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Game Design for Mobile App-Based IoT Introduction Education in STEM Learning

Indra Puja Laksana[1], Evi Dwi Wahyuni[2], Christian Sri Kusuma Aditya[3]
[1,2,3]Department of Informatics, Universitas Muhammadiyah Malang
[1]indrapuja25@gmail.com, [2]evidwi@umm.ac.id, [3]christianskaditya@umm.ac.id

Abstract

STEM education has received considerable attention in recent years. However, developing valid and reliable assessments in interdisciplinary learning in STEM has been a challenge. Therefore, many students ranging from junior high school to university students are only familiar with the Internet of Things (IoT) from social media but do not know its concept and function in STEM learning. This is also supported by the absence of educational applications about IoT. This research aims to introduce IoT by using mobile applications. This research refers to the multimedia development method according. The data collection method in this study was carried out by means of observation and interviews randomly to high school students to university students. This data collection was carried out using the experimental method of application testing to analyze user needs from several aspects such as features, images, and fonts. This research is also supported by the existence of literature studies derived from several journals. The results show that the functions in the application can operate as expected. Based on the survey results of the application, 75.37% of respondents rated this application in the very good category and gave positive responses so that this application could be well received by users

Keywords: game education; IoT; STEM; game-based learning; aplikasi mobile

1. Introduction

STEM education (Science, Technology, Engineering, and Mathematics), which refers to education in the fields of science, technology, engineering, and math [1]. STEM education aims to prepare students with the skills and knowledge needed to understand and how to solve problems, and to compete in an increasingly competitive labor market [2]. STEM education also focuses on improving students' skills in critical thinking, collaboration, and problem solving, using an approach based on projects, experiments, and innovation [3].

In addition, IoT or Internet of Things is a concept that refers to the connection and interaction between electronic devices connected to the internet [4]. IoT allows these devices to communicate and share data automatically, without involving human interaction [5]. In the Design of Mobile-Based IoT Introduction Education Game in STEM Learning, IoT is used to provide an interactive and interesting learning experience for students in STEM (Science, Technology, Engineering, and Mathematics) learning. In the game, IoT can be used to enable students to understand how devices connected to the internet can work together in a system [6].

In this game, students will learn how to design and connect IoT devices in an integrated system, as well as understand the basic concepts of how IoT devices work and interact with the internet, so as to increase their interest and ability in STEM fields, thus increasing efficiency and productivity in various fields, such as industry, agriculture, education and health [7].

In education, IoT can be used to improve the interaction between students and their learning environment, as well as to improve learning effectiveness [8]. For example, by using IoT sensors, students can monitor the temperature, humidity, and light levels within their science labs, so that they can understand how these factors affect the results of experiments. In addition, IoT can also be used in programming and robotics learning, where students can program IoT devices to perform specific tasks [9]. With interactive and fun learning experiences, it is expected that students will be more interested and motivated to learn STEM concepts, which are crucial in facing future challenges [10].

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Based on the Indonesian digital literacy index released by the Ministry of Communication and Information Technology (Kemkominfo) and Katadata Insight Center (KIC) in 2021, Indonesia's digital literacy index stands at 3.49. The index measures the level of digital literacy of Indonesian society in four dimensions, namely information literacy, media literacy, technology literacy, and data literacy. This digital literacy index continues to be improved by the Indonesian government through programs in the field of communication and information. The figure puts Indonesia in the medium category, with an index score of 0 to 5 [11].

Based on this, the existence of this IoT educational game application can foster knowledge related to IoT digitalization and can further increase motivation and interest in learning the subject matter, so that students can later be more [12]. Therefore, a learning media application program based on IoT educational games in STEM learning that supports government programs was developed. As for some of the material contained therein, namely in the form of theories and types related to the Internet of Things, as well as an explanation of the usefulness of each existing sensor. It is hoped that with this, students and the general public can be interested in studying information and communication technology networks [13].
With this application, research was conducted in an effort to make it easier for teachers and students to be more effective and easy to understand in learning. Research in the form of making IoT educational game applications using the MDLC (Multidisciplinary Design and Learning Cycle) method [14], from this method researchers can find out the level of comfort and effectiveness of the interface display of a design and later determine the user as a consideration of system design. This method ensures that the software has a level of user usability according to Lucher-Sutopo. This application is expected to provide opportunities for students to learn more about IoT.

2. Research Methods

2.1. Luther-Sutopo MDLC (Multidisciplinary Design and Learning Cycle)

This research uses the MDLC (Multidisciplinary Design and Learning Cycle) method in user experience design which can help designers to produce better designs that meet user needs. Meanwhile, the choice of the multimedia development method is in line with the application to be built.

MDLC is a way of approaching design to users that involves collaboration between various disciplines to produce effective and efficient designs [15]. MDLC includes six stages, namely planning, needs analysis, conceptual design, detailed design, implementation, and evaluation [16]. In MDLC, the designers will focus on the performance of the system and ensure that the design meets the business needs [17].

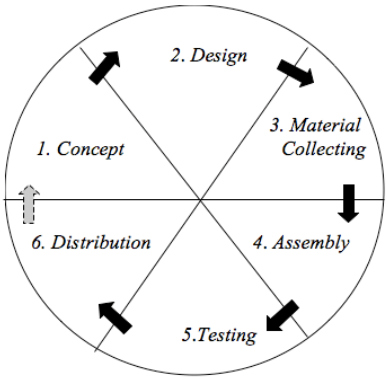

Figure 1. Luther-Sutopo MDLC

Conception is the initial planning stage for making mobile-based IoT educational games. At this stage, an analysis of the educational needs to be delivered through the game and identification of target users is carried out. Then, the game concept will be designed based on the results of the analysis and the learning objectives to be achieved. This game concept includes various aspects such as genre, visual style, and type of interaction that will be used in the game. The results of the Concept stage will be the initial guide for the next stages of game development, such as Content Design and Development. This stage is the initial stage in the MDLC and is an important basis for the entire process of creating a mobile-based IoT educational game.

The Design stage is the stage of designing the visual design and interaction of mobile-based IoT educational games. At this stage, the game concept that has been designed in the previous stage will be converted into a more concrete and clear visual design. This visual design includes various aspects such as the appearance of the user interface, characters, objects, and the game environment. In addition, this stage also designs the interaction between the user and the game, such as control mechanisms, information displays, and game responses to user actions. The results of the Design stage will serve as a reference for the Content Development stage, where the visual elements and game interactions will be implemented into the game application in more detail. This stage of Design is important to ensure that the game is in accordance with the concept and learning objectives that have been set, and can provide a fun and effective gaming experience for its users.

The stage of collecting materials that will be used to make mobile-based IoT educational games. At this stage, researchers will search for and collect various types of materials, such as text, images, audio, and video that are relevant to the educational content to be conveyed through the game. These materials will then be processed and adjusted to a format that suits the

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needs of making games, such as image or audio formats that can be integrated with game applications. The results of the Material Collecting stage will be the raw material for the next stages of game creation, such as Content Design and Development.

The Assembly stage in the MDLC is the stage where the game elements are assembled together to form a complete game. At this stage, aspects such as graphics, audio, animation, and interface interactions are combined with educational materials that match the game's objectives. The end result of the Assembly stage is a complete educational game that is ready to be tested. This stage is carried out after the previous stages such as Analysis, Design, and Content Development are carried out.

The Testing stage in MDLC (Mobile Device Learning Content) is the stage of testing and evaluating educational games that have been made. At this stage, the game will be tested by identifying technical problems, design errors, or errors in educational content. Tests are conducted on various mobile devices and by using various types of operating systems to ensure the game runs well and does not experience compatibility problems. In addition, the use of educational games in a learning context is also evaluated to ensure educational objectives are achieved and the user experience is good. The results of the Testing stage will be a reference for making improvements and improvements to the educational games made.

The last step is the Distribution Stage, the stage where the educational game that has been completed will be distributed to users or target audiences. Before the game is distributed, it is necessary to conduct trials and evaluations to ensure that the game runs well and in accordance with its educational objectives. In addition, it is also necessary to pay attention to the policies and requirements of the distribution platform used. After the educational game is successfully distributed, users can download and play it on their mobile devices according to their needs and desired learning objectives. The Distribution stage is usually done after the Testing and Update stages have been carried out to ensure good game quality and user experience.

Once the initial to final steps have been completed, the development team can then start the next spiral cycle to develop more complex and complete multimedia features and functionality. The spiral model allows the development team to develop multimedia iteratively and accommodate changes that occur during development.

2.2. Data Collection Methods

The following are the data collection methods used in this study:

Literature Study, this method is done by searching for references related to STEM learning to identify problems online and current news articles that have something to do with the problem at hand. Conversely, this research is conducted by searching for journals or supporting data regarding IoT games.

At the stage of data collection in this study was carried out by means of observation and interviews. This stage is carried out to users in order to find out what needs and features will need to be included in the IoT game application and to find out the extent to which users know about IoT.

The questionnaire conducted in this study contains several questions that must be answered by respondents from junior high school students to university students [18]. This questionnaire is a source of data used to determine the importance of designing IoT education games and introducing them to the public, especially students [19].

3. Results And Discussions

3.1. Application Concept Details

The IoT game application has 4 multimedia elements, each of which has interaction with the user. This application also has an advantage in its use, which can be used offline and online. At this stage the IoT education game application has several predetermined features such as game features, materials, quizzes, and learning videos [20]. The purpose of this application includes introducing the application, educating IoT tools, how IoT works, how to assemble the tool until it becomes a sensor, and there are quizzes that can be used for learning in groups that have a point system that can be achieved by users. Where in the point system can be ranked from the highest to the lowest point acquisition, with the aim that users are encouraged to always want to learn about IoT [21].

3.2. Application Design

The application design is built with a multimedia-based design, using a storyboard device that is useful as linear multimedia. According to Luther-Sutopo [20], Storyboard is an explanation of each scene that combines images and words that explain the flow of the application [22]. The following is part of the overall storyboard display, there are 4 menus displayed, namely storyboard 3, storyboard 12, storyboard 17 and storyboard 20. In storyboard 3 displays the login menu, shown in table 1.

3.3. App Creation

The assembly stage is done when all the objects or materials used in making the application are based on the time of the design stage. The following are the stages of object building

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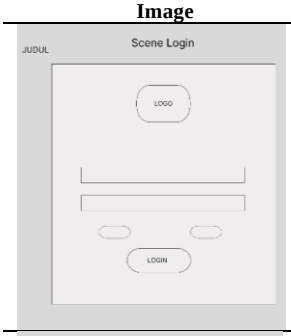
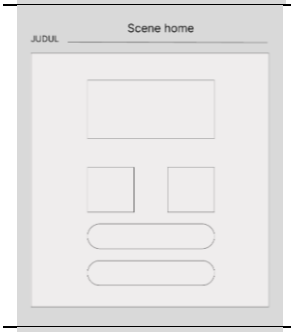
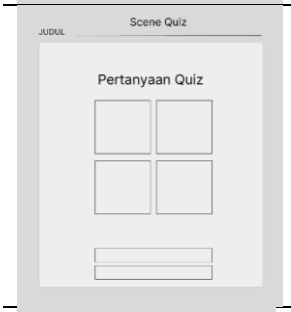
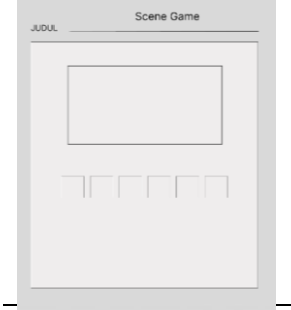
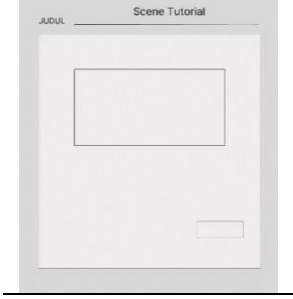
Table 1. Storyboard

Image	Description
	This login scene users before entering the application will register and then login to enter the application.
	This home scene has a menu choice between game and quiz.
	This quiz scene has many questions that can be made learning for students to add insight and can play with friends.
	This game scene allows users to assemble various devices into a sensor
	This tutorial scene allows users to see how the sensor is assembled.

The application creation process is supported by the use of Android Studio software and then exported into .apk format. The object creation model created consists of a login, home and in-game display. Below the process of making the login display application can be seen in Figure 2.

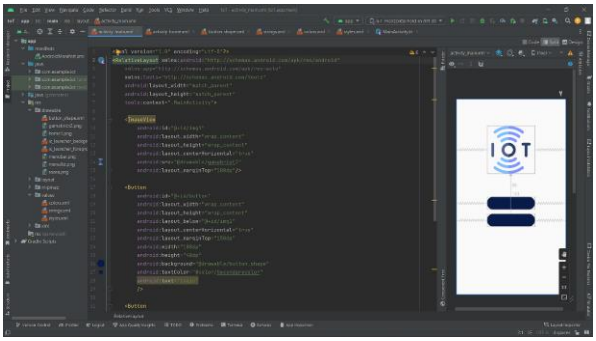


Figure 2: Login view creation process

Figure 3 is the process of making the home menu display application, where to make the home display use some animated images to make it look more attractive. In the home view there are several other menus such as game, quiz and material menus. Below the process of making a home display application can be seen in Figure 3.

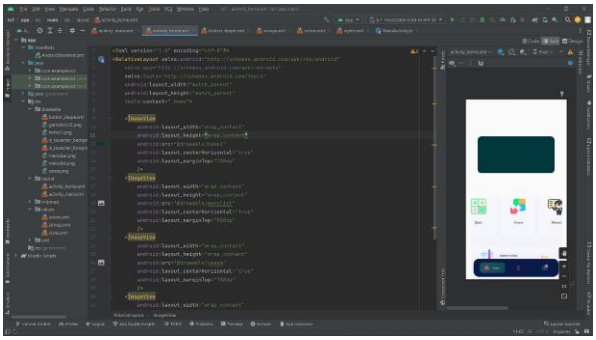


Figure 3: Home Display Creation Process

3.4. App Creation Result

The results of making the application will display a total of 5 of the whole [23]. Based on the making of the application that will be displayed, namely part of scene 3, scene 12, scene 17, scene 20 and scene 27. The following is a display of the results of making the application.

Figure 4. Scene 3 Login Menu

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Scene 3 - Application Login Menu. In this section is the main login display in the application. In this menu, users can login to the application in several ways including, login using a username and password, login using a facebook account or google account that can help users connect to the application. From making the login display, the results can be seen in Figure 4.

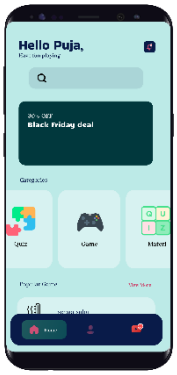

Figure 5. Scene 12 Main Menu

Scene 12 - App Main Menu. In scene 12 is the main menu section of the application that can display all the features in the application. The features displayed are games, materials or quizzes that can be accessed by users. In this main menu there are also notification, profile and tutorial menus. From the creation of the menu can be seen the results in Figure 5.

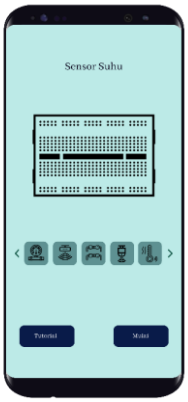

Figure 6. Scene 17 Game Menu Display

Scene 17 - Game Menu. In Scene 17, there is a game menu display in the application that shows various sensors that can be assembled into an IoT device. This menu provides different sensor options that can be selected by the user, such as temperature sensors, light sensors, motion sensors, and humidity sensors. Once the sensor is selected, the user can assemble the sensors into an IoT device that can function as needed. Through this feature, users can learn how to assemble and operate various sensors used in IoT technology, so that they can get a more interactive and practical learning experience. The game menu can be seen in Figure 6.

Scene 20 - Tutorial Menu. In Scene 20, there is a tutorial menu display that shows how to assemble sensors that can be accessed by users during play or before starting the game. This tutorial aims to help users understand how to assemble sensors more easily and practically. In this tutorial display, there are steps presented in detail and clearly, starting from the preparation of materials to the assembly stage. This tutorial is also equipped with images and animations that clarify the steps that must be followed by the user. With this tutorial, users can learn to assemble sensors independently and gain a more interactive and practical learning experience. From the making of the tutorial menu display can be seen in Figure 7.

Figure 7. Scene 20 Tutorial Menu Display

Scene 20 - Quiz Menu. In scene 27 is a display of the quiz menu in the application, which contains various questions related to IoT. When the user guesses one of the answers to the multiple choice questions, the answer will be matched with the correct answer. If the answer choice is correct, then the user gets points. The results of making the quiz menu can be seen in Figure 8.

Figure 8. Scene 27 Quiz Menu Display

3.5. Testing Phase

Before an app is deployed and used by users, a bugfixing process is performed on the app in case of errors so that it can function properly and with all its content and features functioning as intended by the users and the app designers. In addition, these

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precautions can reduce problems that can arise and contribute to a lack of user enthusiasm for the application. In the test, the application was run on the visualization.

Smartphone based on Android Nougat 7.1.1Operating System (OS); Laptop with intel® Core™ i5-1035G1 CPU @ 3.60GHz (2 CPUs), 3.60GHz processor and 12048MB RAM.

This application testing aims to ensure that this application can later be in line with the predetermined design and it is hoped that this application will have minimal deviations and will be ready for use.

Application Trial, application testing is one of the important aspects to be done by someone who is building or constructing an application before the application is submitted to the user. Testing is done using the Black Box method, the method is used to conduct audits related to the system to determine whether the software developed is as expected or not. The purpose of the Black Box experiment is to understand the inherent functionality of the program. With the Black Box methodology, the only thing that can be determined about the execution result is the input data and functional analysis of the software. Tests regarding the function of some of the buttons available on the application are also carried out during the Black Box testing process. In general, in the testing process, no errors were detected so that each button gets accurate output results. The tests in question are listed in Table 2 which will display only 9 of all the tests that have been carried out. Based on the tests that have been carried out, it can be concluded that the operationalization of this project is running according to the goal, which is universal success [24].

Table 2. Iot Game App Blackbox

Function	Desired Testing Results	Results of Application Testing	Description
Featuring app start screen	When the user opens the application will display a splash screen, then display the login menu	Splash screen runs and displays the login menu	Successful
Login page	User logs in by entering username and password, if correct leads to the main menu	Users can enter the main menu if login is successful	Successful
Main page appearance	Users can select the menu available on the main page.	User can go to the selected page	Successful
Game menu selection	When the menu display appears, there will be several games that can be played by users	The game menu will appear after the user selects the game type	Successful
Material menu display	When the menu display appears there will be material related to IoT	The material display appears after the user presses the material button	Successful
Quiz menu display	When the quiz menu display is related to games that can be played with friends	A quiz display appears and there is a point system earned by the user When the answer is correct	Successful
In-game display	When entering the game menu the user can play the game and can also see the tutorial when playing	Images can be drawn onto the breadboard	Successful
Tutorial menu display	When the user is about to play the game, the tutorial menu can be viewed at any time	The tutorial menu runs when the user is in the game	Successful
Notification menu display	If the user has not completed the game or quiz, there will be a notification that goes to the notification menu.	Notifications appear when a game or quiz has not been completed or completed.	Successful

Beta Application Testing is the second step in software testing when the product has been created. This test is an assessment conducted by users of the application. User Acceptance Testing (UAT) is a procedure carried out by users and produces a document with test results that the application can be used properly. To find out the user's point of view on the development of the IoT introduction game education application, research was conducted by asking 6 questions to 74 respondents from junior high school, high school and college students, with question data can be seen in table 3.

Table 3. List of Questions to Users

No	Question
P1	Is the app concept interesting to use?
P2	Is the usefulness of the features in the application helpful?
P3	Is the material in the application easy to understand?
P4	Is the suitability of objects, shapes, locations and colors in the Application appropriate and comfortable when used?
P5	Can the IoT quiz feature help to increase knowledge?
P6	Is the ease of using the application comfortable when used?
P7	Do all these features generate interest in learning IoT?

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The purpose of the Questionnaire Question List table in the design of the Mobile-Based IoT Introduction Education Game is to design and develop a questionnaire that can be used to collect data from potential users of the game. The questionnaire will help to understand the needs and preferences of users for educational games with the theme of mobile-based Internet of Things (IoT) introduction. The data collected from the questionnaire will be used as the basis for developing a game that is right on target and meets user needs. In addition, data from the questionnaire can also be used to improve or enhance existing features in the game and add new features that users want.

The results obtained from testing the Beta Application with 74 respondents show that 75.37% have very good criteria and 15.91% have good criteria. The questionnaire filling process is carried out by asking respondents to provide answers to several questions that have been provided. In each question asked, there are five possible answers, namely very good (SB), good (B), quite good (CB), less good (KB), and very less (SK). Seen in table 4.

Table 4. Respondent's Result Score

No	Value					
	SB	B	CB	KB	SK	Total responden
P1	52	14	5	3	0	74
P2	45	13	9	7	0	74
P3	55	19	0	0	0	74
P4	60	8	6	0	0	74
P5	56	10	6	2	0	74
P6	66	8	0	0	0	74
P7	61	5	8	0	0	74

3.5.3. Distribution Phase

During the distribution phase of this research, the process of transferring .apk files of applications that have been created can use third-party applications such as WhatsApp or other sharing applications.

4. Conclusion

Based on research that has been done, educational games can assist in providing material that has a good impact on increasing understanding of the material to students and the general public [25]. Likewise, the IoT educational game application also has a positive impact on users to increase understanding of IoT, around 75.37% of respondents' responses to application evaluation criteria are for very good criteria, and 15.91% for good criteria, so it can be concluded that the application can be well received by users, and with this research can help in STEM education to be more developed [26].

Suggestions for development that can be done in future research on this educational game application, namely that further applications can be further developed in terms of material, games and features that support the players. users to be more comfortable in using the application. And can also be developed in other operating system versions such as IOS, so that all can be affordable to use the IoT educational game application.

References

[1] I. Chirikov, T. Semenova, N. Maloshonok, E. Bettinger, and R. F. Kizilcec, “Online education platforms scale college STEM instruction with equivalent learning outcomes at lower cost,” 2020. [Online]. Available: http://advances.sciencemag.org/

[2] B. Wahono, P. L. Lin, and C. Y. Chang, “Evidence of STEM enactment effectiveness in Asian student learning outcomes,” *International Journal of STEM Education*, vol. 7, no. 1. Springer, Dec. 01, 2020. doi: 10.1186/s40594-020-00236-1.

[3] X. Gao, P. Li, J. Shen, and H. Sun, “Reviewing assessment of student learning in interdisciplinary STEM education,” *International Journal of STEM Education*, vol. 7, no. 1. Springer, Dec. 01, 2020. doi: 10.1186/s40594-020-00225-4.

[4] Y. Du, Y. Li, J. Chen, Y. Hao, and J. Liu, “Edge computing-based digital management system of game events in the era of Internet of Things,” *Journal of Cloud Computing*, vol. 12, no. 1, Dec. 2023, doi: 10.1186/s13677-023-00419-5.

[5] M. Padmaa *et al.*, “Oppositional chaos game optimization based clustering with trust based data transmission protocol for intelligent IoT edge systems,” *J Parallel Distrib Comput*, vol. 164, pp. 142–151, Jun. 2022, doi: 10.1016/J.JPDC.2022.03.008.

[6] M. Y. Jamro, “IoT security with QoS: Game changer for Industry and STEM Education,” in *Proceedings - International Carnahan Conference on Security Technology*, Institute of Electrical and Electronics Engineers Inc., 2021. doi: 10.1109/ICCST49569.2021.9717385.

[7] E. Lailatus Sofa, “Routing Attacks Pada Internet Of Things Berbasis Smart Intrusion Detection System,” vol. 7, no. 2, pp. 329–338, 2020, doi: 10.25126/jtiik.202071926.

[8] L. Petrović, D. Stojanović, S. Mitrović, D. Barać, and Z. Bogdanović, “Designing an extended smart classroom: An approach to game-based learning for IoT,” *Computer Applications in Engineering Education*, vol. 30, no. 1, pp. 117–132, Jan. 2022, doi: 10.1002/cae.22446.

[9] Y. Cui, D. Zhang, T. Zhang, L. Chen, M. Piao, and H. Zhu, “Novel method of mobile edge computation offloading based on evolutionary game strategy for IoT devices,” *AEU - International Journal of Electronics and Communications*, vol. 118, May 2020, doi: 10.1016/j.aeue.2020.153134.

[10] Y. R. Liana, S. Linuwih, and S. Sulhadi, “Internet of Things Based Learning Media with Problem Solving Approach: Its Effect on Higher Order Thinking Skills,” *Jurnal Ilmiah Pendidikan Fisika Al-Biruni*, vol. 9, no. 2, pp. 225–239, Oct. 2020, doi: 10.24042/jipfalbiruni.v9i2.6313.

[11] “H. T. Husna,” “Indeks Literasi Digital Indonesia 3.49, Ini yang Bisa Dilakukan Pemerintah,” *www.suara.com*, Mar. 24, 2022. https://www.suara.com/lifestyle/2022/03/24/203405/indeks-literasi-digital-indonesia-349-ini-yang-bisa-dilakukan-pemerintah (accessed Apr. 30, 2023).

[12] P. Tangworakitthaworn, V. Tengchaisri, and P. Sudjaidee, “Serious Game Enhanced Learning for Agricultural Engineering Education: Two Games Development Based on IoT Technology,” in *InCIT 2020 - 5th International Conference on Information Technology*, Institute of Electrical and Electronics Engineers Inc., Oct. 2020, pp. 82–86. doi: 10.1109/InCIT50588.2020.9310786.

[13] R. Listya Rizalni, A. Trisnadoli, M. Ihsan Zul, J. Teknologi Informasi, and P. Caltex Riau Pekanbaru, “Pengembangan Game Edukasi Mobile Makhluk Hidup Kelas Reptilia Untuk Siswa Smp,” 2019.

[14] R. Indra Borman and Y. Purwanto, “Impelementasi Multimedia Development Live Cycle pada Pengembangan Game Edukasi Pengenalan Bahaya Sampah pada Anak,” 2019.

DOI: https://doi.org/10.29207/resti.v7i3.5007

[15] H. Antoni Musril and M. Hurrahman, "Implementasi Teknologi Virtual Reality Pada Media Pembelajaran Perakitan Komputer," 2020.

[16] W. Untoro, I. Putu Satwika, A. Agung, A. P. Ardyanti, and W. Sujarwo, "Perancangan Game Bedugul Forest Dengan Metode Pengembangan Multimedia Luther-Sutopo," 2019. [Online]. Available: http://publikasi.dinus.ac.id/index.php/andharupa

[17] A. Pandhu Dwi Prayogha and M. Riyan Pratama, "Implementasi Metode Luther Untuk Pengembangan Media Pengenalan Tata Surya Berbasis Virtual Reality," 2020.

[18] Nadiah Ratnaduhita, Ian Mahendra Putra, Ully Asfari, Yupit Sudianto, and Benazir Imam Arif Muttaqin, "Implementasi Virtual Reality Berbasis Foto 360o Untuk Memvisualisasikan Fasilitas Perguruan Tinggi Surabaya," *Jurnal RESTI (Rekayasa Sistem dan Teknologi Informasi)*, vol. 5, no. 1, pp. 155–162, Feb. 2021, doi: 10.29207/resti.v5i1.2759.

[19] I. Made Sukarsa *et al.*, "Evaluasi Usability Dan Perbaikan Antarmuka Untuk Meningkatkan User Experience Menggunakan Metode Usability Testing (Studi Kasus : Aplikasi Warga BalI)", doi: 10.25126/jtiik.202295408.

[20] S. K. Dirjen *et al.*, "Pengembangan Aplikasi Virtual Reality dengan Model ADDIE untuk Calon Tenaga Pendidik Anak dengan Autisme," *masa berlaku mulai*, vol. 1, no. 3, pp. 672–681, 2020.

[21] S. Astuti *et al.*, "'Tooth And Fairy' Berbasis Android Menggunakan Unity Engine," vol. 9, no. 2, pp. 287–292, 2022, doi: 10.25126/jtiik.202294992.

[22] A. Cahya Wardhana, N. Anggraini, and N. F. Rozy, "Pengembangan Aplikasi Web Perancangan Agenda Perjalanan Wisata Menggunakan Metode User Experience Lifecycle," vol. 8, no. 2, pp. 303–310, 2021, doi: 10.25126/jtiik.202182548.

[23] A. Naziihah, D. Herwanto, and B. Nugraha, "Rancang Bangun Aplikasi Sis-Log In Apps untuk Mempersingkat Distribusi Hasil Pertanian Sayuran," *Jurnal Nasional Pendidikan Teknik Informatika (JANAPATI)*, vol. 10, no. 2, p. 110, Jul. 2021, doi: 10.23887/janapati.v10i2.34870.

[24] E. Mulyadi, A. Trihariprasetya, I. Gede Wiryawan, J. Teknologi Informasi, and P. Negeri Jember Jember, "Penerapan Sistem Presensi Mobile Dengan Menggunakan Sensor Gps (Klinik Pratama X Di Jember)," 2020.

[25] A. Manzano-León *et al.*, "Between level up and game over: A systematic literature review of gamification in education," *Sustainability (Switzerland)*, vol. 13, no. 4, pp. 1–14, Feb. 2021, doi: 10.3390/su13042247.

[26] I. K. Larasati, W. Hayuhardhika, N. Putra, and R. I. Rokhmawati, "Perancangan User Experience Aplikasi E-Business Pasar Tradisional Dengan Metode Human Centered Design (Studi Kasus: Pasar Oro-Oro Dowo)," vol. 9, no. 1, pp. 163–172, 2022, doi: 10.25126/jtiik.202295592.

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