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DESIGN AND DEVELOPMENT OF A MOBILE GAME-BASED APPLICATION FOR BINARY NUMBER CONVERSION

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Abstract

The topic of binary numbers often poses challenges for students in understanding fundamental concepts of computer science and mathematics. To address this difficulty, this research designs and implements an educational game application based on mobile platforms aimed at facilitating the learning process of binary numbers. The application is developed using Flutter, an open-source framework that enables efficient cross-platform mobile application development. Key features of this application include interactive tutorial modules, exercises for converting binary numbers to decimal and vice versa, and educational games designed to reinforce concept understanding through gamification methods. Additionally, the game features can be shared via email, allowing for enhanced collaboration and feedback among users. Testing results indicate that users experience a significant improvement in their understanding and skills in binary number conversion. Specifically, 87% of users agreed that this application can be effectively used as a practice medium for converting binary, octal, decimal, and hexadecimal number systems. With an intuitive interface and an enjoyable learning approach, this application is expected to become an effective learning aid for students in mastering binary numbers..

Keywords: Binary Number, Educational Game, Mobile Application, Flutter

INTRODUCTION

The mastery of converting binary numbers into other number systems like octal (base 8) and hexadecimal (base 16) holds paramount importance in the field of information technology. Understanding these conversions facilitates various aspects of digital computing, including memory management, data representation, and network communication protocols. Although the binary number system existed long ago, it has become even more relevant in modern times due to the widespread development of information technology. They are widely used in information technology and computer technology (Shamilov et al. 2021). The learning system for this topic is currently undergoing a shift from conventional models to learning models that utilize technological advancements. Learning media continue to evolve along with the development of technology and the educational world. Technology and education have become two inseparable entities (Yulianti 2021). Technology can also influence how you think, learn, and interact (Dakhi et al., 2020). Consequently, the conventional learning system, which is less effective in providing user experience for learners, continues to seek better patterns or approaches.

Learning through video and animation media is one of the digital learning methods frequently utilized in leveraging the continuously growing technological advancements. Video-Based Learning (VBL) means that new knowledge and skills will be acquired through audiovisual content (Galatsopoulou et al. 2022). Learning with video media tends

to be more passive and less encouraging of active participation. Additionally, video-based learning generally has limitations in terms of interaction between users and the learning content. One solution to address this issue is a learning model packaged in the form of educational games. The use of educational games as a learning medium makes the learning activities less monotonous and can prevent students from feeling bored by involving them more in the learning activities, thus making them more active (Damarjati, Miatun.2021). The educational game learning model is often presented in the form of animations run on computers. Animated educational games run on computers might only be accessible on certain computers with limited mobility. Meanwhile, mobile-based educational games can be accessed on various devices, such as smartphones and tablets, allowing for more flexible and portable access.

Along with the widespread growth of mobile devices and the continuously evolving mobile platform environment, which presents a more engaging development environment, learning systems using technology have also experienced a shift. Flutter is one of the mobile application development platforms that can run on various platforms, including iOS and Android, using the same source code. Additionally, an interesting aspect of this framework is that all the code is compiled into native code (Android NDK, LLVM, AOT-compiled) without any interpreter in the process, making the compilation process faster (Sudrajat 2021).

Based on the background mentioned above, an educational game application for learning binary number conversion was designed to create a fun and interactive learning experience. The binary conversion learning system using the Flutter framework is offered as a solution to enhance understanding of the subject matter. The presence of this educational game learning is expected to provide a higher level of participation and interest in the learning process. Learners can identify the difficulty level they face, and the scores from the educational game can be shared via email.

METHOD

In designing a mobile-based binary number conversion application system within the Android environment, it involves the workflow of application development and the workflow of the application itself. This system design is a stage that details the overall picture of an application or system.

A. Application Development Workflow

The design of the application development workflow is the process of planning the sequence of steps that must be taken in creating an application, from conceptualization to development and implementation.

The goal of designing the application development workflow is to ensure that the application development is carried out efficiently and in a structured manner, resulting in a high-quality application that meets user needs. In designing the system, the following steps are involved :

- Literature Study

- Creation of Graphic Elements with Adobe Illustrator
- Creation of Music and Sound Effects with FL Studio
- Integration of Graphic Elements and Sound Effects into Flutter using VS Code
- Application Testing
- Compilation into APK

Here is the workflow for creating the Binary Application if we depict in flowchart

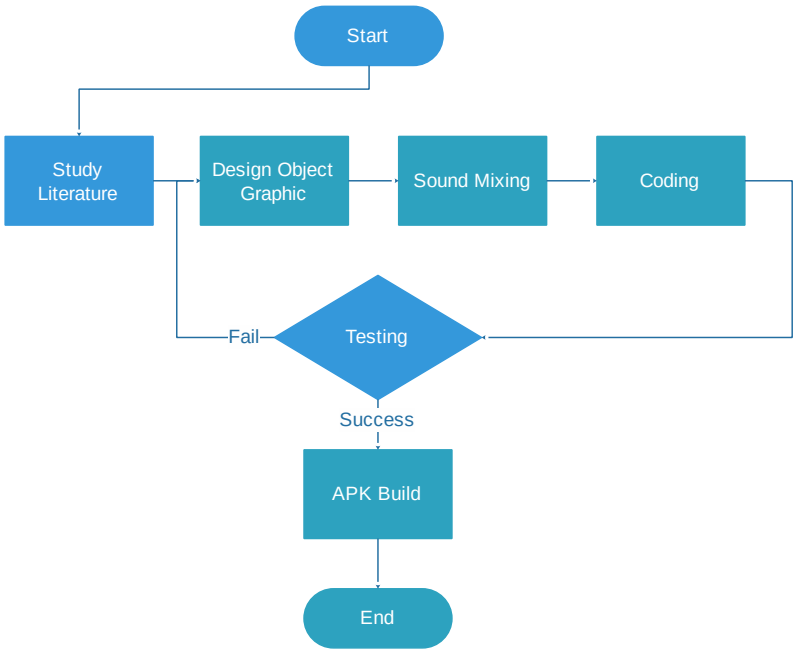

Fig.1 Flowchart of System Development

Description :

1. Literature study is conducted to learn, analyze, and understand the relevant materials for creating this application.
2. Adobe Illustrator is used to create various graphic elements needed in the application, such as logos, graphic objects, backgrounds, icons, and UI.
3. FL Studio is used to create music and sound effects for the game, enriching the gaming experience and enhancing the quality of sound and music provided in the game.
4. Integrating the graphic elements and sound effects created in steps 1 and 2 into the application design (Flutter) using the VS Code editor.
5. The testing stage involves a series of tests and evaluations of the created application to ensure it functions well and meets the desired requirements.
6. The process of compiling the application into an APK (Android Package) file.

B. Application Workflow

We need to gather user requirements during the analysis stage, as the analysis stage was the basis of the system design [Muhamad et al. 2019]. It is essential to obtain accurate user requirements and analyze the demands during this phase to determine system needs. We then proceed with designing the application development workflow, which involves planning the sequence of steps to be taken in creating an application, from conceptualization to development and implementation. The purpose of designing the application development workflow is to ensure that the application development is carried out efficiently, in a structured manner, and meets user needs

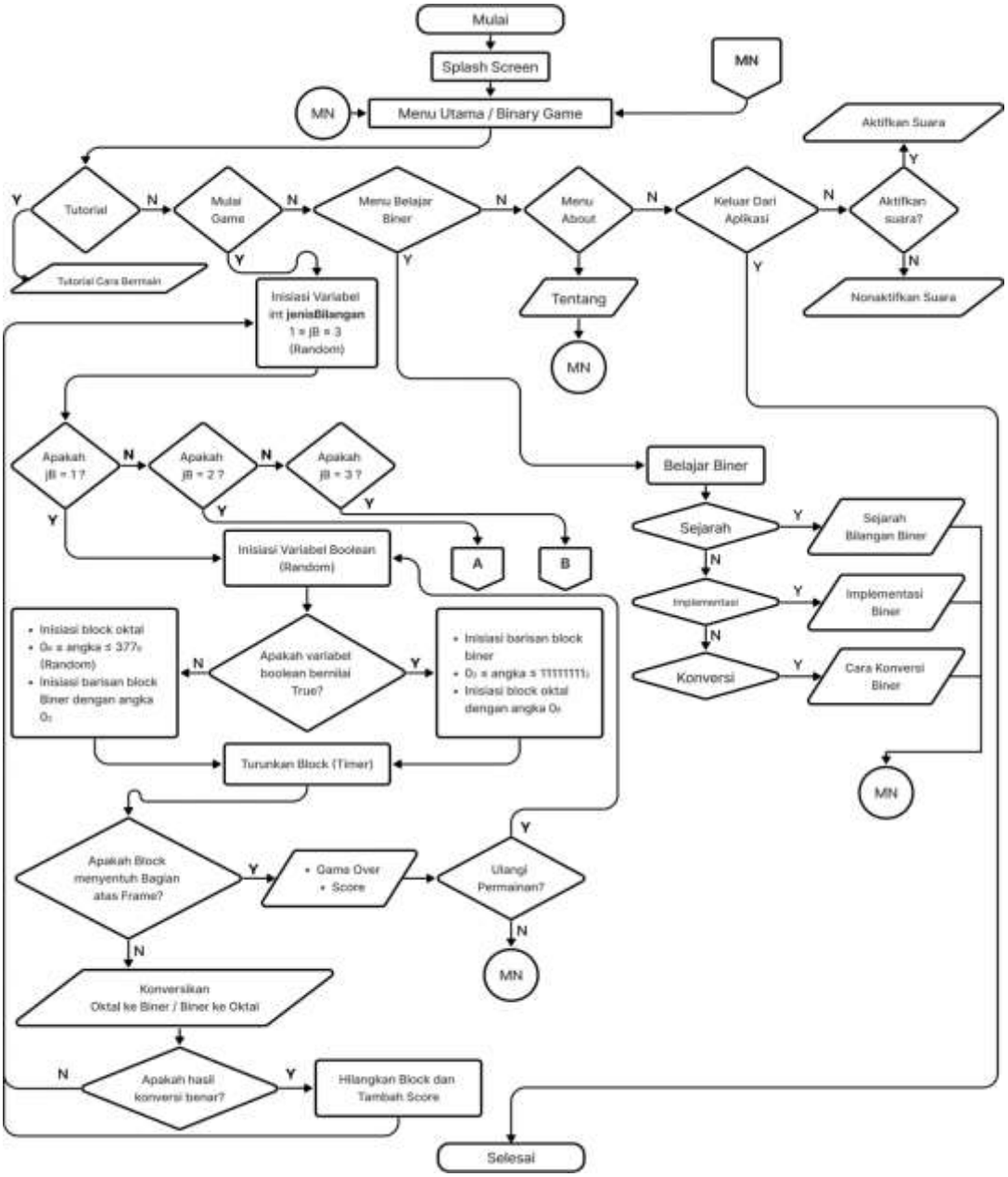

Fig.2 Flowchart of Application Workflow

Description:

1. When the application starts, a Splash Screen will appear, displaying the Application Logo and an indication of the loading process.
2. After the loading process is complete, the application will enter the Binary Game menu, which by default also serves as the Main Menu. Here, several options are displayed, such as "Tutorial," "Start Game," a sound on/off button, and several other sub-menus, including the Learn Binary Menu and the About Menu.
3. The Binary Game Menu contains a block puzzle game that requires players to convert binary numbers into octal, decimal, or hexadecimal numbers, and vice versa. These puzzles are presented in 8 binary blocks representing 8 bits, with one additional block randomly representing an octal, decimal, or hexadecimal number.
4. The Tutorial Menu provides brief instructions on how to play the game, while the Start Game Menu begins the game.
5. The game starts with a series of binary number blocks (8 squares containing 0 or 1) and a number block with a different numbering system (octal, decimal, or hexadecimal).
6. The values on these blocks are randomized.
7. The series of blocks will move down the screen or up other rows of blocks. The appearance and descent of these blocks depend on a predetermined timer.
8. The series of blocks will continue to appear and move down the screen (stacking) regardless of whether the player successfully converts the numbers correctly or not.
9. If a binary block is randomized (initialized with a value), it means the player is expected to convert the binary number into octal, decimal, or hexadecimal and input the result into the decimal block.
10. If an octal, decimal, or hexadecimal block is randomized (initialized with a value), it means the player is expected to convert the octal, decimal, or hexadecimal number into binary by inputting it into the respective binary blocks.
11. If the conversion is correct, the series of blocks will disappear, and the score will be added to the scoreboard. If incorrect, the block will remain on the screen until the player inputs the correct conversion or until "game over."
12. The Learn Binary Menu contains educational material on binary, divided into 3 topics: History of the Binary Number System, Binary Implementation in the Digital World, and Binary Conversion.
13. The About Menu contains a brief description of the application, developer bio, and application version.
14. Users have the option to enable or disable sound in this application. This option is available in the Binary Game Menu, presented as a button in the top right corner of the menu screen."

RESULTS AND DISCUSSION

Since this system is intended for mobile users and the Android environment, the framework involved in the application development is Flutter. In development time, flutter apps take less time as in flutter everything is a widget that takes less time to create a navigation drawer, app bar, and bottom navigation [Hussain et al.2021]. The result of the system divided into Application Impelementation and Aplication Test Result.

A. Application Implementation

Once the user requirements for the binary conversion application are clearly defined and the design process is completed, the next step is implementation. Using Flutter facilitates building mobile applications with the presence of widgets for constructing the interface. A widget is a way to declare and build the user interface to help build that look-alike native platform for Android and iOS, and all that Flutter requires of the platform is a canvas on which to render the widgets so they can appear on the device screen, and access to events and services(Ameen, Y. Mohammed. 2022).

1) Main Menu and Binary Learning Page

The figures below show the main menu page and the binary learning page. The main menu provides initial information about the various features available in the application, while the binary learning page offers information about binary numbers and how to convert them into other number systems.

Fig.3 Main Menu Page and Binary Learning Page

On the main menu page, there are three sub-menus that the user can choose from: Learn Binary Menu, Binary Game, and Settings/About. The Main Menu page also serves as the Binary Game page, providing users with three options: 'Tutorial,' 'Start Game,' and a

button to enable or disable sound (represented by a speaker icon) located at the top right corner.

On the binary learning page, there is introductory educational material about the binary number system for users. The material includes the history of binary numbers, their implementation in everyday life, and the steps for converting binary numbers to other number systems and vice versa.

2) Tutorial Page Display

The following figures is a tutorial page that contains a guide for users in playing games from the binary conversion application.

Fig.4 Tutorial Page

The tutorial page in the game is designed to assist players in learning and understanding the game mechanics and rules. Tutorials help players to grasp the game quickly and avoid confusion while playing. Therefore, it is highly recommended to use the tutorial menu in this game before starting to play

3) Game Page Display

If the user already understands the game rules of the application, by clicking the "start game" button, the user will be taken to a display like the figure below.

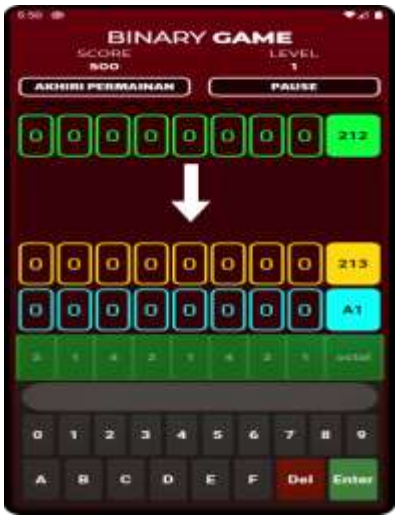

Fig.5 Game Page Display

The working system of this game is that binary puzzles appear from the top of the screen and continue to move towards the bottom of the screen. Players are expected to convert from binary numbers to octal, decimal or hexadecimal and vice versa by touching each binary bit to form a sequence of binary numbers with the same value as the given octal, decimal or hexadecimal number. These puzzles will continue to appear at certain predetermined time intervals and may fill the game screen to the top of the screen. If that happens then the game ends, which means the player fails to complete the puzzles until they pile up on the screen.

4) Score Page Display

The following figure shows the score page which can be slided left or right which contains information about the level of success in playing the binary conversion application.

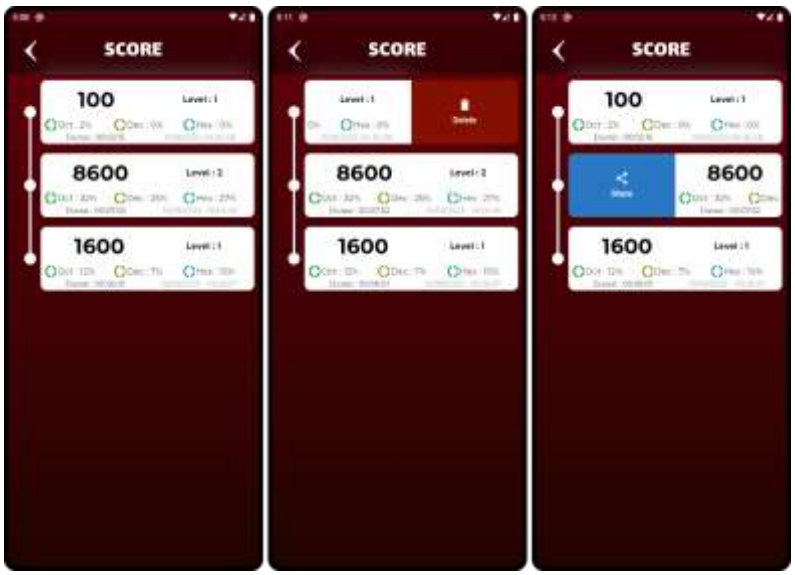

Fig.6 Slideable Score Tile

There are five detailed information on the score tile which contains user score information, namely : mark, level, percentage of completion of each number system, duration and also the date the game session was played.

This application also allows users to share their achievements in playing this game by clicking the "Share" icon. The sharing process is carried out by sending via email. The application will provide notification whether the sending process via email was sent successfully or failed.

B. Aplication test result

The application testing is conducted to ensure that the application meets expectations in terms of both logic and functionality. Additionally, this testing aims to determine on which smartphone specifications the application can run optimally. Therefore, the application will be tested on three smartphones with different specifications.

The following table is an information that shows the application test results on three different devices.

Tabel.1 Delay test result

No	Device	Chipset	CPU	RAM	OS	Delay
1	Samsung Galaxy A50	Exynos 9610 (10nm)	Octa-core 2.3GHz	4 GB	Android 11	1,93 second
2	Redmi Note 11	Snapdragon 680 4G (6nm)	Octa-core 2.4GHz	4GB	Android 13	0,33 second
3	OPPO A12	Mediatek MT6785 Helio G90T	Octa-core 2.05 GHz	4GB	Android 10	0,77 secaond

Based on test results on three different devices, it was concluded that RAM capacity, CPU and Android version greatly influence the speed of delay in this binary conversion application.

CLOSING

Conclusion

After carrying out the application creation process starting from the design stage to testing, the following conclusions can be drawn:

1) This application can be a medium for practicing the ability to convert binary, octal decimal and hexadecimal numbers.
2) The puzzle game feature provides an interactive and interesting learning experience, which can increase student motivation in learning binary to octal, decimal and hexadecimal conversions
3) This application can only be run on Android devices with a minimum version of 10

REFERENCES

Shamilov, Aladdin, Natiq Quliyev, and Zafar Shamilov. "On the Application of the Binary Number System in Creating Questions Strategy." InterConf, 2021, pp. 320-328. DOI: 10.51582/interconf.7-8.05.2021.034.

Yulianti, Ary, and Ekohariadi Ekohariadi. 2021. "Pemanfaatan Media Pembelajaran Berbasis Game Edukasi Menggunakan Aplikasi Construct 2 Pada Mata Pelajaran Komputer Dan Jaringan Dasar". IT-Edu : Jurnal Information Technology and Education 5 (01), 527-33. https://ejournal.unesa.ac.id/index.php/it-edu/article/view/38272.

Dakhi, Oskah, Jalius Jama, Dedy Irfan, Ambiyar, and Ishak. "Blended Learning: A 21st Century Learning Model at College." International Journal Of Multi Science.

Galatsopoulou, Fani, Clio Kenterelidou, Rigas Kotsakis, and Maria Matsiola. 2022. "Examining Students' Perceptions towards Video-Based and Video-Assisted Active Learning Scenarios in Journalism and Communication Courses" Education Sciences 12, no. 2: 74. https://doi.org/10.3390/educsci12020074

Damarjati, Syamsi, and Asih Miatun. "Pengembangan Game Edukasi Berbasis Android Sebagai Media Pembelajaran Berorientasi Pada Kemampuan Berpikir Kritis." ANARGYA: Jurnal Ilmiah Pendidikan Matematika, October 2021. https://jurnal.umk.ac.id/index.php/anargya/article/view/6442/2975.

Sudradjat, Budi."Penggunaan Teknologi Flutter Dalam Aplikasi Mobile Untuk Pengembangan Kedai Kopi."REMIK: Riset dan E-Jurnal Manajemen Informatika Komputer, October 2021. https://jurnal.polgan.ac.id/index.php/remik/article/view/11123

Muhamad, Zainab Hassan, Dhafer AbdulAmeer Abdulmonim, and Bashar Alathari. "An Integration of UML Use Case Diagram and Activity Diagram with Z Language for Formalization of Library Management System." International Journal of Electrical and Computer Engineering (IJECE), August 4, 2019. https://ijece.iaescore.com/index.php/IJECE/article/view/14044/12892.

Hussain, Hina, Kamran Khan, Faiza Farooqui, Qasim Ali Arain, and Isma Farah Siddiqui. "Comparative Study of Android Native and Flutter App Development." Memory 47 (2021): 36-37.

Ameen, Siddeeq Y., and Dilkhaz Y. Mohammed. 2022. "Developing Cross-Platform Library Using Flutter". European Journal of Engineering and Technology Research 7 (2):18-21. https://doi.org/10.24018/ejeng.2022.7.2.2740