Educational Game Using Coordinate-Based Augmented Reality At Green Fresh Farm

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Abstract— Tourist destinations in Indonesia are incredibly diverse. One of these destinations is Green Fresh Farm, located in the Gunungpati district, specifically in Jatirejo Village. Green Fresh Farm serves as a place for dairy cow farming and is also a tourist destination. Children visit this place for recreational purposes and to learn about cows.

The creation of the MooLand AR game aims to determine whether the MooLand AR game is accepted as a means for introducing and educating about cattle farming at Green Fresh Farm. This includes educating visitors about cattle barn facilities, feeding techniques for dairy cattle, and educating about cattle diseases at Green Fresh Farm.

Based on the test results, the MooLand AR game is accepted as a means of introducing and educating visitors about cows at Green Fresh Farm. The analysis results indicate that the game correlates with ease of use, utility, and enjoyment, making MooLand AR successful and accepted as an educational game about cows at Green Fresh Farm.

Keywords— augmented reality, GPS, educational game, cows.

I. INTRODUCTION

In the present time, technological advancements are rapidly increasing, including in the field of gaming[1]. There is a wide variety of games available, including those that use Augmented Reality. However, games are often perceived negatively and believed to have adverse effects because they are considered purely for entertainment and can be addictive[2]. Games can also serve as a creative learning platform with the assistance of Augmented Reality[3]. According to research conducted by the Massachusetts Institute of Technology (MIT), games are highly effective in sharpening logic and quick problem-solving skills[4].

Tourist destinations in Indonesia are diverse and have the ability to attract both local and international tourists. One is the tourist village in Semarang City, specifically in the Gunungpati District. The introduction to this tourist village is done by creating a game using Augmented Reality based on coordinates. This game serves as a means of introducing and educating visitors about dairy cows found at Green Fresh Farm in Jatirejo, located in Gunungpati[5].

Augmented Reality is a technology that combines three-dimensional and two-dimensional objects into real-life settings, projecting these objects in real-time [6]. Indonesia's culture is incredibly diverse, and with the help of augmented reality, cultural introductions can become more engaging and enjoyable[7]. Augmented Reality technology has the advantage of being realistic and interactive, making it suitable for various educational activities[8]. Therefore, in this final project, it is proposed to create a location-based Augmented Reality game to introduce the

tourist village in Gunungpati. The game will be developed using Unity and the programming language C# (C Sharp).

II. LITERATURE REVIEW

2.1 Previous Research

Based on the research [9] conducted in 2014, in a journal titled "GPS-Based AR Games Development Potential," it was found that GPS-based AR games garnered considerable interest among respondents. About 44% of the respondents found the game appealing due to its engaging gameplay, while 16% were attracted by the novelty of AR technology. Additionally, 16% of respondents were influenced to try the AR game based on invitations from friends, and the remaining 24% had other reasons for trying out the AR game. The main factor that piqued the respondents' interest was the utilization of GPS technology, which automatically transformed the real world into the game's arena.

According to the research [10] conducted in 2018, in a journal titled "Promote Folksong Use Game Based on Augmented Reality," this educational game aims to introduce traditional folk songs using AR-based gameplay. The results of the game tests showed that 96.7% of the respondents strongly agreed that the game can help preserve folk songs, while 3.3% agreed. Moreover, 83.3% of the respondents expressed an interest in completing the game, 6.7% were very interested, and the remaining 10% were not interested in completing the game. It can be concluded that the gameplay in this game is highly engaging and easy to play, and it effectively contributes to the preservation of traditional folk songs in Indonesia.

Based on the research [11] conducted in 2020, in a journal titled "Design and Development of the Garut Culture and Tourism Role-Playing Game," it was found that this role-playing game aims to introduce the culture and tourism of Garut. The game testing results showed that 87.6% of the players stated that the game could serve as an informative medium for the culture and tourism in Garut.

2.2 The Definition of a Game

Game originates from the English language, which means "permainan" in Indonesian. Games are generally considered a form of entertainment that aims to delight and engage the players while they play the game[12]. Furthermore, games are interactive activities that require tools or computers to play[13]. Apart from being a source of entertainment, games can also enhance cognitive abilities. For instance, a game like Lumosity measures aspects such as flexibility, memory, attention, speed, and problem-solving skills[14].

Based on the explanations in the previous paragraph, it can be interpreted that games are something that entertains and serves as a medium for learning to alleviate boredom while enhancing brain function. Games as a learning tool have been proven to be more effective and increase learning interest compared to methods that do not incorporate games[15]. In addition to their effectiveness, combining games and education has long-term engagement and influence, leading to mastery of content and continuous learning[16]. This ensures that the learning material isn't forgotten immediately but will be remembered into adulthood because the visual elements in games stimulate the brain's memory to retain specific events from the games played.

2.2 Dairy Cows

Friesian Holstein (FH) cattle is the most widely raised cattle breed in Indonesia and is typically imported from sub-tropical climates like Australia[21]. The advantages of FH cattle include their ease of adaptation to new environments, high milk production, and low-fat content in their milk[22]. FH cattle are also known for their distinctive black and white coat, similar to Dalmatian dogs.

2.3 Pests in Cattle

Pests are living organisms that are harmful or disruptive to humans, plants, and livestock. There are three examples of pests that are known to disrupt and pose a danger to cattle, including dairy cows:

Rats can be a dangerous pest for cattle because they can transmit a disease called Leptospirosis, which can affect both humans and animals, including cattle. Indonesia's climate, with relatively high levels of rainfall, provides an environment where Leptospirosis can easily thrive and spread in humid conditions[23].

Mosquitoes can transmit a disease in cattle called Bovine Ephemeral Fever (BEF) or three-day fever. This disease is often prevalent during the rainy season in tropical regions like Indonesia. BEF can significantly reduce milk production in dairy cows, and if not treated promptly, it can lead to cattle fatalities[24].

Flies are commonly found in cattle housing areas when hygiene is not well maintained, such as when livestock waste is not promptly cleaned. Flies are vectors for various diseases in cattle. Cattle can experience a significant reduction in milk production and weight loss if flies are not promptly controlled[25].

2.4 Global Positioning System

GPS is a satellite-based navigation system capable of determining a person's location based on longitude and latitude coordinates using signals from three or more satellites. When signals are received from four or more satellites, GPS can also provide three-dimensional location information, including longitude, latitude, and elevation. GPS can also provide data such as speed and direction when someone is traveling. It operates 24/7 and can be accessed by anyone with a GPS receiver[26].

2.5 Augmented Reality

Augmented reality is a variation of Virtual Reality (VR). AR allows users to see virtual objects as if they were in the real world. AR technology has many uses, especially in the field of education[27]. In augmented reality, a tracking system is required to display virtual objects in the real world. The tracking system used can be markerless, meaning it enhances user interaction and perception between virtual objects and the real world. Markerless AR uses the surrounding environment as markers, but implementing markerless AR is more complex and intricate than marker-based approaches[28].

III. RESEARCH METHODOLOGY

3.1 Data Collection Methods

The data collection process for this final project is carried out using quantitative data collection techniques, specifically using descriptive data and observing three villages in the Gunungpati District, Semarang, namely Jatirejo, Cekopo, and Kandri. After the observations, Jatirejo village will be selected as the coordinate point to be featured in this location-based AR game, specifically at the Green Fresh Farm, which is a dairy farm located in Jatirejo.

3.1.1 Data Sources

Primary Data Sources, this data source involves collecting data directly from the participants who have tried the created game. Subsequently, and distributing questionnaires to assess their validity.

Secondary Data Sources involve collecting and processing data from reputable and publicly available journals and books.

3.2 Data Collection Techniques

The data collection techniques used are as follows:

1. Literature Review

Data is gathered from trusted and widely published documents such as journals and books. Before reviewing, it is essential to ensure that the selected journals and books are reliable sources with proven research to avoid data inaccuracies.

2. Questionnaires

This method is implemented by distributing questionnaires to participants who have tested the created game.

3.3 Game Testing Methodology

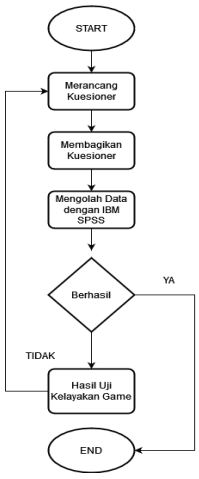

Figure 3.2 Game Testing Flowchart

This testing method utilizes quantitative methods involving observation and subsequently distributing questionnaires. Here is an explanation of the flowchart for the game testing method:

1. Creating Questionnaires

   In this phase, the entire game programming process is already completed. Therefore, a questionnaire is required to assess the game's feasibility.

2. Distribution of Questionnaires

   The questionnaires are then distributed to the participants who have played this educational game.

3. Data Processing

   The collected data is then processed using three types of tests: correlation, reliability, and validity tests, utilizing IBM SPSS 26 software.

4. Game Feasibility Test Results

   After the data is processed using SPSS and found to be valid, it can be concluded that the MooLand AR game is accepted for teaching education about cattle.

3.4 Respondent Data

Age, a total of 33 respondents were aged 21-30 years, accounting for 94.3%, and the remaining 2 respondents were aged 30 years and above, accounting for 5.7%.

Gender, a total of 33 respondents were male, accounting for 94.3%, and 2 respondents were female, accounting for 5.7%.

Last Education, a total of 31 respondents had their last education as high school (SMA), accounting for 88.6%, 3 respondents had a bachelor's degree (S1), accounting for 8.6%, and 1 respondent had junior high school (SMP) as their last education, accounting for 2.9%.

IV. RESEARCH RESULT AND DISCUSSION

4.1 Game Design Development

4.1.1 Concept and Gameplay of MooLand AR

The gameplay of "MooLand AR" is inspired by "Pokemon GO" and consists of a map. Before entering the map, there is a tutorial for players to grant GPS

access to the "MooLand AR" application. Since this game uses GPS assistance from the player's smartphone to determine the player's location on the map, the map automatically changes based on the player's location. Below, in Figure 4.1, is the flowchart illustrating the gameplay sequence of the "MooLand AR" game.

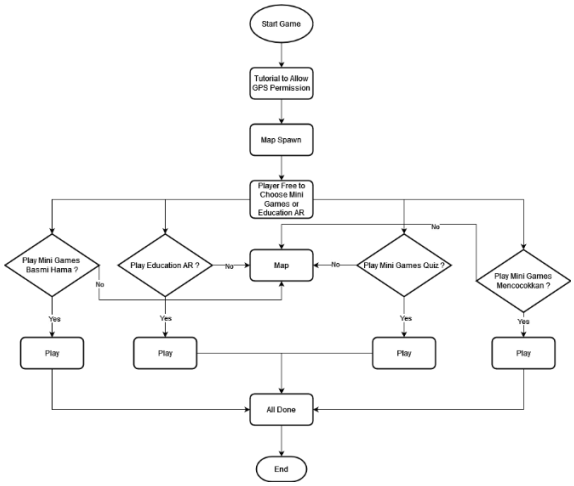

Figure 4.1 Flowchart of Gameplay Sequence

4.2 Game Development

4.2.1 Map Creation

The map was created with the assistance of GO Map assets created by Alan Grant [30] and the Mapbox API as the foundation for the map. After successfully creating the map, the next step is to determine the coordinates of the location of Green Fresh Farm in Jatirejo Village. Once these coordinates are established, they serve as the basis for designing and placing mini-games and AR educational content within the map. Subsequently, testing is conducted by building the application for Android, and the location is successfully obtained by utilizing the GPS feature on Android devices.

4.2.2 Object and Spawn Creation on the Map

After creating the map, the next step is to create objects to be placed on the map, which can be interacted with by players to access mini-games and AR educational content. The objects used include 3D models of Holstein cows and blue poles. Scripts are created to detect touch or interaction with the objects on the map. Both the cow and blue pole objects must be equipped with Box Colliders for the scripts to function properly.

After successfully making the objects functional, the next step is to create a script for spawning objects on the map using the original coordinates of the location where spawning should occur. This game is designed for players to play while they are at Green Fresh Farm only, so a distance limit is established. Players can only access the spawned objects on the map when they are within a certain proximity to the objects. If a player is too far away, the objects won't react when touched on the screen. The following is a picture of the map and objects in Figure 4.2.

Figure 4.2 Map and Objects

4.2.3 Creation of Quiz Mini Games

After the objects and map are functioning as desired, the next step is to create the necessary mini-games to support education about cattle farming. The first mini-game created is the "Quiz." This Quiz game contains simple

questions about cows and topics related to cattle farming, as shown in Figure 4.3.

Figure 4.3 Mini Games Quiz

4.2.4 Creation of Mencocokkan Mini-Games

The initial step in creating these mini-games is to start by designing the main menu, which doesn't yet utilize AR and contains buttons for starting, accessing tutorials, and returning to the map. Afterward, scenes for selecting game levels are created, and there are three levels in these mini-games: level 1, level 2, and level 3. The development of scenes for these levels is illustrated in Figure 4.4.

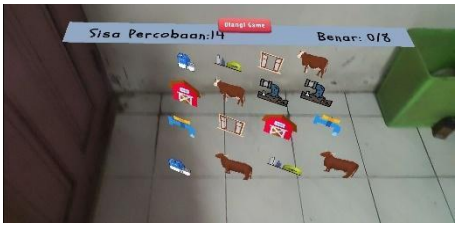

Figure 4.4 Mini Games Mencocokkan

4.2.5 Creation of Basmi Hama Mini-Games

The initial step is to create the main menu scene, which contains buttons for starting the game, accessing tutorials, and returning to the map. After pressing the start button, the player is directed to a scene to choose the level of difficulty. Three levels of difficulty are created: easy, medium, and hard. These mini-games incorporate a time limit, which becomes shorter as the difficulty level increases. Each difficulty level presents different pests to deal with. In the easy level, the player combats mice, in the medium level, mosquitoes, and in the hard level, flies. Before starting the game, a brief educational segment is presented about the dangers of these pests to cows, tailored to the type of pest being confronted. The visual representation of the "Basmi Hama" mini-game is depicted in Figure 4.5.

Figure 4.5 Mini Games Basmi Hama

4.2.6 Creation of Education AR

Education AR utilizes coordinate-based concepts, displaying objects according to the given coordinates. In the first AR education segment, a game object is created and then replaced with an image taken from a website, categorized as a free license. This image depicts a signboard used for educational information. The visual representation of this education AR segment is presented in Figure 4.6.

Figure 4.6 Education AR

4.3 Validity Test

The validity of each variable was tested using the comparison of the r $_{hitung}$ and the r $_{tabel}$ values. If the calculated r is greater than the tabled r, the variable is considered valid. Using N = 35, in line with the total number of respondents, and a significance level of 5%, the r $_{tabel}$ value is determined to be 0.334. The results of the validity test for the PE, EE, HM, and BI variables are presented in Table 4.1.

Table 4.1 Results of Validity Test

Variabel	R_{hitung}	R_{tabel}	Keterangan
PE1	0, 617	0,334	Valid
PE2	0,917	0,334	Valid
PE3	0,790	0,334	Valid
EE1	0,473	0,334	Valid
EE2	0,616	0,334	Valid
EE3	0,430	0,334	Valid
HM1	0,373	0,334	Valid
HM2	0,609	0,334	Valid
HM3	0,400	0,334	Valid
BI1	0,709	0,334	Valid
BI2	0,562	0,334	Valid
BI3	0,799	0,334	Valid

4.4 Reliability Test

After conducting the validity test, it is essential to assess the reliability of the questionnaire's variable data to determine the consistency. Reliability tests are performed for each variable PE, EE, HM, and BI. Cronbach's Alpha is used with a guideline of > 0.6 to ascertain whether the variables are reliable. In table 4.2, the criteria for reliability are based on Sugiyono (2013) [29].

Table 4.2 Reliability Criteria

Cronbach's Alpha	Tingkat Reliabilitas
0,00 < r < 0,2	Sangat Rendah
0,2 ≤ r < 0,4	Rendah
0,4 ≤ 0,6	Cukup
0,6 ≤ 0,8	Tinggi
0,8 ≤ 1	Sangat Tinggi

In Table 4.3, the reliability results for the PE (Performance Expectancy) variable are presented. The Cronbach's Alpha result for the PE variable is 0.878. Based on the criteria, the reliability level for the PE variable is high(tinggi)

Table 4.3 PE Reliability Results

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.873	.878	3

In Table 4.4, the reliability results for the EE (Effort Expectancy) variable are presented. The Cronbach's Alpha result for the EE variable is 0.507. Based on the criteria, the reliability level for the EE variable is considered sufficient(cukup).

Table 4.4 EE Reliability Results

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.508	.507	3

In Table 4.5, the reliability results for the HM (Hedonic Motivation) variable are presented. The Cronbach's Alpha result for the HM variable is 0.507. Based on the criteria, the reliability level for the HM variable is high(tinggi).

Table 4.5 HM Reliability Results

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.421	.423	3

In Table 4.6, the reliability results for the BI (Behavioral Intention) variable are presented. The Cronbach's Alpha result for the BI variable is 0.727. Based on the criteria, the reliability level for the BI variable is considered sufficient(cukup).

Table 4.6 BI Reliability Results

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.727	.727	3

4.4 Correlation Test

The results of the correlation test for the average values of PE, EE, HM, and BI variables are presented in Table 4.3. Based on the results in Table 4.7, it can be observed that:

The variables PE and BI have a strong correlation because their significance values are below 0.01.

The variables EE and BI have a strong correlation because their significance values are below 0.01.

The variables HM and BI are correlated, but not very strongly, as their significance value is above 0.01 but below 0.05.

Table 4.7 Results of Correlation Test

Correlations

		SPE	SEE	SHM	SBI
SPE	Pearson Correlation	1	.485**	.529**	.700**
	Sig. (2-tailed)		.003	.001	.000
	N	35	35	35	35
SEE	Pearson Correlation	.485**	1	.267	.548**
	Sig. (2-tailed)	.003		.121	.001
	N	35	35	35	35
SHM	Pearson Correlation	.529**	.267	1	.404*
	Sig. (2-tailed)	.001	.121		.016
	N	35	35	35	35
SBI	Pearson Correlation	.700**	.548**	.404*	1
	Sig. (2-tailed)	.000	.001	.016	
	N	35	35	35	35

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

V. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

MooLand AR game is implemented using Unity and designed according to the waterfall method. MooLand AR game utilizes Augmented Reality (AR) technology combined with GPS to make it engaging and can only be played at Green Fresh Farm. The game provides education about cows, cowshed facilities, feeding techniques for dairy cows, pests that affect cows, and diseases in cows caused by these pests.

Based on the results of testing 35 respondents, the game MooLand AR is accepted as a medium for introducing and educating about cattle farming. This can be proven based on the results of the first correlation test between the level of educational utility within the game and the intention to play the game, which showed a strong correlation between them. Based on the results of the second correlation test between the ease of operating the game and the intention to play the game, the results showed a strong correlation as well. However, based on the results of the third correlation test between the level of enjoyment while playing the game and the intention to play the game, there is a correlation, although it is less strong.

5.2 Recommendations

Here are some recommendations for further relevant research:

1. Development of Virtual Reality (VR) in education to facilitate simultaneous learning and play for children. For instance, using VR for simulating activities like milking cows.
2. Provide technology awareness and training in the target areas before conducting research, as not all regions are familiar with the use of new technologies such as Augmented Reality (AR) and Virtual Reality (VR).

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