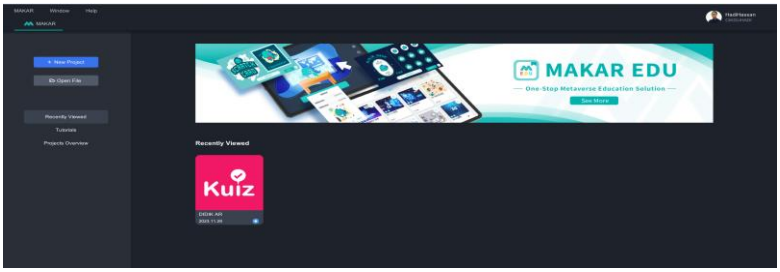
Design Phase

Researchers classify design into three primary categories: content, interaction, and interface design. The researcher created a storyboard following a comprehensive analysis and data collection process. This storyboard depicts the layout, sequence, and specifics for presenting the Didik BacaAR application. Additionally, the researcher incorporated two design types:

content topics, interaction types, and interface types for multimedia elements, as identified during the analysis phase. The storyboards were developed using the Buildbox classic web application, selected for its user-friendliness, organization, and ease of maintenance. Table 5 details the preparation and planning process for the main components of the design phase.

Table 5
BacaAR Application Design Phase Process

<table>
<tr><th>No</th><th>Design</th><th>Display and Description</th></tr>
<tr><td>1.</td><td>Content Design</td><td> 



Instruction: A link to build an application using the web Buildbox Classic, by coding. While to develop Augmented Reality using the MAKAR application.</td></tr>
<tr><td>2.</td><td>Interface Design</td><td> 

Petunjuk:
a. Learning main menu
b. Transition button
c. Share the app to media social</td></tr>
<tr><td>3.</td><td>Interaction Design</td><td> 

<table>
<tr><th>Instruction</th><th>Item</th><th>Description</th></tr>
<tr><td>C1</td><td>Face display button</td><td>Button to access the main page</td></tr>
<tr><td>C2</td><td>Button syllable opens with a (KV) 1</td><td>Button to read syllable (KV) 1</td></tr>
</table></td></tr>
</table>

		C3	Button syllable opens with a (KV) 2	Button to read syllable (KV) 2
		C4	Button syllable ends with (NG) 1	Button to read syllable (NG) 1
		C5	Button syllable ends with a (KVK) 1	Button to read syllable (KVK) 1
		C6	Button syllable ends with a (KVK) 2	Button to read syllable (KVK) 2
		C7	Button syllable ends with a (NG) 2	Button to read syllable (NG) 2

Development Phase

This phase encompasses the applications utilized in the development of the Didik BacaAR application, integrating necessary multimedia elements and technology. The researcher employed various tools, including Buildbox Classic software, the MAKAR application for Augmented Reality, Audacity, and Autodesk 3DS Max, to support the development process. Additionally, the researcher reviewed the first-year primary school education syllabus as a foundation for enabling users to learn reading through a bottom-up approach. The development phase follows the completion of the design phase and includes a range of activities, such as creating content material and incorporating multimedia elements like text, graphics, audio, and video. These multimedia components are essential for engaging students in enjoyable learning experiences, particularly in comprehending the subject matter. Furthermore, interface design plays a crucial role, as it shapes the user's initial impression of the application; therefore, the development process must be meticulously executed to align with the topic and achieve the intended learning objectives.

Phase

During this phase, the instructional materials will be applied in practical contexts. The fully developed Didik BacaAR application will undergo testing with actual users to detect any errors that may arise throughout the product development process. Should any issues be identified, they will be addressed prior to final submission. This phase occurs following the completion of the development stage and encompasses several processes aimed at evaluating the functionality of the Didik BacaAR application in supporting students' reading acquisition, focusing on content design, interaction, and interface.

Evaluation Phase

In this phase, the Didik BacaAR application undergoes evaluation by a team of three qualified experts in relevant fields. This assessment involves multiple groups of specialist lecturers with expertise in language, educational technology, and Malay language education, contributing to the enhancement of quality and ensuring that the goal of prototype production is met. During this stage, the functionality of the Didik BacaAR application will be assessed using a checklist to gather feedback on its usability and areas for improvement, focusing on aspects such as content design, interaction, and interface.

Findings of the Study

Expert Evaluation Analysis

Evaluation of content, interaction, and interface design involved 3 experts. The experts involved are experts on the application to be developed. The evaluation involves several groups of expert lecturers who are specialized in a certain field, which includes several areas of their expertise to provide a consensus value to improve quality while also ensuring that the objective of producing prototypes can be achieved Expert evaluation.

Table 8

Expert Evaluation Analysis for Content, Interaction, and Interface Design

No	Item	Yes	No	Acceptance Percentage (%)
Content Design				
1.	The contents of the topics in this application meet the learning objectives	3	0	100
2.	The contents of the topics in this application correspond to the learning topics	3	0	100
3.	The information in this video through this application coincides with the content of the learning topic	3	0	100
4.	The information in this video through this application is compatible with the latest syllabus	3	0	100
5.	The presentation of information in this application is clear and easy to understand	3	0	100
Interaction Design				
1.	The use of text on each navigation button of this application helps users to explore to other displays	3	0	100
2.	The use of buttons in this application is consistent	3	0	100
3.	The size of the buttons in this application is appropriate	3	0	100
4.	The position of icons in this application is consistent	3	0	100
5.	Every button in this app works well	2	1	66.7
6	The button to the next view in this application works well	2	1	66.7
7.	The function of the navigation buttons used in this application can be easily identified	2	1	66.7
Interface Design				
1.	The colors and background of the application interface design used are appropriate	3	0	100
2.	The type of writing used for each application content statement is appropriate	3	0	100
3.	The use of text on application videos is appropriate	3	0	100
4.	The use of button warrants on the application is appropriate	3	0	100

5.	The size of the video displayed on the application is appropriate	3	0	100
6.	The introductory content description in the video on the application is appropriate	2	1	66.7
7.	The duration of the application is sufficient	2	1	66.7
8.	The video quality on the app is decent	3	0	100
9.	The use of audio in the application is clear and easy to hear	2	1	66.7
10.	The background music used in the application is appropriate	3	0	100

Based on the data obtained, most experts agree that the content in the application developed by the researcher coincides with the learning objectives, is relevant to the target user and interesting. However, there are some parts in this application that need to be improved and improved according to expert recommendations.

Discussion

Prior to the development of this application, researchers conducted scientific readings and studies to gather information, ensuring the relevance of the learning topic through needs analysis techniques. Throughout the research process, challenges emerged, including inadequate content and unengaging multimedia materials. Nonetheless, a well-structured storyboard enabled the early identification of these issues. A storyboard serves as an initial visual representation of how various components of the application interconnect (Hamzah et al., 2022). The integration of multimedia elements—text, images, animations, and audio—plays a crucial role in engaging users and enhancing learning. Sofian, Hashim, & Sarlan (2021) note that multimedia can significantly improve learning outcomes compared to traditional methods reliant solely on textbooks, especially for students with special needs.

The incorporation of videos is highly recommended to facilitate students' comprehension of foundational reading skills, as videos present information more effectively than other multimedia formats. Makmuroh (2021) emphasizes that interactivity is essential for helping students grasp the information presented. A well-crafted video can enhance student engagement with the application, aligning with learning objectives.

A critical aspect of designing and developing this application involves selecting the appropriate product development model. The researchers employed the Design and Development Research (DDR) approach due to its non-linear nature and flexibility, allowing for easy adjustments throughout the development process. This approach aligns with the systematic components of planning, implementation, and evaluation aimed at optimizing educational technology applications, as noted by Sriwahyuni & Saehana (2021).

The primary platform for developing this application is BuildBox Classic software, which enables the creation of interactive animations for various applications, including games and eLearning content. BuildBox Classic, alongside MAKAR applications, facilitates the publication of content across multiple formats, thereby expanding its accessibility. Setiawan, Alpindo, & Astuti (2022) assert that this software supports the development of animations with high interactivity, making it ideal for engaging learning media. However, the completion of

interface, navigation, and content design is essential before commencing the development phase.

This application targets school students, particularly first-year students, necessitating careful selection of text types due to their initial phase of alphabet recognition. Text content must be concise and utilize accessible language, with narratives conveyed through animations and reinforcing text. Graphic elements are designed using Audacity and Autodesk 3DS Max, while navigation buttons are meticulously crafted to enhance user experience. This focus on navigation design aligns with Harun et al (2021), who assert that effective applications require an orderly visual arrangement to aid user comprehension.

The evaluation of the Didik BacaAR application's functionality in assisting first-year students with reading revealed positive feedback from experts, who recognized its effectiveness as a self-learning tool. The content and design of the interface and interactions were deemed straightforward, facilitating the mastery of reading skills. The application employs user-friendly multimedia technology to adhere to the recommendation of incorporating technological elements in education. Thus, the designed application enriches students' learning experiences, aligning with the vision of the Fourth Industrial Revolution.

As the demand for applications grows, the integration of Information and Communication Technology (ICT) in classrooms becomes increasingly vital. Familiarizing the younger generation with technology from an early age is essential. Jemimah & Suziyani (2019), highlight that Malaysian preschool teacher are already integrating ICT into their classrooms in preparation for the demands of the Industrial Revolution. Consequently, employing the Didik BacaAR application in basic reading instruction will help broaden students' thinking, supporting primary education's objective of establishing a robust foundation across cognitive, psychomotor, social-emotional, language, and communication domains.

Furthermore, expert evaluations confirmed the Didik BacaAR application's effectiveness in supporting reading skill development, particularly concerning content design, interaction, and interface. The design is user-friendly, assisting students in mastering reading skills. The Malaysian Education Development Plan 2013-2025 aims to equip students for the technological advancements anticipated during the Industrial Revolution. With the growing importance of ICT in classrooms, introducing technology to younger students is critical. Research by Jemimah and Suziyani (2019), found that preschool educators in Malaysia are utilizing ICT to address the evolving demands of education. An effective learning approach can enhance students' cognitive, psychomotor, social-emotional, language, and communication skills, consistent with the overarching goal of foundational education.

Conclusion

This study aimed to develop the Didik BacaAR application, designed to enhance basic reading skills among first-year (level one) students. The application has the potential to facilitate visual learning, making information delivery clearer and easier to understand. Additionally, it is expected to positively impact the effectiveness and engagement of knowledge delivery. The study also provides a comprehensive guide on the design and development process of the Didik BacaAR application, tailored specifically for first-year students. The application is anticipated to aid the teaching and learning process, thereby increasing students' knowledge

levels. It is hoped that the findings of this study will serve as a reference for various stakeholders, particularly in supporting the development of learning applications by teachers and guiding industry players in creating multimedia learning environments across all school levels.

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