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IMPLEMENTATION OF FISHER-YATES SHUFFLE ALGORITHM IN ANDROID-BASED JAVANESE BATIK CULTURE EDUCATION GAME

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Abstract— *Batik, as one of Indonesia's precious cultural heritages, has a variety of motifs in the art of batik in this country. The preservation of batik is important and the success of educational games in supporting this goal has been proven. Understanding the complex meaning and philosophy of batik is difficult given the variety of motifs. Therefore, this research creates an Android game that incorporates elements of batik culture to introduce the meaning and philosophy of Indonesian batik to the next generation. Android technology makes learning more flexible, allowing unrestricted access to information. By following the Game Development Life Cycle (GDLC) method and integrating the Fisher-Yates Shuffle algorithm and Finite State Machine (FSM), this game takes players on an adventure against Non-Playable Character (NPC) characters using the FSM model. The Fisher-Yates Shuffle algorithm is used to randomize 10 questions, making each game session unique. The algorithm test results showed an average question execution time of about 35.6 microseconds, indicating stable performance despite variations in each trial. The alpha test results showed an average score of 87%, covering aspects of information readability, responsiveness, player motivation, combat experience, educational benefits, as well as satisfaction, and game design that showed good performance. Thus, this research succeeded in creating an educational game that is entertaining and educational, as well as helping to maintain and introduce batik cultural heritage to the next generation.*

Keywords*: batik, finite state machine, fisher-yates shuffle algorith, game development life cycle.*

Abstrak— *Batik sebagai salah satu kekayaan warisan budaya yang sangat berharga di Indonesia, memiliki beragam motif dalam seni batik di tanah air ini. Pelestarian batik menjadi penting dan keberhasilan game edukatif dalam mendukung tujuan tersebut telah terbukti. Memahami makna dan filosofi batik yang kompleks menjadi sulit mengingat keragaman motifnya. Oleh karena itu, penelitian ini menciptakan sebuah game Android yang menggabungkan unsur budaya batik untuk memperkenalkan makna dan filosofi batik Indonesia kepada generasi penerus. Penggunaan teknologi Android membuat pembelajaran menjadi lebih fleksibel, memungkinkan akses tanpa batasan terhadap informasi. Dengan mengikuti metode Game Development Life Cycle (GDLC) dan mengintegrasikan algoritma Fisher-Yates Shuffle serta Finite State Machine (FSM), game ini mengajak pemain dalam petualangan melawan karakter Non-Playable Character (NPC) dengan menggunakan model FSM. Algoritma Fisher-Yates Shuffle digunakan untuk mengacak 10 pertanyaan, menjadikan setiap sesi game menjadi unik. Hasil uji algoritma menunjukkan waktu eksekusi pertanyaan rata-rata sekitar 35,6 mikrodetik, menunjukkan kinerja yang stabil meskipun terdapat variasi dalam setiap percobaan. Hasil uji alpha menunjukkan skor rata-rata sebesar 87%, mencakup aspek keterbacaan informasi, responsivitas, motivasi pemain, pengalaman pertarungan, manfaat edukatif, serta kepuasan dan desain game yang menunjukkan kinerja yang baik. Dengan demikian, penelitian ini berhasil menciptakan sebuah game edukatif yang menghibur dan mendidik, serta turut menjaga serta memperkenalkan warisan budaya batik kepada generasi penerus.*

Kata Kunci*: batik, mesin keadaan terhingga, algoritma shuffle fisher-yates, siklus hidup pengembangan permainan.*

INTRODUCTION

Indonesia has a tangible and intangible cultural heritage, and one of the most famous is batik [1]. In 2009, Indonesian Batik was inaugurated as part of the list of intangible human cultural heritage by UNESCO [2]. Batik is globally recognized as a historic heritage of human civilization. The term "batik" is often used generically to refer to the process of fabric dyeing, which is traditionally done on materials such as cotton and silk by applying resist techniques. There are also various other batik techniques, such as the hand-painting method, the watering method, and the screen printing process [3]. Batik not only functions as a product but also symbolizes activities in Indonesia [4].

Indonesian batik features a variety of different batik motifs. It is important to introduce the meaning and philosophy of batik to the next generation. Using fun educational games can be an effective method of preserving batik heritage. Educational games have great potential in transferring knowledge, as well as providing convenience in delivering information to students [5]. Attention to Indonesian batik motifs is important to preserve and maintain this cultural heritage. Each motif not only varies in type but also has a unique philosophy and meaning [6].

Using Android-based media improves education quality and offers a flexible approach to learning, adapting to modern developments [7]. Games refer to a form of entertainment with user interface interaction through video image representation. In addition, games can also function as a means of learning or education [8]. A game is not just about system planning, art, creativity, and imagination, but a combination of all these aspects.

Therefore, game development requires a more detailed and specialized procedure. This is why the term Game Development Life Cycle (GDLC) was coined, which is a method that guides the development of a game from the initial stage to the final stage [9]. GDLC was created as a modification of the Software Development Life Cycle (SDLC) because the SDLC did not fully meet the specific needs of game development [10]. Game development will be made using the Godot Engine software. Godot is free or at no cost, nothing is hidden, and there are no royalties to pay for user revenue [11].

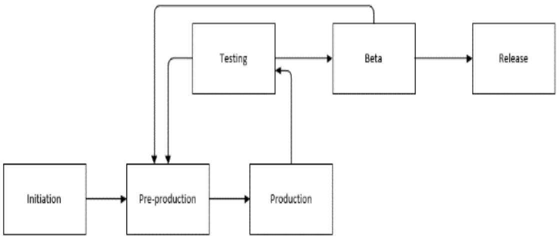
The game will be implemented using the Fisher-Yates Shuffle algorithm, the Fisher-Yates Shuffle algorithm can be implemented in randomizing questions well even for a large number of questions and can produce a different number of questions from each other [12]. During the process, the questions in this app will be randomized automatically, so users will not encounter the same question for the same number [13]. The Fisher-Yates Shuffle algorithm, first introduced by Ronald Fisher and Frank Yates, is also referred to as the Knuth Shuffle. This algorithm is commonly used to create random permutations of a linear array with a finite number of elements [14]. This algorithm can produce non-duplicate randomization solutions and can randomize objects with a wide variety [15]. If the implementation of Fisher-Yates Shuffle is done correctly, the result of this algorithm will not be biased, so each permutation has the same probability [16].

Non-Player Character (NPC) has a significant role in supporting the story and difficulty level in the game, giving a sense of realism to the world in the game and making the characters feel more alive. NPC, which stands for Non-Player Character, is a character object in the game that can be human, animal, robot, and others that cannot be controlled by the player. Although not directly controlled by the player, NPCs can perform actions and activities as if controlled by the player. This process is governed by a computational program that utilizes artificial intelligence, which allows the NPC to act and interact in the game [17].

Finite State Machine can be used as artificial intelligence to determine the traits and behavior of enemy NPC based on the players interactions with them [18]. The new state is determined by the next state function, which is a function of the current state and input signal [19]. Over time, FSM transitions from one state to another. A system operates within one active state at any given time period. The system can switch to another state upon receiving specific event inputs. Such transitions typically involve actions that the system performs in response to the incoming inputs [20]. By describing behavior or action based on state, event, and action. With this working principle, NPCs that have been implemented with FSM can determine the appropriate response or action for each movement made by the player in the game [21].

MATERIALS AND METHODS

Game Development Life Cycle (GDLC), wherein the GDLC there are several stages, namely initiation, pre-production, production, alpha testing, beta testing, and release.



Source: (GDLC Stage [22], 2020)

Figure 1. GDLC Stages

Figure 1 depicts the stages of the Game Development Life Cycle (GDLC) [22]. Starting from the first stage, namely initiation, where the educational game concept idea is developed. Next, in the pre-production stage, the game design is drawn up, including gameplay and mini prototypes. The production stage focuses on creating a game design that includes gameplay and mini prototypes to determine the gameplay that will be implemented. Testing is carried out at the next stage, by evaluating the functionality of the game features according to the initial design. The beta testing stage is carried out to test the game more widely involving users to detect and fix errors or bugs that may exist. Finally, the release stage is the final stage in game development, where applications that have passed the beta testing process will be launched and available for use by users [23].

1. Initiation

In the initiation stage, the researcher designed a concept for an educational game that combines elements of batik culture with Android game elements. This game concept aims to increase the younger generation's understanding of Indonesian batik motifs and regional origins. In the game, players undergo an adventure against a Non-Player Character (NPC) with random questions about batik. The NPC setting uses a Finite State Machine (FSM) model to interact with the player. The use of the Fisher-Yates Shuffle algorithm to randomize questions is expected to add to the appeal of the game. This game was developed specifically for the Android platform using the Godot Engine.

2. Pre-production

This stage is the core of the production process, where the main attention is focused on designing the game to be developed. During this stage, researchers designed the game mechanics, in-game challenges, and storyboards as a rough in-game overview, including the overall game flow. In addition, the game logic flow was also designed by creating a system flowchart that explains how the game will run. This process includes designing flowcharts for the Fisher-Yates Algorithm and the Finite State Machine (FSM) model that will be applied. The mechanism of this game is as follows:

1) Players battle against a Non-Player Character (NPC) in each map to obtain the contained agate and break it to free the NPC's soul.
2) NPC souls will provide insight into batik in the form of dialogs.
3) Players face enemy leaders on each map that must be defeated.
4) If the player wins, they get a chest box as a prize.
5) The crate box opens with the correct answer to the question randomized by the Fisher-Yates Shuffle algorithm.
6) Correct answers earn scores and player status upgrades.
7) Wrong answers trigger game repetition.

Game challenges should be well designed to increase the difficulty level. By determining interesting game challenges, it is expected to increase the player's attraction to the game. The challenges applied can be seen in Table 1 below:

Table 1. Game Challenges

No.	Challenge	Description
1	Fight With NPC	Players participate in battles against NPC enemies on each map. Enemies have different strengths on each map.
2	Stone Crystals	The player finds the crystal stone object after fighting the NPC character. crystal stone knowledge information about batik.
3	Crate Box	When opening the crate box, players are presented with random questions about batik culture. Players must answer correctly to get a score and improve the character's status.

Source: (Research Results, 2024)

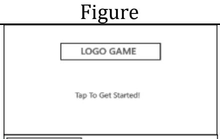
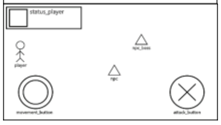
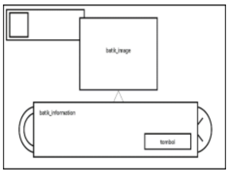
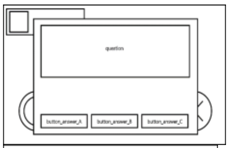
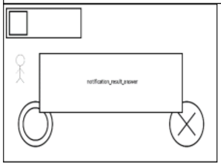
Table 1 above provides a detailed overview of the challenges that players will face on their journey. Each challenge is designed to provide an interesting and educational gaming experience, focusing on the cultural aspects of batik.

The system pseudocode below will help illustrate how the entire game will run:

```
start
    # Start game
    def start_game():
      display_start_menu()

      # Enters the player into the stage map
      stage_map = enter_stage_map()
        # Initial state in the game
      while True:
        # Battle against the enemy
        if battle_against_enemies():
          spawn_object("Batu Kristal")

          # If the player takes the object
          if object_taken():
            show_batik_information()

        # NPC bosses appear
        spawn_boss_npc()

        # Battle against the enemy again
        if battle_against_enemies():
          spawn_object("Chest Box")

          # If the player takes the object
          if object_taken():
            shuffle_and_show_questions()

            # If the player answers all questions correctly
            if answer_all_questions():
              game_stage_repetition()

              # Calculates scores and player stats
              score_and_player_status()

              # Move to the next stage
              move_to_next_stage()

              # If this is the last stage
              if is_last_stage():
                enter_next_stage()
      end_game()
end
```

The storyboard in Table 2 below is an early version of the game that gives a rough idea of how the game will look and operate:

Table 2. Storyboard Game

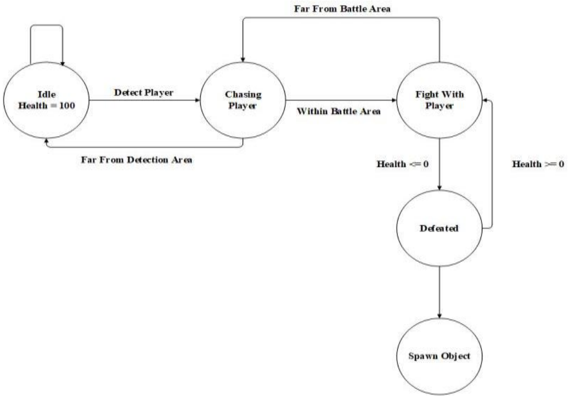
No.	Figure	Description
1		This start menu helps players to understand how to start the game.
2	 status_player player npc_boss npc movement_button attack_button	This is the game scene, where the player interacts with the challenges and problems in the game
3		This scene will explain the information about Batik itself from the picture of the motif, the origin of the motif, and the meaning stated on the Batik motif itself.
4	 question button_answer_A button_answer_B button_answer_C	It will feature a variety of questions that allow players to deepen their knowledge of batik.
5		It will provide an informational response regarding the results of the answers given, helping players to understand the extent of their success in the quiz or test.

Source: (Research Results, 2024)

Table 2 provides a comprehensive overview of the game's sequences, from the initial menu display to the interactive stages in the game. The pseudocode of the algorithm developed by researchers for randomizing batik questions is as follows:

```
function fisher_yates(array):
  n = length(array)
  while n > 0 do:
    j = random_number(1, n)
    swap(array[j], array[n-1])
    swap (array[j], list_array)
    n = n - 1
  print(list_array)
```

The researcher presents a model shown in Figure 1 below that illustrates various logical states with FSM for NPC characters:



Source: (Research Results, 2024)

Figure 2. FSM model for NPC behavior

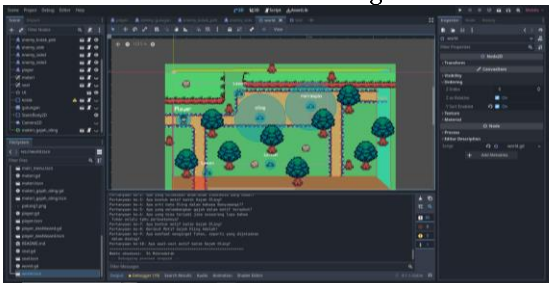
The Finite State Machine (FSM) in Figure 2 above, describes the behavior of a Non-Player Character (NPC) in a game. The FSM starts with an initial state of "Idle.", where the NPC has a full health of 100. During the game, the system continuously checks whether the player is detected or the NPC is outside the detection area. If the player is detected, the NPC switches to the "Chasing Player" state to pursue the player. If the NPC is outside the detection area, it returns to the "Idle" state. If the NPC is in the "Chasing Player" state and is inside the battle area, it enters the "Fight with Player" state.

During the battle, the NPC checks whether it is still in the battle area, or if the health is less than or equal to 0, the NPC moves to the "Defeated" state. If the NPC's health is more than 0, the NPC returns to the "Chasing Player" state. If the NPC is in the "Defeated" state, the system calls the function to pop the object (crystal stone or chest box) and the FSM ends. The states in this FSM involve "Idle", "Chasing Player", "Fight with Player" and "Defeated" creating logical transitions between states based on certain conditions in the game. The Finite State Machine (FSM) pseudocode developed by researchers for the Non-Player Character (NPC) state is as follows:

```
start
# Initialize initial state
state = "Idle"
health = 100

# Main
while True:
  # Check if the player is detected
  if detect_player():
    state = "Chasing Player"
  # Check whether the NPC is far from the detection area
  else if far_from_detection_area():
    state = "Idle"

  # If you are in the "Chasing Player" state
  if state == "Chasing Player":
    # Check whether it is in the fighting area
    if within_battle_area():
      state = "Fight with Player"

  # If you are in "Fight with Player"
  if state == "Fight With Player":
    # Check whether the NPC is far from the battle area
    if far_from_battle_area():
      state = "Chasing Player"
    # Check whether the NPC's health is less than or
     equal to 0
    else if npc_health <= 0:
      state = "Defeated"
    # Check whether the NPC's health is more than or
     equal to 0
    else if npc_health >= 0:
      state = "Chasing Player"

  # If it is in the "Defeated" state
  if state == "Defeated":
    # Spawn object (agate/chest box)
    spawn_object()
End
```

3. Production

At the stage of developing educational games about batik culture, there is an implementation of the previous stages, namely the development of game material and the application of the Fisher-Yates Shuffle Algorithm and the Finite State Machine (FSM) model. In this stage, researchers are involved in the coding process and the creation of game assets. The use of the Fisher-Yates Shuffle Algorithm is implemented to randomize the order of questions about batik in the game, providing a variation of randomization each time the player plays it and the FSM model is applied to regulate the behavior of NPC characters in the game.



Source: (Research Results, 2024)

Figure 3. Game Creation Process

Figure 3 illustrates the production process of this game using the Godot Engine, where all aspects of design, from NPC character creation, to map and feature creation, have been implemented. In addition, the Fisher-Yates Shuffle algorithm and FSM have been implemented to randomize the questions in the game and govern the behavior of the NPCs. The results can be seen through the print output of the image above which shows that the questions have been randomized, and on the NPC there is a detection area marked with a blue circle, indicating the implementation of FSM on the NPC character.

4. Testing

After production is completed, the game will undergo comprehensive testing. This includes evaluating various aspects such as game accessibility, feature usage, and the level of difficulty faced by players. Additionally, testing is conducted on the question randomization process using the Fisher-Yates Shuffle algorithm to ensure smooth randomization, as well as on the implementation of the Finite State Machine (FSM) to test the behavior of Non-Playable Character (NPC) in the game. The aim of these tests is to ensure that the game operates according to the standards set during the development process. Researchers will search for bugs, technical issues, or disruptions in the game that require rectification.

5. Beta

After going through the testing process, the game will be submitted to external or third-party testers. They will play the game and provide feedback through questionnaires. The feedback from these questionnaires is invaluable in evaluating the game before it is officially launched. Feedback is obtained through an evaluation process involving respondents using a Google Form questionnaire. A total of 20 questions with a rating scale of 1 to 5 were asked of the respondents, which were then answered and summed up for each set of indicators.

The total score per indicator was obtained by summing up all the answers, and the maximum score was calculated by multiplying the number of questions by the maximum value per question which is 5. The average score was calculated by dividing the total score obtained by the total maximum score, then multiplying by 100 to get a percentage. The following table 3 presents the batik educational game assessment indicators and descriptions:

Table 3. Question Indicator

Indicator	Description
Readability and Comprehensibility of Information	Evaluate how easily the information in the game is understood and remembered.
Responsiveness and Interactivity	Assesses how quickly and easily the player interacts with the game.
Motivation and Attraction	Measuring the game's ability to motivate players to learn about Javanese batik and its appeal.
Battles with NPC Characters	Assess the difficulty and challenge of combat with Non-Player Characters (NPC) and their response to player interaction.
Questions and Randomization	Evaluate the difficulty of the questions and the impact of the randomization algorithm on the game experience.
Educational Benefits and Understanding of Javanese Batik	Assess the extent to which the game helps players understand the concept of Javanese batik and provides educational benefits.
Satisfaction and Game Design	Evaluate player satisfaction and satisfaction with game interface images.

Source: (Research Results, 2024)

Table 3 details the indicator questions used to evaluate the various aspects of the game, ranging from the ease of understanding the information to the player's level of satisfaction with the interface design, providing a basis for measuring the quality and effectiveness of the overall play experience. The following table 4 presents the questions to illustrate the evaluation of the various aspects of the game:

Table 4. Beta Tester Questions

No.	Indicator	Question
1	Readability and Comprehensibility of Information	How easy was it for you to understand the main objective of the game?
2	Readability and Comprehensibility of Information	Is the info in this *game* easy to understand?
3	Readability and Comprehensibility of Information	Is the information you got from this *game* easy toremember?
4	Readability and Comprehensibility of Information	How much clear information about batik did you get afterwinning the battle?
5	Responsiveness and Interactivity	Does the *game* respond quickly when you interact with it?
6	Responsiveness and Interactivity	How easy is it for you to interact with the *game*?
7	Motivation and Attraction	Do you think this *game* can motivate you to learn moreabout Javanese batik?
8	Motivation and Attraction	How exciting do you think this *game will be* to play?
9	Battles with NPC Characters	How difficult do you think the battles between you and non-player characters are?
10	Battles with NPC Characters	To what extent do you think non-player characters provideinteresting challenges in combat?
11	Battles with NPC Characters	To what extent do you think the non-player characters in this *game* respond well to player interactions?
12	Questions and Randomization	What do you think is the difficulty level of the questions inthe crate box?
13	Questions and Randomization	How challenging was it for you to answer the questionsabout batik correctly?
14	Questions and Randomization	To what extent does this game help you understand more about Javanese batik?
15	Questions and Randomization	To what extent does this game help you understand more about Javanese batik?
16	Responsiveness and Interactivity	To what extent does this game help you understand more about Javanese batik?
17	Responsiveness and Interactivity	Do you feel like you got useful information about batik through this game?
18	Satisfaction and Game Design	What do you think of the images and interface of this game?
19	Satisfaction and Game Design	What is your level of satisfaction with the game's diverse features?
20	Satisfaction and Game Design	How satisfied are you overall with the game?

Source: (Research Results, 2024)

Table 4 contains the questions asked to the beta testers to evaluate various aspects of the game, ranging from the ease of understanding the information to the level of satisfaction with the interface design, providing valuable insights to improve and optimize the gaming experience.

In addition, the beta testing stage also involves testing the randomization of questions using the Fisher-Yates Shuffle algorithm and evaluating the behavior of Non-Player Character (NPC) characters controlled by a Finite State Machine (FSM). Testers will assess various aspects, including game quality, difficulty level, ease of access, and game features, and look for bugs to ensure that the game functions properly before reaching the release stage.

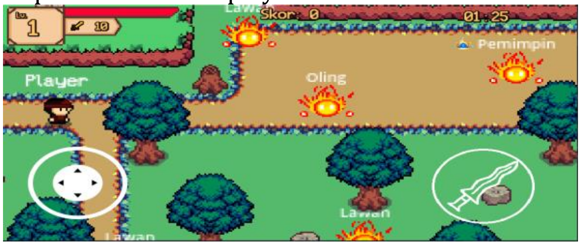
6. Release

After completing the testing stage, the educational game about batik culture will be ready for release. At the release stage, the game will be uploaded to the distribution platform and become available to players.

RESULT AND DISCUSSION

The figure below shows the various views of this game. First, the scene in Figure 3 is a game display that allows players to fight Non-Player Character (NPC). Once the player has defeated the NPC, they will be presented with the scene in Figure 4 which provides information related to batik to enhance their understanding. When the player defeats the NPC Leader, they will enter the scene in Figure 6 which contains a series of questions about batik, providing an opportunity to test the player's knowledge. After answering the questions, their answers are checked, and the correctness of the answers is evaluated.

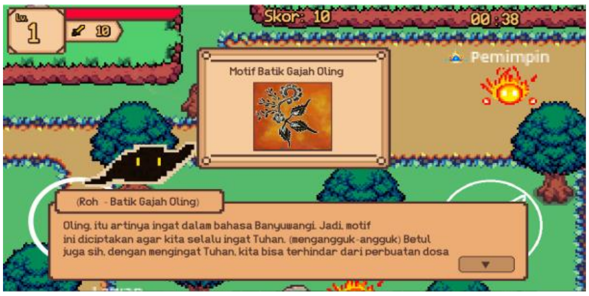
By involving 12 respondents in the beta testing stage in Table 9, the results show a score of 86% expressed an increase in their understanding of batik cultural heritage after playing the game, providing strong evidence that this game is not only entertaining but also manages to educate effectively. In the production stage, the Fisher-Yates Shuffle algorithm was applied to randomize the order of questions in the game, creating significant variations in each game session. Meanwhile, a Finite State Machine (FSM) model was used to control the behavior of the NPC characters, adjusting the NPC responses based on player interactions.



Source: (Research Results, 2024)

Figure 4. Game Display

Figure 4 is a game display that allows players to fight against Non-Player Characters (NPC). After defeating the NPC, players will be presented with the display in Figure 5 which provides information related to batik to increase their understanding.



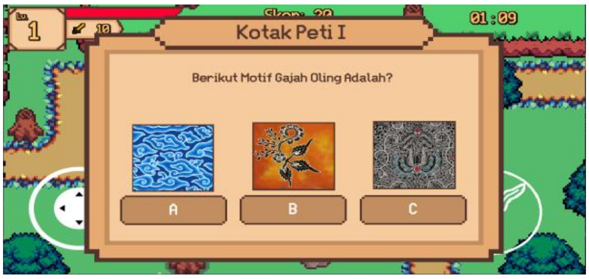
(Roh - Batik Gajah Oling)

Oling, itu artinya ingat dalam bahasa Banyuwangi. Jadi, motif ini diciptakan agar kita selalu ingat Tuhan. (mengangguk-angguk) Betul juga sih, dengan mengingat Tuhan, kita bisa terhindar dari perbuatan dosa

Source: (Research Results, 2024)

Figure 5. Batik Information Display

Figure 6 is a display where the player will enter a series of questions about batik after defeating the NPC Leader, providing an opportunity to test the player's knowledge.



Berikut Motif Gajah Oling Adalah?

Source: (Research Results, 2024)

Figure 6. Question View

Next, in the alpha testing stage, the game was thoroughly tested. Below is Table 5, the results of the testing which includes an evaluation of various aspects of the game:

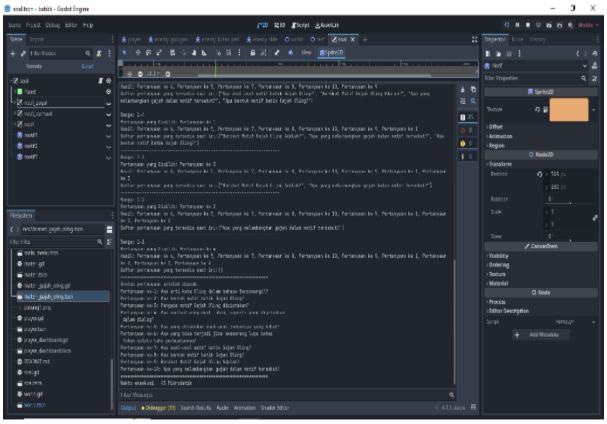
Table 5. Game Feature Testing

No.	Features	Testing	Results
1	Main Menu	Testing access to the game from the main menu	Smoothly, no problems
2	Button Play	Testing the function of the "Play" button to start the game	Button works well
3	Play Scene	Testing the appearance and functionality of the play scene	Display runs well
4	Movement Control Button	Testing the function of character movement control buttons	Movement control works well
5	Attack Control Button	Testing the function of character attack control buttons	Attack control works well
6	NPC Behavior	Testing the behavior of NPC characters	NPC characters behave according to the FSM model
7	Agate Objects	Testing the appearance and function of agate objects	The agate object displays correctly and works well
8	Crate Box Object	Testing the appearance and function of the crate box object	The crate box object appears correctly and works well
9	Scene Material	Testing the appearance and content of the material scene	Batik content is well-displayed
10	Scene Question	Testing the availability of questions in the question scene	Questions appear according to the Fisher-Yates algorithm

No.	Features	Testing	Results
11	Answer Check Scene	Test the player's answer evaluation in the check answer scene	Answers are evaluated correctly
12	Answer Button	Testing the button to answer questions	Question question-answer button works
13	Status Ascension Scene	Testing the player's status upgrade after answering a question	Status upgraded correctly
14	Score	Testing the calculation and display of player scores	Score updated correctly
15	Character Blood	Testing the appearance and change of character blood	Health changes according to game rules
16	Player Power	Testing the appearance and power changes of the the player	Power changes according to game rules

Source: (Research Results, 2024)

Table 5 details the results of testing in-game features, including the main menu access test, control button functionality, NPC character behavior, object display, and question scene. The test results show that all features run well and by the desired game design.



```
Hasil: Pertanyaan ke 6, Pertanyaan ke 5, Pertanyaan ke 7, Pertanyaan ke 8, Pertanyaan ke 10, Pertanyaan ke 9
Daftar pertanyaan yang tersedia saat ini:["Apa asal-usul motif batik Gajah Oling?", "Berikut Motif Gajah Oling Adalah?", "Apa yang melambangkan gajah dalam motif tersebut?", "Apa bentuk motif batik Gajah Oling?"]

Range: 1-4
Pertanyaan yang Dipilih: Pertanyaan ke 1
Hasil: Pertanyaan ke 6, Pertanyaan ke 5, Pertanyaan ke 7, Pertanyaan ke 8, Pertanyaan ke 10, Pertanyaan ke 9, Pertanyaan ke 1
Daftar pertanyaan yang tersedia saat ini:["Berikut Motif Gajah Oling Adalah?", "Apa yang melambangkan gajah dalam motif tersebut?", "Apa bentuk motif batik Gajah Oling?"]
----------------------------------------------------------------
Range: 1-3
Pertanyaan yang Dipilih: Pertanyaan ke 3
Hasil: Pertanyaan ke 6, Pertanyaan ke 5, Pertanyaan ke 7, Pertanyaan ke 8, Pertanyaan ke 10, Pertanyaan ke 9, Pertanyaan ke 1, Pertanyaan ke 3
Daftar pertanyaan yang tersedia saat ini:["Berikut Motif Gajah Oling Adalah?", "Apa yang melambangkan gajah dalam motif tersebut?"]
----------------------------------------------------------------
Range: 1-2
Pertanyaan yang Dipilih: Pertanyaan ke 2
Hasil: Pertanyaan ke 6, Pertanyaan ke 5, Pertanyaan ke 7, Pertanyaan ke 8, Pertanyaan ke 10, Pertanyaan ke 9, Pertanyaan ke 1, Pertanyaan ke 3, Pertanyaan ke 2
Daftar pertanyaan yang tersedia saat ini:["Apa yang melambangkan gajah dalam motif tersebut?"]
----------------------------------------------------------------
Range: 1-1
Pertanyaan yang Dipilih: Pertanyaan ke 4
Hasil: Pertanyaan ke 6, Pertanyaan ke 5, Pertanyaan ke 7, Pertanyaan ke 8, Pertanyaan ke 10, Pertanyaan ke 9, Pertanyaan ke 1, Pertanyaan ke 3, Pertanyaan ke 2, Pertanyaan ke 4
Daftar pertanyaan yang tersedia saat ini:[]
============================================================
Urutan pertanyaan setelah diacak:
Pertanyaan ke-1: Apa arti kata Oling dalam bahasa Banyuwangi??
Pertanyaan ke-2: Apa bentuk motif batik Gajah Oling?
Pertanyaan ke-3: Mengapa motif Gajah Oling diciptakan?
Pertanyaan ke-4: Apa [illegible], seperti yang dijelaskan
 dalam dialog?
Pertanyaan ke-5: Apa yang dilakukan anak-anak Indonesia yang hebat?
Pertanyaan ke-6: Apa yang bisa terjadi jika seseorang lupa bahwa
 Tuhan selalu tahu perbuatannya?
Pertanyaan ke-7: Apa asal-usul motif batik Gajah Oling?
Pertanyaan ke-8: Apa bentuk motif batik Gajah Oling?
Pertanyaan ke-9: Berikut Motif Gajah Oling Adalah?
Pertanyaan ke-10: Apa yang melambangkan gajah dalam motif tersebut?
============================================================
Waktu eksekusi: 45 Mikrodetik
```

Source: (Research Results, 2024)

Figure 7. Fisher-Yates Shuffle Algorithm Test Results

This alpha test allows researchers to identify problems and make improvements before the game is released to the next stage. In Figure 7 above, the test results of the Fisher-Yates Shuffle algorithm are shown, which illustrates the success of the algorithm in performing a random and evenly distributed shuffle of a set of questions on the Godot Engine console. This information will be taken as the basis for testing the algorithm. First, it involves determining the 10 questions that will serve as input for the random permutation. The next step is to set a range for the questions that have not been selected.

Table 7. Execution Time Testing

Randomization	Execution Time (microseconds)
0	3
1	40
10	209
20	292
30	338
40	446
50	700
60	663
70	840
80	1009
90	1070
100	1208

Source: (Research Results, 2024)

Based on the results in Table 8, testing conducted on ten experiments with the Fisher-Yates Shuffle algorithm, the average execution time is 35.6 microseconds. Although there are variations in execution time in each test, the overall results show that the algorithm tends to have stable performance. In the context of randomized questions in each test, the Fisher-Yates Shuffle algorithm managed to provide randomized and balanced results, demonstrating reliability in the randomization process.

Table 8. Testing Execution Time and Randomized Questions

Testing to-	Execution Time	Randomized Questions
1	51	6, 5, 7, 8, 10, 9, 1, 3, 2,4
2	41	7, 4, 9, 6, 10, 8, 2, 1, 3, 5
3	30	2, 8, 5, 9, 4, 1, 10, 7, 3, 6
4	39	5, 9, 3, 1, 8, 7, 2, 10, 6, 4
5	25	6, 2, 9, 1, 8, 4, 7, 3, 10, 5
6	28	5, 9, 2, 7, 1, 3, 8, 10, 6, 4
7	34	6, 3, 1, 9, 7, 4, 10, 8, 2, 5
8	33	5, 9, 1, 3, 7, 2, 6, 8, 10, 4
9	43	6, 3, 8, 1, 9, 2, 5, 7, 10, 4
10	32	6, 2, 8, 1, 5, 9, 7, 3, 10, 4
Average Execution Time		35,6

Source: (Research Results, 2024)

After going through the development and testing stages, the game is ready to undergo beta testing. In this beta testing stage, the game will be given to external testers or game testers. These testers will play the game and provide feedback, this is very valuable in evaluating the game before it is officially released. Based on the results of the beta stage testing, there were 12 general public respondents as testers. The results of the beta stage answers after playing the game can be seen in Table 9 below:

Table 9. Beta Testing Results

No.	Indicator	Question	Total Score	Total Maximum Score	Percentage
1	Readability and Comprehensibility of Information	How easy was it for you to understand themain objective of the *game*?	52	60	86.67
2	Readability and Comprehensibility of Information	Is the info in this *game* easy to understand?	52	60	86.67
3	Readability and Comprehensibility of Information	Is the information you got from this *game* easy to remember?	51	60	85.00
4	Readability and Comprehensibility of Information	How much clear information about batik didyou get after winning the battle?	52	60	86.67
5	Responsiveness and Interactivity	Does the *game* respond quickly when youinteract with it?	52	60	86.67
6	Responsiveness and Interactivity	How easy is it for you to interact with the *game*?	52	60	86.67
7	Motivation and Attraction	Do you think this *game* can motivate you tolearn more about Javanese batik?	52	60	86.67
8	Motivation and Attraction	How exciting do you think this *game will be* toplay?	52	60	86.67
9	Battles with NPCCharacters	How difficult do you think the battles betweenyou and non-player characters are?	53	60	88.33
10	Battles with NPCCharacters	To what extent do you think non-player characters provide interesting challenges in combat?	52	60	86.67
11	Battles with NPCCharacters	To what extent do you think the non-player characters in this *game* respond well to playerinteractions?	53	60	88.33
12	Questions and Randomization	What do you think is the difficulty level of thequestions in the crate box?	53	60	88.33
13	Questions and Randomization	How challenging was it for you to answer the questions about batik correctly?	53	60	88.33
14	Questions and Randomization	Do you feel that randomization technology makes the gaming experience more engaging?	51	60	85.00
15	Questions and Randomization	To what extent do you think randomization technology affects the difficulty of the questions?	51	60	85.00
16	Responsiveness and Interactivity	To what extent does this *game* help youunderstand more about Javanese batik?	51	60	85.00
17	Responsiveness and Interactivity	Do you feel like you got useful information about batik through this *game*?	52	60	86.67
18	Satisfaction and *Game* Design	What do you think of the images and interfaceof this *game*?	51	60	85.00
19	Satisfaction and *Game* Design	What is your level of satisfaction with the *game's* diverse features?	51	60	85.00
20	Satisfaction and *Game* Design	How satisfied are you overall with the *game*?	53	60	88.33

Source: (Research Results, 2024)

Table 9 displays the results of the beta testing stage with indicators including readability, responsiveness, motivation, combat with NPC characters, questions and randomization, educational benefits, and satisfaction with game design. The evaluation results showed a good level of game readiness, with an average score percentage of 86.33%, indicating a positive response from the beta testers.

Next, in each indicator, the score obtained on the batik educational game assessment is calculated by averaging the total score of the questions included in each indicator. Thus, each indicator has an average score that reflects the respondents' level of success or satisfaction with a specific aspect of the game. Below is Table 10 with the average score for each indicator:

Table 10. Assessment of Batik Educational Games

Indicator	Score
Readability and Comprehensibility of Information	86
Responsiveness and Interactivity	87
Motivation and Attractiveness	87
Battles with NPC Characters	88
Questions and Randomization	87
Educational Benefits and Understanding of Javanese Batik	86
Satisfaction and Game Design	86
Average	87

Source: (Research Results, 2024)

In Table 10, the indicator scores show consistent and positive results for each aspect assessed in the game. The scores, averaging 87%, indicate that the game is of good quality in terms of information readability, responsiveness, player motivation, combat experience, educational benefits, batik-related satisfaction, and game design. Overall, the evaluation of the indicators shows that the game has successfully achieved the goal of presenting an interesting, educational, and satisfying experience for its players.

CONCLUSION

The development of the educational game on Indonesian batik followed a systematic approach, employing the Game Development Life Cycle (GDLC) methodology to ensure a high-quality end product. From the conceptualization stage to beta testing, each phase was meticulously executed, integrating elements of batik culture with Android gaming mechanics. Utilizing tools like the Godot Engine and algorithms such as the Fisher-Yates Shuffle and Finite State Machine (FSM) model enhanced gameplay dynamics and question randomization, contributing to a satisfying player experience.

Beta testing affirmed the success of the game, with an average score of 87% indicating strong performance across various metrics including educational value and player satisfaction. Furthermore, performance testing of the Fisher-Yates Shuffle algorithm demonstrated consistent execution times and reliable question randomization, underscoring its effectiveness in ensuring balanced gameplay experiences. Moving forward, the game's sustainability and improvement remain ongoing pursuits, with future developments potentially including content updates, additional levels, and aesthetic enhancements to further engage players and enhance overall appeal.

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