The Development of 2D Android Learning Application on the Topic of Light Properties for Elementary School Science Subject

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ABSTRACT

The nature of light is one of the core topics in the science subject of the fourth year (Grade 4) curriculum in schools. However, it is acknowledged that some students find it difficult to grasp the content of this topic, not because it is inherently challenging, but because each student has their own unique learning style. Conventional teaching methods typically involve instructing a group of students simultaneously, which leads to a few students struggling to understand the concept of light and consequently becoming less motivated to learn. To address this issue, researchers have developed an Android application for the topic of light properties in the fourth-year science curriculum, as an alternative approach to help students enhance their comprehension through the integration of multimedia elements within the application. The researchers also utilize the ADDIE model as a framework for the overall development of the Android application. Once the Android application is developed, its functionality is evaluated using a structured interview form of three expert evaluators. These experts evaluated three instructional designs implemented in the application, namely content design, interface design, and interaction design. Based on the results of the study, it shows that the development of this product has had a good impact on the parties involved, especially students and teachers, where it becomes a fuel to improve students' understanding better.

Keywords
Android Application, Mobile Learning, Science

Introduction

Learning often incorporates digital media as a Teaching Aids. Mobile learning (m-learning) has been introduced to school students in line with the rapid development of information technology in the education system (Zahari, Syed Bidin & Wan Syamsuddin, 2021). The use of mobile devices for learning not only enhances Information and Communication Technology (ICT) skills but also enables students to acquire knowledge anytime and anywhere. Additionally, numerous educational applications have been developed and distributed to users through mobile devices.

This 2D Android application serves as an additional alternative for students to learn about the topic of Light Properties in a more engaging manner. According to Reiners and Seymour (2013) stated that the abstract nature of light properties can be challenging for young students to grasp without visual and interactive aids. Therefore, it is necessary to develop a 2D Android Learning Application on the Topic of Light Properties for Elementary School Science Subject to ensure students can visualize using various multimedia elements to increase students' understanding regarding the topic being studied. This Android application is developed by integrating multimedia elements such as animations, graphics, text, videos, and audio. All these elements are incorporated into the development of the application to comprehensively explain the topic of Light Properties. This application allows fourth- grade students to acquire knowledge about this topic while being entertained through mobile learning. An effective way to enhance knowledge is through instructional

communication using computer technology applications (Razali, 2016). Therefore, the problem statement in this study can be addressed through the development of the Android application "Light Properties".

Mobile Learning (M-Learning)

Mobile learning can occur with or without Internet access because mobile learning only requires mobile devices such as smartphones and computers. In additional, mobile learning is flexible as it allows users, namely students, to access education anywhere and at any time without limitations (Murat, Din & Alis, 2020). This learning method is more relaxed as students engage in the learning process independently, with the teacher serving as a guide.

M-learning has the potential to engage students and enhance academic performance (Al- Rahmi, Mutambara & Bagaya, 2021). Students' ability to explore learning through mobile learning is evidence that the learning process is taking place and helps improve their motivation to pay attention and enhance their thinking process. Therefore, the use of mobile learning can transform pedagogical concepts to make the teaching and learning process more creative and interactive (Shaharim & Abdul Rahman, 2021). In addition, according to Crompton (2013), the evolution of mobile learning and the potential of m-learning is to create a learner-centred educational experience. Therefore, m-learning is very necessary nowadays to create a better educational experience following the times.

Multimedia Elements in Learning

Multimedia refers to communication using different forms of media (Hamzah, 2021). It is a technology that combines various media to deliver information. Learning that utilizes multimedia is a process to solve problems and ensure more effective information delivery. Integrating multimedia elements such as animation, video, audio, graphics, and text into one application can assist in the learning process for students with different reception levels, such as visual, auditory, and kinesthetic learners. According to Mayer (2020), Integrating multimedia elements such as animation, video, audio, graphics, and text into educational applications can significantly enhance the learning process for students with different learning styles, including visual, auditory, and kinesthetic learners.

This approach not only makes learning more engaging but also caters to individual preferences, thus improving educational outcomes.Text is a fundamental element in information delivery. Text can convey information concisely and systematically (Trinawindu, 2016). The use of audio as a teaching aid helps enhance the teaching quality of teachers (Mohd Nabil, 2018). Graphics, on the other hand, can illustrate information more realistically and make it easier to be mapped in students' memory (Sharul Azim & Mustaffa, 2020).

The incorporation of animation in learning can provide a better experience for students (Gellerstedt, Babaheidari & Svensson, 2018) and facilitate the presentation of content in a more accessible manner (Hayat, 2021). According to Johnson and Mayer (2023), Multimedia learning, which involves the integration of text, images, audio, and interactive elements, can significantly enhance educational outcomes by catering to diverse learning styles and improving engagement and retention.

Methodology

The development of the Android application on the topic of Light Properties for the fourth-grade Science subject is based on the ADDIE systematic design model introduced in 1987. The researcher chose this model because it is interactive, where each phase builds upon the findings from the previous phase. As a result, the data obtained becomes more accurate and reduces errors as it progresses to the next phase.
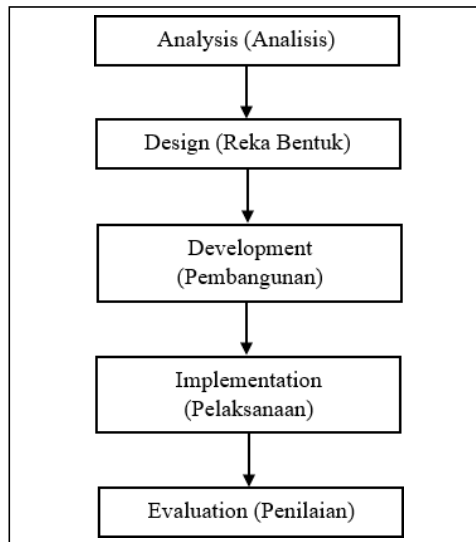
Figure 1. ADDIE (Rosset, 1987) Design Model

ADDIE design model was used in this application development process which involves five (5) phases, namely the analysis phase, design phase, development phase, implementation phase and evaluation phase as shown in Figure 1.

The researcher obtained information through information analysis methods by conducting interviews with selected school teachers who served as experts in this study. These interviews aimed to identify the challenges faced in delivering teaching on the topic of Light Properties. The findings from the interviews will assist in establishing the objectives, problem statement, and determining the research findings. Storyboarding is a series of sketches that provide an overview of the content on the multimedia screen to be created through three types of design: content design, interaction design, and interface design.

Adobe Animate was used to develop the overall application, along with the integration of other multimedia elements aided by software such as Adobe Photoshop, Adobe Illustrator, and Audacity. The result of the application will be converted into an APK format to be tested on Android smartphones. The application needs to be tested to obtain feedback on its functionality and to facilitate the evaluation process.

Three research experts were involved in the implementation and testing process. The application will be tested before the experts fill out an assessment form evaluating the functionality of the three design aspects in the Android learning application on the topic of Light Properties. Feedback will be collected using a survey instrument, and the researcher will analyze the findings from the survey instrument to improve the application according to the needs of the target users.

Data Analysis and Results

Figure 2 displays the homepage interface for the Android application on the topic of "Properties of Light," showing the application's title section to the users. This page has one button, namely the "Start" button, which will take the users to the menu page that consists of six (6) menu button options.

Figure 2. Homepage Interface

Figure 3 is the menu page that consists of six (6) menu options, namely 'Introduction,' 'Understanding the Properties of Light,' 'Simulation Videos,' 'Quiz,' and 'User Manual.' Users are free to choose any page they want from this menu page. Users can also exit the application and turn off the audio section located at the top left.

Figure 3. Main Menu

Figure 4, The note section is a part of the page that contains explanatory notes for each subtopic within the "Properties of Light" topic. The note section begins with the display of learning objectives that users will achieve after using this application. The notes consist of multiple pages, organized into 4 subtopics. Users are free to explore the note section using buttons to navigate forward and backward through the note pages.

Figure 4. 'Understanding the Properties of Light' Menu

Figure 5 depicts the "Simulation Videos" menu with four (4) subtopic options. The animated video page allows users to play and pause the videos at their own pace. The simulation videos clearly demonstrate what will be learned and allow users to exit the menu page at any time.
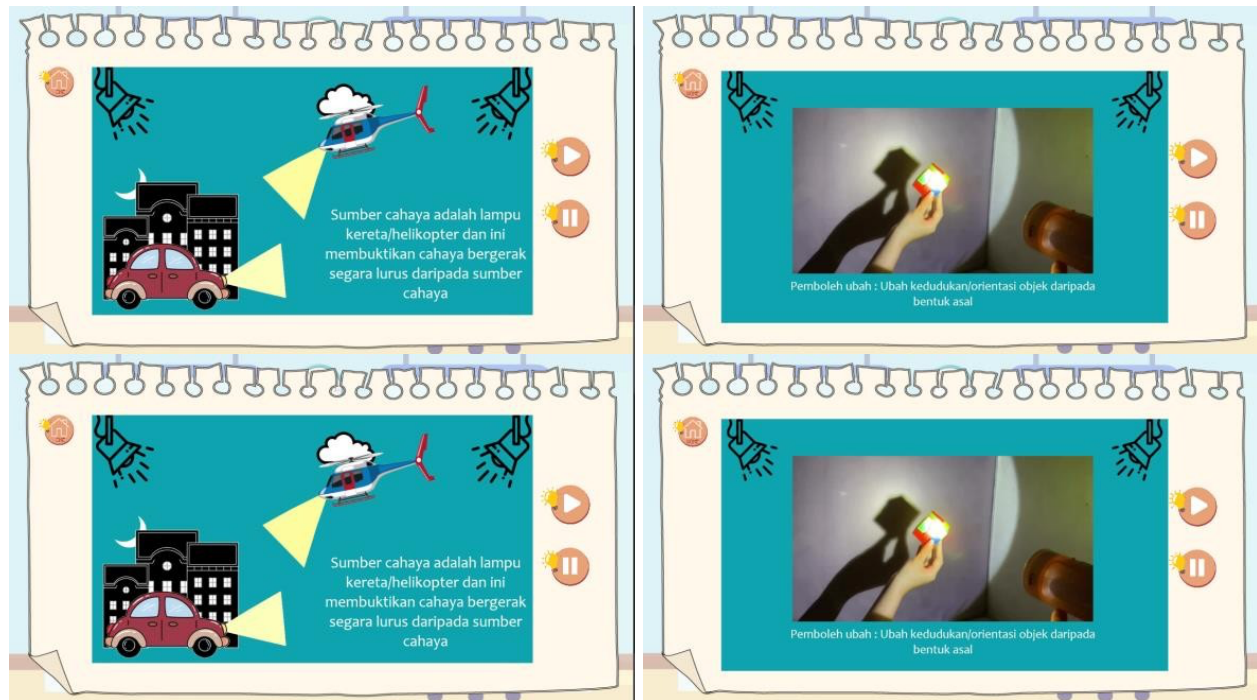

Figure 5. Design Model 'Simulation Videos' Menu

Figure 6 represents the quiz page for this application. After users have gone through the note and simulation video pages to understand the topic of "Properties of Light", the developer provides a quiz section to test their comprehension. The quiz consists of two (2) difficulty levels: Easy and Difficult. Each level has ten (10) multiple-choice questions. If a user answers a question incorrectly, immediate feedback will be provided, and a step-by-step animation will be displayed on the scoreboard. If a user answers correctly, a star will be displayed.

Figure 6. 'Quiz' Menu

Figure 7 depicts the prompt that appears when the user presses the exit button on the menu page. This prompt seeks confirmation from the user whether they want to exit the application or not. If the user presses the 'Yes' button, they will exit the application immediately. If they press 'No', they will return to the menu page.

Figure 7. 'Exit' screen

Discussions

This Android application on the topic of "Properties of Light" has been successfully developed by incorporating multimedia elements that align with the objectives and preferences of the users. After the development phase, the researcher needs to test and evaluate the functionality of the application before it can be used by the target users. Testing and evaluation are obtained from three (3) expert assessors, and subsequent improvement actions are required. Table 1 presents an analysis of the evaluation findings from the experts, listed in tabular form.

Table 1. Experts' views and comments on the development

Expert	Expert Position	Reviews and Comments
Expert 1	Primary school science teachers 20 years experienced in teaching science subject	Add and improve notes for the topic of shadows. Create questions using simpler words. Replace some scientific terms with easier ones.

		Modify the application title to be more specific.
Expert 2	Lecturer in Information Technology (Networking) field from UTHM	Change the objectives.
		The font size is somewhat small.
	16 years of experienced in teaching	Exit to the home page after pressing the exit button.
Expert 3	Lecturer in Information Technology and Multimedia field from UTHM	The use of text types needs to be consistent.
		Include an exit button throughout the screen.
	20 years of experienced in teaching	Add a home button on the quiz question screen.

Table 1, show the feedback received from three (3) experts involved in the evaluation process of the developed application's functionality. The evaluator has listed several comments and suggestions provided by all the experts. The first expert, an experienced primary school teacher with 16 years of experience in the field of science, provided comments and suggestions to add and improve the notes section on the topic of shadows. The use of animated images in the shadow clarity notes section is somewhat unclear and may cause misunderstandings for students using the application.

According to Gellerstedt, Babaheidari & Svensson (2018), animated media can be another alternative for student learning as it provides students with experiences, especially through the integration of multimedia elements in Android applications that have been developed. The expert also suggested creating quiz questions using words that are easier to understand since the target users of this application are fourth- grade students in primary school. Furthermore, the expert commented on changing some scientific terms used to more appropriate and suitable terms for the target users. The first expert provided positive feedback for all three design aspects involved in the development of this application.

The second expert, a lecturer specializing in information technology (networking), provided positive feedback on the design of the content and suggested making the application title more specific to the target users of the developed application. Additionally, the expert provided suggestions to rephrase the objectives in the application to ensure that the stated objectives are achievable by users when using the application. The font selection on the quiz page is smaller and makes it difficult for users to read, and the expert suggested increasing the font size and adding a prompt to ask users if they want to exit the application as evidence that allows users to freely explore the application.

The third expert is also a lecturer specializing in information technology and multimedia and provided positive feedback on all three designs developed in the application. The expert commented on the need for consistent use of text types because a good interface incorporates consistency, especially in terms of text type, text size, and color. Choosing appropriate texts can convey information systematically and effectively (Trinawindu, 2016). Additionally, the expert suggested including an exit button on all pages of the application to allow users to exit the application at any time, as well as adding a home button to the quiz display.

Based on the findings of the study on the development of this Android application, the functionality of this 2D application works well and smoothly, aligning with its objectives and addressing the stated issues. This statement is supported by the integration of multimedia elements during the development of the Android application. Text elements are used to convey content and provide guidance to users on using buttons to navigate through the application's pages. Other multimedia elements help enhance motivation and enthusiasm among students while using this Android application. This statement is also supported by Wahyugi & Fatmariza (2021), who stated that the development of multimedia in learning media can enhance students' learning motivation.

Each design, including content design, interaction design, and interface design, is created by integrating multimedia elements such as text, graphics, audio, video, and animation. Learning will take place through the implementation of these multimedia elements in the developed application. According to Marjuni & Hamzah Harun (2019), problem-solving is essential to ensure that students can analyze, find solutions, and even attempt to solve the problems. Designs that incorporate multimedia can facilitate learning anywhere, whether in classrooms, laboratories, or at home, to encourage self-directed learning.

This study was able to implement a learning strategy that involves two-way interaction between students and teachers, where the application incorporates guidance and simulations involving the use of video elements. This is because one effective learning method is simulation, where students learn through virtual representations displayed on mobile device screens as accurately and realistically as in the real world (Majorsy & Juniati, 2015). Therefore, this Android application is expected to become a new alternative for students to learn about the topic of "Properties of Light" using a more engaging method. This learning approach is often employed by many institutions to capture students' attention and enhance motivation.

The suggestions and improvements for this developed application so that it is more meaningful that is able to integrate interactive elements such as quizzes, puzzles and mini games that reinforce the concept of the nature of light. Incorporate gamification elements such as badges, points and leaderboards to motivate students. In addition, suggestions for improvement such as implementing AR features to allow students to visualize light phenomena such as reflection, refraction and scattering in a more immersive way. the next improvement suggestion is to make sure the app is intuitive and easy to navigate for young students. Use clear instructions, age-appropriate language and attractive visuals.

Conclusion

Overall, the Android application on the topic of "Properties of Light" for the Science subject in Year 4 has been successfully developed using Adobe Animate software based on the defined objectives, research questions, and study scope during the analysis and development phase. The application was further evaluated by experts during the assessment phase. The development of the application began with the creation of a storyboard, which served as the initial draft for the application to be developed. Subsequently, the ADDIE instructional design model was selected as a guiding framework for the implementation of the application, starting from the initial stages until the completion of a functional application that needs to be tested for its usability. The ADDIE model encompasses five phases: Analysis, Design, Development, Implementation, and Evaluation, ensuring a systematic approach to the application development process. The assessment feedback obtained from the experts has been utilized to enhance the quality of the application and provide a positive impact on its intended users, which are the fourth-grade students. The suggestion for further study is encouraged to enhance the interactive level of this developed application. The researcher recommends adding brief simulations and making the application bilingual, allowing users to freely choose their desired language.

Acknowledgment

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