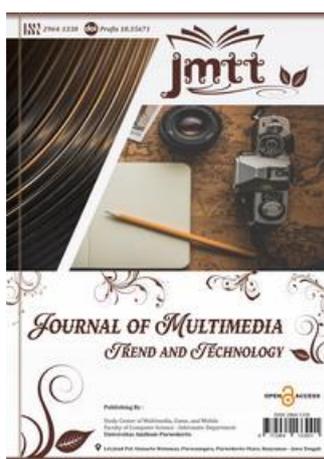# Augmented Reality Model Design in Urban Farming Learning Activity Simulation Based on GamePlay-Centric

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ABSTRACT

Based on available statistics, Indonesia ranks fourth globally in terms of the number of mobile phone users. Android is one of the operating systems (OS) for smartphones that is expanding quickly. Based on the results of the survey, Android-powered smartphones are the most popular. With 85.9% of smartphones running Android OS, the number of users in the first semester of 2023 grew very quickly. IOS, with 62.0% of users globally, came in second. This is a result of the growing selection of games and apps for smartphones running Android OS. Accompanied by the rapid development of Android smartphones, Augmented Reality (AR) has emerged. Augmented Reality is an environment that inserts 3D virtual objects into the real environment. Gameplay-centric in the context of games refers to a type of game where the main focus and highest priority is on game mechanics and player interaction with the game system itself. The core mechanics of the game are highly emphasized and carefully designed. This could be a deep combat system, challenging puzzles, responsive and satisfying controls, or interesting world exploration. Player enjoyment and engagement come from how players interact with the game. Challenges, feedback, and progress in the game are the main attractions. Other elements such as narrative (story), characters, and visuals may be present, but their roles are more supporting or secondary. They are not the main focus of the gaming experience. In fact, some gameplay-centric games may have minimal or no story at all.

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INTRODUCTION

Currently, it is estimated that 50 percent of the world's population lives in urban areas [1]. In Indonesia itself, it is estimated that by 2025, around 65 percent of the population will live in urban areas, especially in 16 major cities in Indonesia. In 2024, the population in Indonesia will reach around 265 million people or around 4 percent of the total world population [2][3]. This figure indicates the large amount of food that must be provided. However, if the increase in population is not balanced by an increase in food production, then the problem between food needs and availability cannot be avoided. Urban agriculture is an agricultural activity in or around urban areas that involves skills, expertise and innovation in food cultivation and processing [1][4]. The main thing that causes this activity to emerge is an effort to contribute to food security, increase the income of the surrounding community as well as a means of recreation and hobby. Urban agriculture has a variety of commodities that can be cultivated and can also be combined with each other, not only food crops but also horticultural plants, fruits, medicinal plants, flowers, fish, poultry, livestock, and others [5]. The definition of urban agriculture itself is an industrial chain that produces, processes and sells food and energy to meet the needs of urban consumers. All activities are carried out using and re-using natural resources and urban waste [2].

Urban farming is a strategy for utilizing narrow land to produce fresh food as an effort to fulfill urban food availability and can increase household economic access through household income [6]. Urban farming or urban agriculture is the act of farming, processing, distributing food within the city limits [7]. This activity involves the community in utilizing abandoned land in urban areas to be planted with productive plants. In addition to supporting food security in urban areas, urban farming also aims to increase the income of its managers [8]. The level of community participation in urban agricultural activities in developing countries also varies, ranging from 10% in Indonesia to almost 70% in Vietnam and Nicaragua [9]. The development of information technology is always growing rapidly. Especially in the field of mobile phones and smartphones. In Indonesia, there are many mobile phones and smartphones available at increasingly affordable prices, this makes mobile phone and smartphone users in Indonesia increase [4].

According to data, Indonesia is in 4th place for the most mobile phone users in the world. One of the OS (operating systems) on smartphones that is growing rapidly is Android. According to survey results, Android-based smartphones have the most users compared to others [10]. Android OS-based smartphone users in the first half of 2023 increased quite rapidly with 85.9% of users followed by IOS which has 62.0% of users worldwide. This is due to the increasing number of applications and games available for Android OS-based smartphones [11].

Accompanied by the rapid development of Android smartphones, Augmented Reality (AR) emerged, Augmented Reality is an environment that inserts 3D virtual objects into the real environment [12]. Therefore, the elements of 2 realities are more prioritized in this system. AR allows its users to interact in real-time with the system. The use of AR has now spread to many aspects of our lives including innovation in agriculture. One of them is learning about urban agriculture [13].

Gameplay-centric in the context of games refers to a type of game where the main focus and highest priority is on game mechanics and player interaction with the game system itself. The core mechanics of the game are highly emphasized and carefully designed [14]. This could be a deep combat system, challenging puzzles, responsive and satisfying controls, or interesting world exploration. Player enjoyment and engagement come from how players interact with the game [15]. Challenges, feedback, and progress in the game are the main attractions. Other elements such as narrative (story), characters, and visuals may be present, but their roles are more supportive or secondary [14][16].

They are not the main focus of the gaming experience. In fact, some gameplay-centric games may have minimal or no story at all [15].

Based on the pre-research data, researchers want to combine augmented reality with Android-based smartphones to support urban farming learning and foster interest in farming among urban communities and indirectly increase food production in urban areas.

METHOD

The Multimedia Development Life Cycle (MDLC) is a framework or model used to guide the process of creating and developing multimedia projects effectively and efficiently [13][14]. Just like the Software Development Life Cycle (SDLC) in software development. The Multimedia Development Life Cycle method consists of 6 stages, namely concept, design, material collecting, assembly, testing, and distribution.
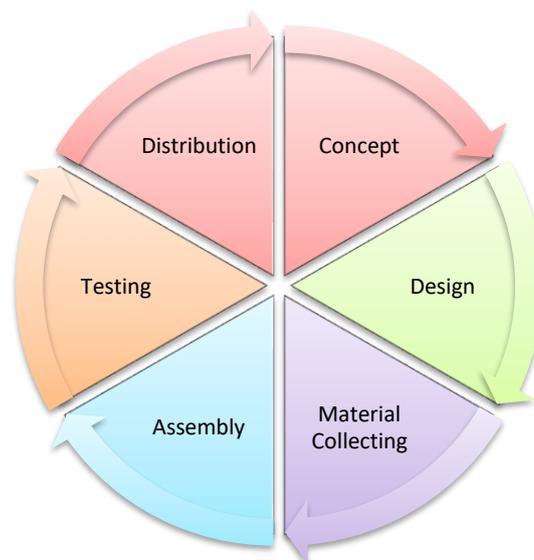

Figure 1. MDLC Framework

1 Concept
This stage is the initial stage of making an application. At this stage, the author carries out activities to determine the learning objectives and concepts of the material and for whom the application is made. At this stage, the author conducts interviews with teachers regarding the concepts and materials for the application to be made.
2 Design
At this stage, it starts with designing the material, creating use cases, creating activity diagrams, and creating storyboards to design each display in the application.
3 Material Collecting
This stage is the stage where at this stage the collection of materials that will be displayed in the interactive learning application is carried out. At this stage the author collects several materials, images, sounds, and animations to be included in the application to be created.
4 Assembly
The assembly (production) stage is where all the materials that have been collected are made into a learning application according to the design that has been made.

5   Testing

Testing is carried out after completing the creation stage by testing the features in the application.

6   Distribution

At this final stage, after the testing is successful, the application will be saved and distributed to teachers to be used as a teaching and learning tool.

Sometimes, there are additional stages such as Evaluation and Maintenance after distribution to collect user feedback and make improvements or updates in the future.

RESULT

Here is a discussion of the results we did. In accordance with the phase we use, namely using a prototype, then in this discussion it will be reviewed in stages. The stages of discussion are as follows:

3.1. Concept.

At this stage, the concept is the initial stage in the MDLC cycle. This stage begins by determining the purpose of creating the application, determining the application users and the function of the application.

1   This study aims to build an Android-based application with Augmented Reality so that the application used becomes interesting and innovative in introducing a farming system for urban areas.

2   The Augmented Reality technology chosen is so that users get a better understanding of Urban Farming which is realized in 3 Dimensions.

3   This application is made into an interesting learning media run with the Android operating system by directing the Augmented Reality camera directly at the object whose use you want to know.

3.2. Design.

At the design stage, the following are carried out, making detailed specifications regarding the project architecture, then designing the user interface (UI) and user experience (UX), making a storyboard or flowchart to visualize the flow and content, then determining the visual style, typography, and other design elements, then planning the type of media to be used (text, images, audio, video, animation), finally making a list of material and equipment needs. At this stage, a concept is created to obtain a clear description of what is needed by the system to be developed through scenarios such as Use Case Diagrams (see Figure 2), Activity Diagrams (see Figure 3), and storyboards to analyze all architectural activities in the application development system.
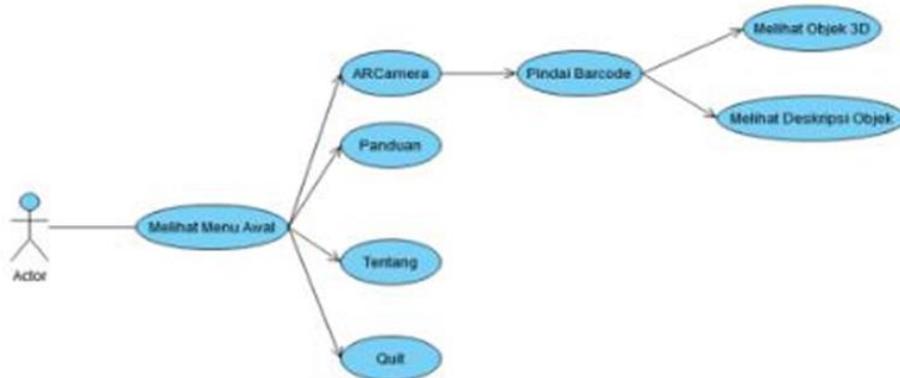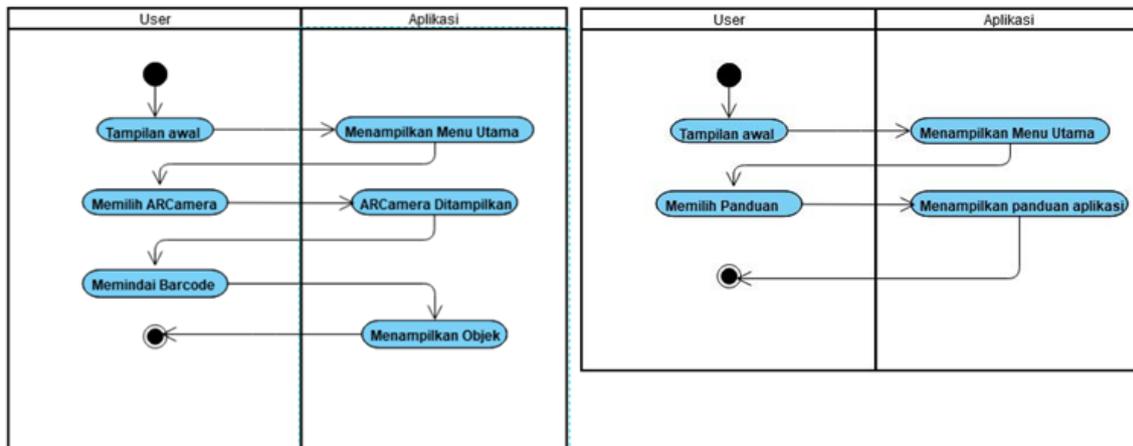

Figure 2. Usecase Model

Figure 3. Activity Diagram Model

3.3. Material Collecting.

At this stage, the material collecting is collected the required materials such as QR Code which will be used as a marker, supporting the creation of this application, and the references needed to create this application. Collecting Material in this study is explained in Table I.

Table 1. Material collecting

No	Material	Description
1	Wallpaper Background	Images or photos to support the game on the background and learning materials.
2	Button (Enter, Quit, Play, Help, Setting)	Images of buttons that function as navigators in urban farming games
3	QR Code	In the form of code results that can help open animated materials.
4	Audio (Intro, Button, Playing, Backsound)	Sound to support explanations in materials and background music in urban farming games
5	Animation (Content Material)	Moving images for learning results through Augmented Reality.
6	Video Tutorial	Assistance to make it easy for users to learn urban farming materials.
7	Text Content	Text to help explain urban farming materials.

3.4. Assembly

This stage is the stage where all objects or multimedia materials are created. The creation of this application is based on the design stage. This assembly stage includes the creation of 3D objects and the creation of applications.

a. Object Creation

Creation of 3D objects of Urban Farming techniques (see image) using Blender 3D. The Assembly stage is used to integrate all multimedia assets (text, graphics, audio, video, animation) into a multimedia application or product. Develop interactivity and functionality according to the design. Use relevant software and tools (eg, authoring tools, video editing software, game engines). In addition, it

also conducts initial testing on internal alpha testing. For a sample of modeling, it can be seen in Figure 4 below,
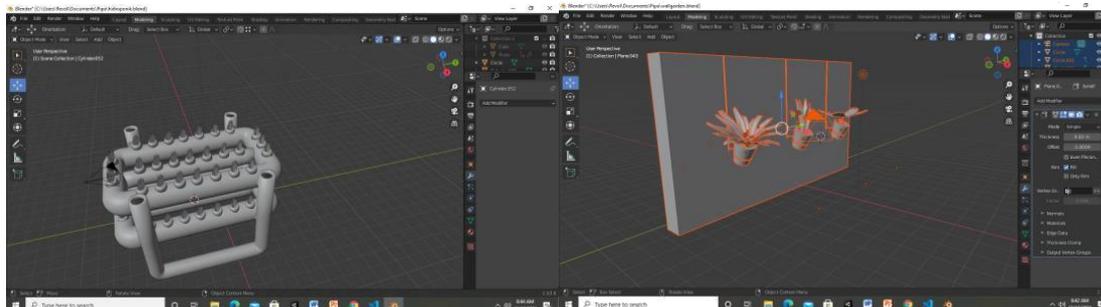

Figure 4. Example of modeling in the Blender 3D application.

b. Application Creation

The application creation stage includes the creation of the main application menu (see image), the creation of the AR Camera menu (see image) and other menus using Unity and Vuforia SDK. For an example of modeling in creating an application, see Figure 5 below,
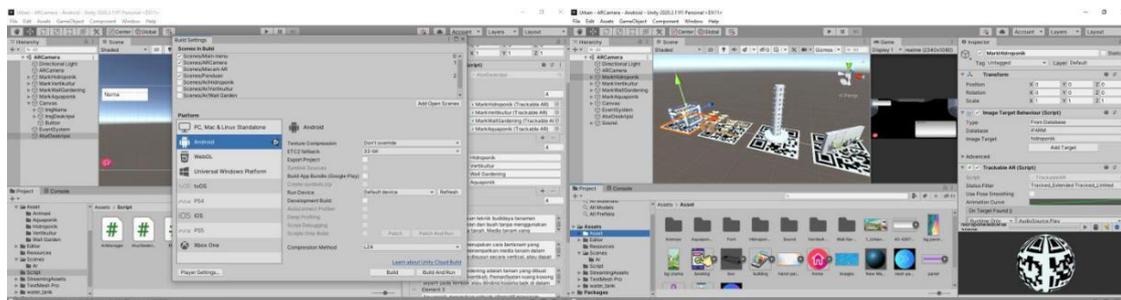

Figure 5. Example of application modeling.

3.5. Testing.

After completing the creation stage, it is continued with the testing stage which directly involves the end users of this application. This stage is used to test multimedia products thoroughly to identify bugs, errors, or other problems, then conduct various types of testing (e.g. usability testing, functional testing, performance testing), and collect feedback from testers (including potential users if possible).

a. Alpha Test

This testing stage is carried out after the application is finished being built and installed on the Android platform. The testing carried out includes testing whether the buttons and application displays are running properly as expected or not. The following are the test results of the application that has been created. In short, alpha testing aims to ensure the product works well at a fundamental level and identify critical issues before involving external users, resulting in a higher quality product and reducing the risk of problems later on. An example of this alpha testing can be seen in Figure 6 below,
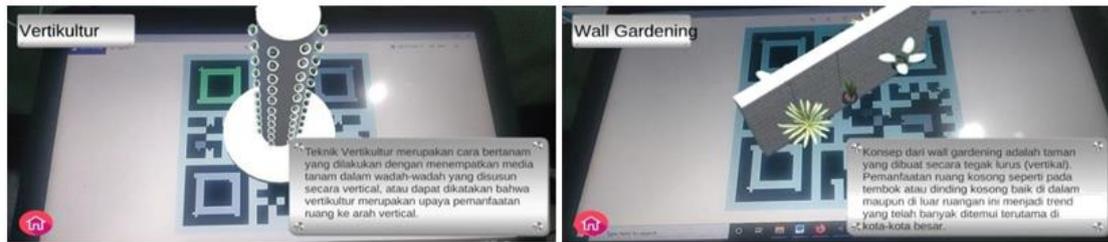
Figure 6. Alpha test results on running game.

b. Beta Test

Beta testing itself is used to identify bugs and usability issues that were missed during alpha testing: Users with different perspectives and varied usage styles often find issues that are not detected by internal teams. In addition, it evaluates the user experience (UX): Beta testing provides insight into how users interact with the product, whether the interface is intuitive, and whether the workflow is logical from a user perspective. More importantly, it validates by measuring the performance and stability of the product in real conditions, meaning testing how the product runs on various devices and network conditions (if applicable).

This stage is a test in the form of giving a questionnaire to 15 respondents which can be seen in tables 2, and the results of the questionnaire can be seen in figures 7.

Table 2. Questionnaire response questions for respondents.

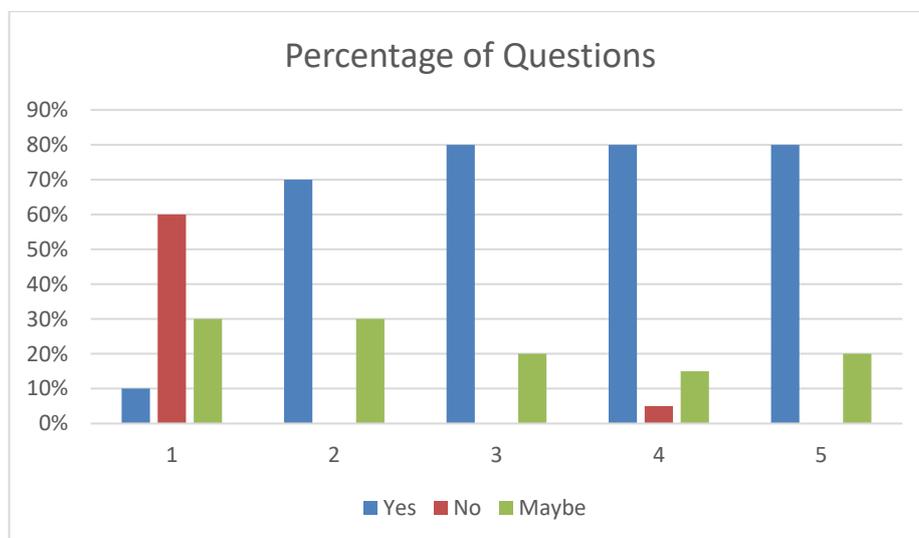| No	Question	Yes	No	Maybe
1	Do you know what Urban Farming is?	10%	60%	30%
2	Have you ever used Augmented Reality technology?	70	0%	30%
3	Is the design of this application interesting?	80%	0%	20%
4	Are the explanations and objects understandable?	80%	5%	15%
5	Are you interested in gardening using the Urban Farming method?	80%	0%	20%

Figure 7. Percentage graph results on questionnaire questions

In the beta test results, it can be seen in Figure 7 with 5 questions that conclude that with this gameplay-centric learning platform, it can be seen from the knowledge provided that it gives the effect of wanting to know and learn to implementing learning through the game material. This game can be interpreted as successful in influencing and providing learning for the community about urban farming.

3.6. Distribution.

The distribution phase in the Multimedia Development Life Cycle (MDLC) is when the finished and tested multimedia product is ready to be launched and reached by the target audience. The activities carried out at this stage depend greatly on the type of multimedia product and its target users. However, in general, here are some things that are usually done at the distribution phase:

1 Finalization and Mastering to ensure all files and assets are in the final and optimal format for distribution. This can be the process of encoding video, compressing audio, or creating master files for replication (if the distribution is physical).
2 Packaging the product is distributed physically (e.g., CD/DVD, flash drive), this involves the design and production of packaging, labels, and other supporting materials.
3 Creation of installation files (If Required) for multimedia applications or software, creating installers that make it easier for users to install the product on their devices.
4 Preparation of user documentation to create user guides, manuals, or FAQs that help users understand how to use the product.

CONCLUTIONS

Based on the research results, the conclusion obtained is that augmented reality technology can be implemented in Urban Farming learning. In the implementation of augmented reality, there are several things that must be considered, such as the placement of objects on the target image and the lighting of the object so that it can be seen clearly. In addition, the success of augmented reality in displaying 3D objects in the augmented reality marker tracking process must also be supported by a distance that is in accordance with the size of the marker and sufficient light intensity so that it can run properly. And with the existence of this Augmented Reality-Based Urban Farming Learning Application, it is hoped that urban communities in Tomohon and Manado can better understand the concept of Urban Agriculture which of course can help various sectors of life. This research certainly still has shortcomings so that there are things that need to be reviewed. Therefore, there are several suggestions made for further application development, namely, in the next design, other features can be added and a more user-friendly design design can be designed. The application can be developed with more complete material and more attractive features.

Author Contributions

Writing, V.T.R., Design, V.T.R., and P.R., Animator, P.R., Concept and Modeling, V.T.R., and P.R.

REFERENCE

[1] Y. Liu, Q. He, R. Tan, K. Zhou, G. Liu, and S. Tang, "Urban growth modeling based on a game between farmers and governments: Case study of urban fringe in Wuhan, Hubei Province in China," *J. urban Plan. Dev.*, vol. 142, no. 2, p. 4015018, 2016.

[2] B. Surya, S. Syafri, H. Hadijah, B. Baharuddin, A. T. Fitriyah, and H. H. Sakti, "Management of slum-based urban farming and economic empowerment of the community of Makassar City, South Sulawesi, Indonesia," *Sustainability*, vol. 12, no. 18, p. 7324, 2020.

[3] A. A. Ahmad, N. R. Nik Omar, R. M. Muhammad, and S. Safari, "Urban Farming Contributes to Shortening the Food Supply Chain," in *Conference on Food and Industrial Crops*, 2022, p. 83.

[4] S. Syarifuddin, M. Pradana, P. Far\'\ias, H. P. Elisa, and A. Putra, "A systematic review on urban farming food business in Indonesia," *WSEAS Trans. Syst.*, vol. 23, pp. 113–120, 2024.

[5] A. Abdillah, I. Widianingsih, R. A. Buchari, and H. Nurasa, "Implications of urban farming on urban resilience in Indonesia: Systematic literature review and research identification," *Cogent Food \& Agric.*, vol. 9, no. 1, p. 2216484, 2023.

[6] K. Srinivasan and V. K. Yadav, "An integrated literature review on Urban and peri-urban farming: Exploring research themes and future directions," *Sustain. Cities Soc.*, vol. 99, p. 104878, 2023.

[7] R. Milestad, A. Carlsson-Kanyama, and C. Schaffer, "The Högdalen urban farm: a real case assessment of sustainability attributes," *Food Secur.*, vol. 12, pp. 1461–1475, 2020.

[8] L. Li, X. Li, C. Chong, C.-H. Wang, and X. Wang, "A decision support framework for the design and operation of sustainable urban farming systems," *J. Clean. Prod.*, vol. 268, p. 121928, 2020.

[9] S. M. Sijabat and B. Grahita, "Urban farming learning application in simulation games for generation Z in Indonesia," in *ICON ARCCADE 2021: The 2nd International Conference on Art, Craft, Culture and Design (ICON-ARCCADE 2021)*, 2021, pp. 359–364.

[10] M. Rais, F. Aryani, A. S. Ahmar, H. Arfandi, and W. K. S. Ahmad, "Learning media edu-games 'my profession' as an effort to introduce various types of profession in early childhood education students," in *Journal of Physics: Conference Series*, 2018, p. 12091.

[11] L. P. Rieber, "Multimedia learning in games, simulations, and microworlds," *Cambridge Handb. Multimed. Learn.*, pp. 549–567, 2005.

[12] R. E. Kasperson, "Games as educational media," *J. Geog.*, vol. 67, no. 7, pp. 409–422, 1968.

[13] S. Solehatin, S. Aslamiyah, D. A. A. Pertiwi, and K. Santosa, "Augmented reality development using multimedia development life cycle (MDLC) method in learning media," *J. Soft Comput. Explor.*, vol. 4, no. 1, pp. 30–38, 2023.

[14] S. L. Rahayu, R. Dewi, and others, "Educational games as a learning media of character education by using multimedia development life cycle (MDLC)," in *2018 6th International Conference on Cyber and IT Service Management (CITSM)*, 2018, pp. 1–4.

[15] E. Molla and V. Lepetit, "Augmented reality for board games," in *2010 IEEE International Symposium on Mixed and Augmented Reality*, 2010, pp. 253–254.

[16] B. H. Thomas, "A survey of visual, mixed, and augmented reality gaming," *Comput. Entertain.*, vol. 10, no. 1, pp. 1–33, 2012.