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The Development of Kuih Escapade 3D Interactive PC Game Application

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Abstract

The young generation nowadays is losing interest in preparing traditional kuih. Existing exploration video games lack local content, and there are limited interactive learning applications to promote awareness and understanding of traditional Malaysian kuih. Therefore, the project developed a 3D interactive PC game, "Kuih Escapade", which provides players, specifically youth aged 15 to 25, a first-person perspective for exploring various traditional kuih within a mysterious apartment. It integrates hidden object gamification, storytelling, and interactive challenges to enhance user engagement. Using an Agile methodology, the project conducted functional testing, confirming that all game features functioned as intended. User acceptance testing results indicated that Kuih Escapade achieved all its objectives, achieving a positive test score of 86.375, equivalent to an "A" grade on the SUS scale. Thus, Kuih Escapade has been successfully developed as a fully functional interactive platform for users to explore the cultural heritage of traditional Malaysian kuih in a modern setting.

1. Introduction

In Malaysia, traditional Malay and Nyonya kuih [1] represent a significant part of the country's culinary traditions, reflecting its rich cultural diversity. "Kuih" [2] is a Malay term generally used to describe Malay traditional desserts. Based on the studies, nowadays the young generation's understanding of traditional Malaysian kuih [3] primarily relies on traditional methods, which are passed down verbally within families and communities. However, this knowledge transfer between generations is becoming less effective and accessible to a wider audience, especially for those outside the immediate cultural circle [4]. Therefore, developing modern technology or learning software related to traditional Malaysian kuih is significantly important for promoting awareness among the young generations.

In this era of modernization and globalization, PC games have become increasingly popular among the young generations. A PC-based game application [5] is a video game specifically designed for personal computers (PCs), covering a wide range of gaming genres, from action and adventure to simulation and strategy. Research indicates that PC games are effective educational tools that have the potential to engage and motivate players in the learning process [6].

The young generation nowadays is losing interest in preparing traditional kuih, especially living in this era of modernization [7]. Existing video games lack local content, limiting the exploration of cultural foods like traditional Malaysian kuih. Interactive learning tools for traditional kuih are also limited. Recognizing the importance of developing modern technology or learning software related to traditional Malaysian kuih to promote awareness among the young generations, a PC-based game named "Kuih Escapade" is proposed.

The objectives of this proposed game are to design a Kuih Escapade PC-based game application using a game approach, to develop a 3D adventure video game by implementing a first-person character controller with elements of exploration and hidden object gameplay on Kuih Escapade, and to perform alpha and beta testing on the developed game application for target users, who are youth aged between 15 and 25. The subject matter expert (SME) participating in this project is Teacher Seow Yim Ho, with 20 years of teaching expertise at Avenue Creative Learning, Ipoh, Perak. "Kuih Escapade" is an English-language interactive PC game that includes a narrative requiring players to search for all hidden traditional Malaysian kuih while completing various in-game challenges to escape from an apartment. A kuih collection book is implemented as a progression system that allows players to keep track of how many kuih they have found and those yet to be discovered.

The proposed game consists of two main modules, which are the learning module and the interactivity activity module. The kuih collection book in the learning module provides players with information on each kuih they discover, including names, ingredients, and preparation methods. Interactive activity modules, such as hidden object searching, puzzle-solving, and keypad passcode unlocking increase the complexity of the game and enhance the gaming experience. The character controller is expected to handle players' basic movements, while smooth camera movement and object interaction mechanics allow players to navigate and manipulate objects within the apartment. Proper collision detection is implemented to ensure realistic interactions. Storytelling and immersive audio are also integrated to set the context for the adventure. Lastly, repetitive testing and optimization will be conducted repeatedly to ensure that the proposed game is fully functional and free of bugs and issues.

The paper structure includes Section 2, which discusses the study domain, the technology used, and a comparison between the reviewed existing applications with the proposed application. Section 3 covers the Agile methodology and the output of analysis and design involved in project development. Moreover, Section 4 describes the result and discussion of the study, followed by the conclusion in Section 5.

2. Related Work

In this section, the study domain, the technology used, and a comparison between the reviewed existing applications with the proposed application are discussed.

2.1 Traditional Malaysian Kuih

Malaysian food, particularly Kuih [8] is a special type of cuisine that mix of Asian and Western influences. It is originated with the Peranakan or Nyonya people who brought Chinese customs to Malaysia and made the first kuih recipes by integrating them with the local language, religion, and food. Even though the term "kuih" comes from China, the flavours are distinctly Malay and Indonesian.

Knowledge about traditional kuih is primarily passed down through oral communication, direct practical experience, and observational learning [9]. Other than that, TV shows, online videos, and cooking demonstrations also provide cultural knowledge about kuih. For example, TV9 organized cooking classes for young kids to teach them how to make traditional kuih [10]. This hands-on approach not only teaches practical skills but also encourages audiences to understand the cultural value of these dishes.

2.2 PC-Based Game

A PC-based game, also known as a computer game [11] is a type of entertainment that combines interactive software, storytelling, and rule-based structures that are played on personal computers (PCs). These games come in a wide range of genres and are available on platforms like gaming websites, app stores, and physical stores. The four main categories of PC-based games are sports games, shooting games, role-playing games, and strategy games [12].

In today's world, playing computer games has become a common social phenomenon, especially among the younger generations. The increase in popularity is mostly due to PC games are typically combined with other audio and video media [13]. These interactive digital experiences have a significant impact on how young generations spend their time as they grow up. Research has shown that PC-based games not only serve as entertainment but also as educational tools, developing players' cognitive, affective, and psychomotor skills [14]. Thus, PC games have significant educational value that can be designed to educate players on various subjects.

The entertainment aspect of PC games can serve as a gateway to learning, as engaging and enjoyable games encourage players to immerse themselves in the subject matter. For example, an educational game like Thrive [15] encourages players to learn about biology through the utilization of actual compounds and organelles based on scientific principles. Besides, PC Building Simulator [16] provides step-by-step instructions, guiding players through identifying computer components, understanding their functions, and constructing customized PCs with real-world components. Additionally, Kerbal Space Program 2 [17] is a famous computer game that engages players by allowing them to explore the solar system, build bases, and construct space stations.

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2.3 Comparison between Reviewed Applications with the Proposed Application

In this section, there are three existing applications relevant to the study on traditional kuih or first-person exploration will be reviewed which are What Never Was [18], Kuih Spotter [19], and KRAYA – Game Kuih Raya 2023 [20]. Figure 1 presents the main interface of the three existing applications while Table 1 outlines the result of the comparative analysis.

Based on Table 1, What Never Was is a 3D PC game compatible with Windows, Mac, and Linux, while Kuih Spotter and KRAYA – Game Kuih Raya 2023 are 2D mobile applications only compatible with Android. Kuih Escapade, on the other hand, is a 3D PC game that supports Windows. In terms of strengths, Kuih Escapade provides larger opportunities for exploration experiences within a multi-room apartment setting with several floors compared to What Never Was, which focuses primarily on storytelling with minimal interactivity within a small attic. In contrast to Kuih Spotter, which lacks interactive features and uses a simple interface without multimedia elements like audio, animation, and video, Kuih Escapade provides immersive gaming experiences by integrating narrative elements, exploration, and interactive challenges. Additionally, Kuih Escapade provides not only identification but also detailed information about each discovered kuih. Moreover, three applications, including Kuih Escapade, do not have in-game advertisements except KRAYA – Game Kuih Raya 2023 which has constant in-game advertisements that disrupt the flow of gameplay and reduce the overall user experience.

(a)

(b)

(c)

Fig. 1 *Existing applications (a) What Never Was; (b) Kuih Spotter; (c) KRAYA – Game Kuih Raya 2023*

Table 1 *Comparison table between reviewed applications with the proposed application*

Element	What Never Was	Kuih Spotter	KRAYA – Game Kuih Raya 2023	Kuih Escapade
Platform	Windows, Mac, Linux	Android	Android	Windows
Technology	PC Game	Mobile Application	Mobile Game	PC Game
Graphics style	3D	2D	2D	3D
Audio	Yes	No	Yes	Yes
Game genres	First-person exploration, puzzle-solving	None	Educational, simulation	First-person exploration, hidden object, puzzle-solving
Content focus	Family history	None	Educational, simulation	First-person exploration, hidden object, puzzle-solving
Narrative theme	Uncovering mysteries of family's past	Not applicable	Hari Raya Festival preparation	Mysterious escape in a Malaysian dessert chef's apartment through kuih discovery
Modules provided	Narrative elements, character controller, puzzle-solving, progression system	Image recognition algorithm	Narrative elements, recipe guides, cooking simulation, interactive gameplay	Narrative elements, character controller, hidden object searching, interactive challenges, progression system
Interactivity	Minimal	None	High	High
Advertisement	None	None	Constant in-game advertisements that disrupt the gameplay	None

3. Methodology

In this project, an Agile approach is chosen as the methodology. The Agile model is a flexible and iterative approach that divides projects into several dynamic phases called sprints [21]. The reason why agile is used in the development of the project is that it provides effectiveness in creating better-quality games that can adapt to changes and undergo continuous improvement without disrupting the flow of a project [1]. Based on Figure 2, Agile methodology breaks down the project into 6 phases which are requirements analysis phase, design phase, develop phase, testing phase, deployment phase and review phase [23]. The phases may be repeated until the final product is delivered.

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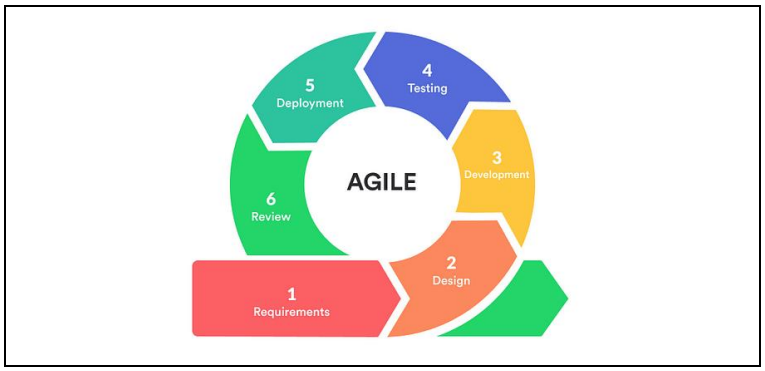


Fig. 2 *Agile Model [24]*

3.1 Requirements Analysis Phase

The requirements analysis phase is the first phase, commonly known as the project's initiation. In this stage, the initial requirements for the proposed application "Kuih Escapade" by identifying the problem statement, objectives, project scope, project significance, and expected result. In this project, there are two information gathering methods are involved. Firstly, an interview was conducted with the Subject Matter Expert (SME), Ms. Seow Yim Ho to gather information and suggestions regarding user requirements for the development of the proposed game.

Additionally, a questionnaire was created using Google Forms and distributed to respondents from the targeted audience. The questionnaire consisted of three sections, which are demographics, knowledge about Malaysian cultures, and gaming preferences, with a total of 16 questions. A total of 32 responses from respondents aged between 15 and 25 are collected.

In summary, 13 respondents (40.6%) were interested in Malaysian culture, while 34.4% were not very familiar with traditional Malaysian kuih. The data shows that 50% of respondents felt not confident at all in preparing traditional kuih independently. Regarding gaming habits, a majority (62.5%) preferred playing games on their personal computers. Action and adventure games were the most popular genres with 56.3% of respondents enjoying each of these genres. Additionally, 84.4% of respondents preferred games with interactive challenges, and 81.3% preferred games featuring narrative elements. The results of the user analysis are tabulated in Table 2.

Table 2 *User Requirements Analysis*

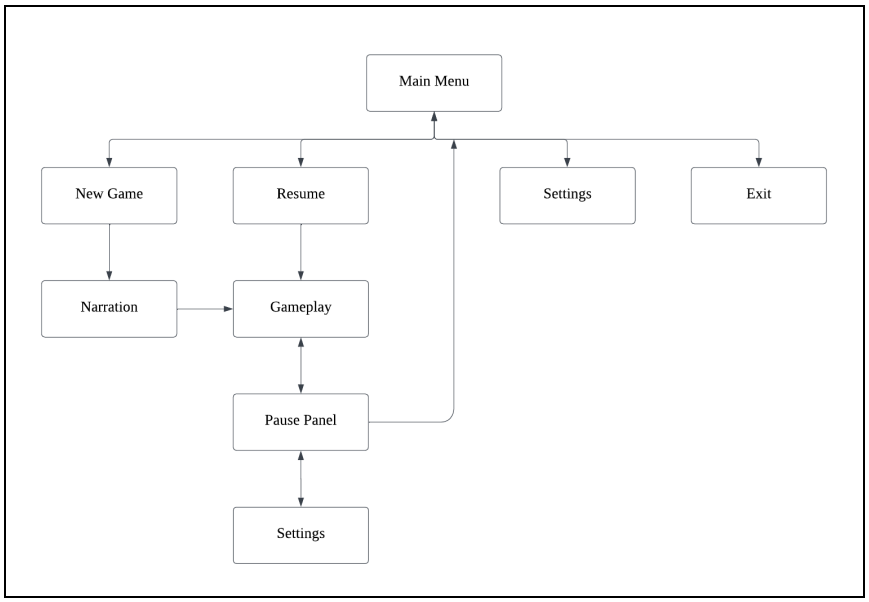
Information Gathering Method	Role in the Project	Design Implications	Actions required
Interview with Subject Matter Expert (SME)	Content consultant expert in educational	User-friendly interface	• Design a simple interface for easy navigation between game sections. • Use clearly labelled buttons within the main menu, settings, and pause menu.
		Educational components	• Provide detailed information about each kuih in the kuih collection book, including the kuih's name, image, description, list of ingredients, and preparation methods.
		Cultural authenticity	• Ensure the accuracy in representations of each kuih's appearance, ingredients, and preparation methods.
		Audio integration	• Integrate immersive audio elements such as background music and narrations.

Table 2 *User requirements analysis (continued)*

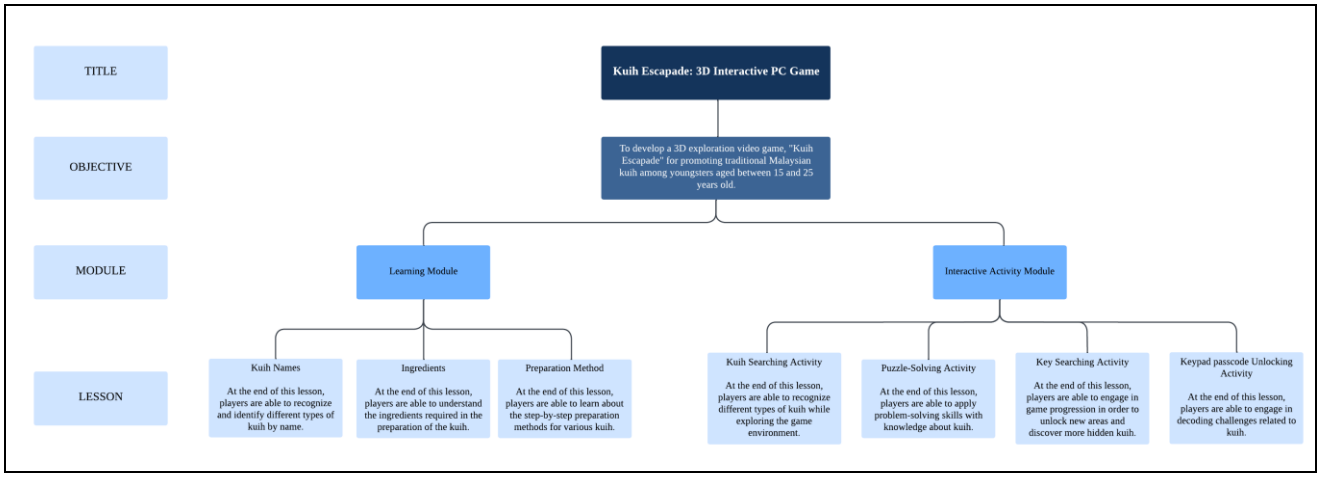
Information Gathering Method	Role in the Project	Design Implications	Actions required
Collect questionnaire responses from 32 respondents	Targeted audiences of the proposed application	Interactivity	• Integrate a variety of interactive challenges such as puzzle-solving related to kuih.
		Narrative elements	• Design a storyline related to kuih. • Implement dialogues and voice-overs for the narration.

3.2 Design Phase

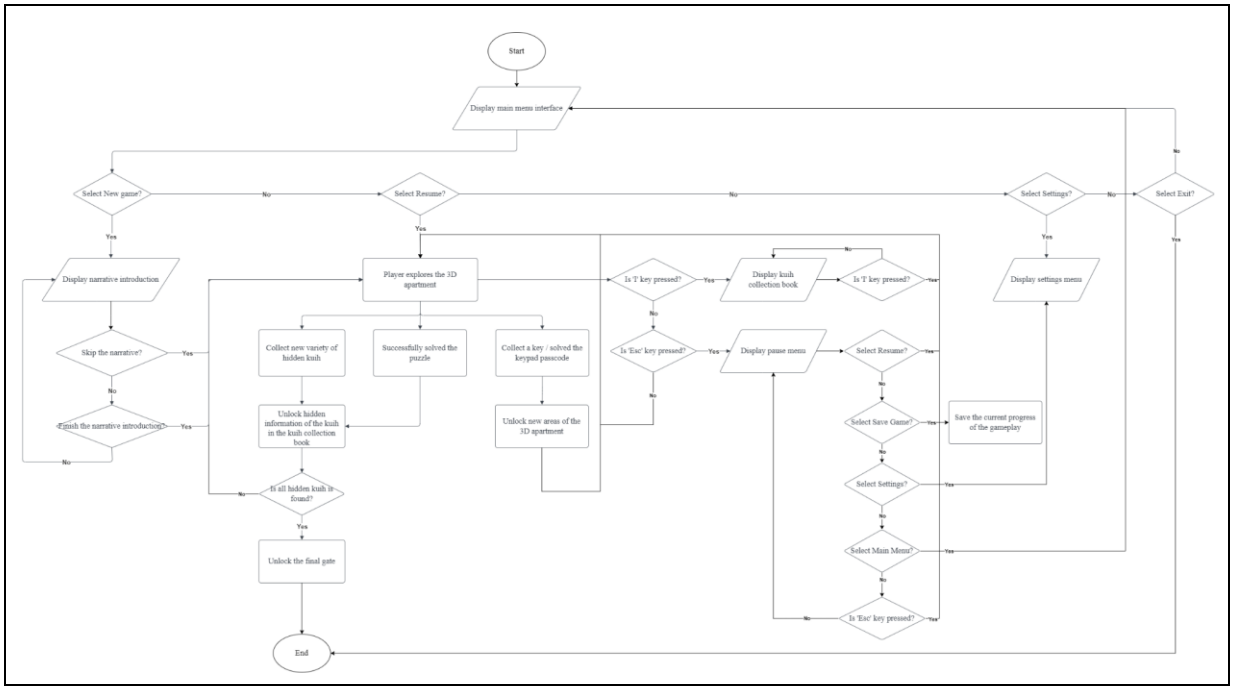
In the design phase of the Agile development cycle, the architecture and structure of the proposed game "Kuih Escapade" are illustrated. This includes designing the navigation structure, content structure, and system flowchart of the game presented respectively in Figure 4(a), Figure 4(b) and Figure 4(c).



(a)



(b)



(c)

Fig. 4 *(a) Navigation structure; (b) Content structure; (c) System flowchart*

On the other hand, the functional requirements and non-functional requirements are analyzed and tabulated in Table 3 and Table 4 respectively.

Table 3 *Functional Requirements*

Functional Requirements	Description
Autonomous	• Once the game is launched, the background music should automatically start playing. • The main menu interface should appear once the game is launched.
User Interface	• The user-friendly interface should feature clearly labelled buttons within the main menu, settings, and pause menu. • The interface should allow easy navigation between different game sections.
Interactivity	• The game should integrate interactive elements to encourage player engagement, such as hidden object mechanics and various mini-games related to *kuih*. • The game should develop interactive mechanics for objects such as keys and *kuih* by allowing players to click and collect them in order to progress through the game.
Character Movement Controls	• The game should implement smooth and responsive character movement controls that enable players to explore the 3D apartment.
Audio Integration	• The background music and narration should be integrated into the game.
Game Progression System	• A progression system based on *kuih* collection should be implemented by allowing players to unlock information about each *kuih* in the *kuih* collection book as they explore and find them in the 3D apartment.
Puzzle-Solving Mechanics	• The game should integrate basic puzzle-solving mechanics within the game to add variety and challenge to the gameplay.

Table 4 *Non-functional requirements*

Non-functional Requirements	Description
Performance	• The game should run smoothly across a range of PC hardware configurations without crashing. • The game should maintain a stable frame rate of at least 30 frames per second (FPS) when running on systems that meet the minimum requirements. • The screen loading duration between different game sections should be optimized to provide efficient scene navigation and reduce waiting periods for players.
Compatibility	• The game should be compatible with various Windows operating systems with Windows 7 and newer versions.
Usability	• The controls of the game such as character movements and object interactions should be highly responsive. • The game should provide clear and easily accessible instructions, including key binding information.
Reliability	• The game should operate with stability by minimizing unexpected terminations or crashes during gameplay. • Players' progress should be saved consistently through the save feature to avoid the loss of game data after exiting the game application.

During the prototyping stage, the game's graphics are initially sketched using Sketchbook on iPad and refined using Figma to create high-fidelity storyboards and UI elements. The button design and interface design are detailed in Table 5 and Table 6 respectively.

Furthermore, various tools are used to develop key assets such as 3D models, graphics, and audio. Blender was the primary tool for modelling traditional kuih models, materials, ingredients and so on. Table 7 presents the 3D models of traditional Malaysian kuih created using Blender. Additionally, 40 audio files, including background music, sound effects, and narration voiceovers are sourced from Pixabay and Zapsplat or generated using Voicemaker, with final editing completed using CapCut before integrating into Unity.

Table 5 *Button Design of Kuih Escapade*

Button	Description	Button	Description
NEW GAME	This is a new game button.	OK	This is the ok button in the settings menu that saves the changes made in the settings menu.
RESUME	This is a resume button.	Click to fast forward	This is a clickable text in the narration interface that allows the player to skip or fast forward through the narrative.
SETTINGS	This is the settings button.	RESUME	This is the resume button in the pause menu.
EXIT	This is the exit button.	SAVE GAME	This is the save game button in the pause menu.
GENERAL	This is the general button in the settings menu.	SETTINGS	This is the settings button in the pause menu.
CONTROLS	This is the controls button in the settings menu.	MAIN MENU	This is the main menu button in the pause menu.
GRAPHICS	This is the graphics button in the settings menu.		This is a clickable right arrow in the kuih collection book that allows the player to navigate to the next page.
AUDIO	This is the audio button in the settings menu.		This is a clickable left arrow in the kuih collection book that allows the player to navigate to the previous page.

Table 6 *Interface Design of Kuih Escapade*

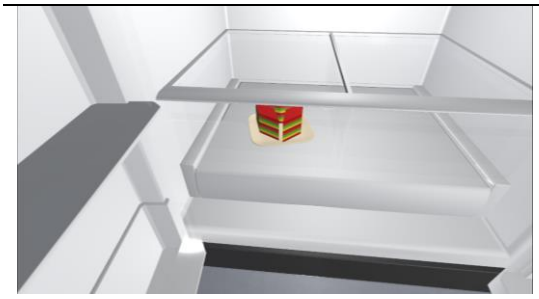
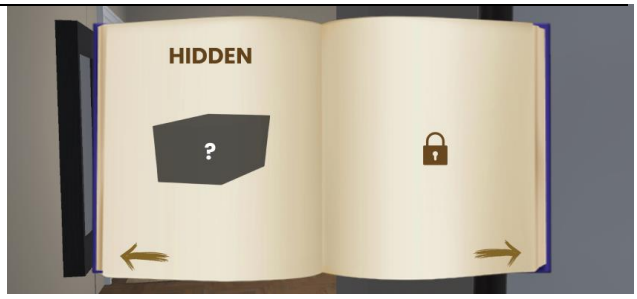
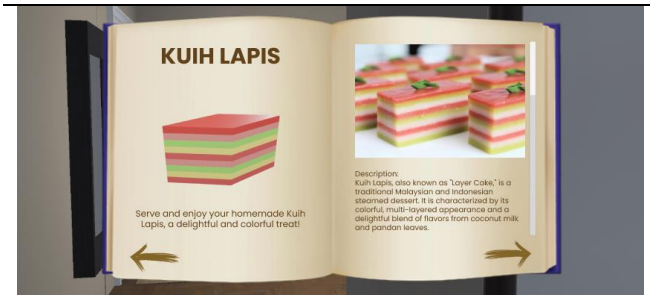
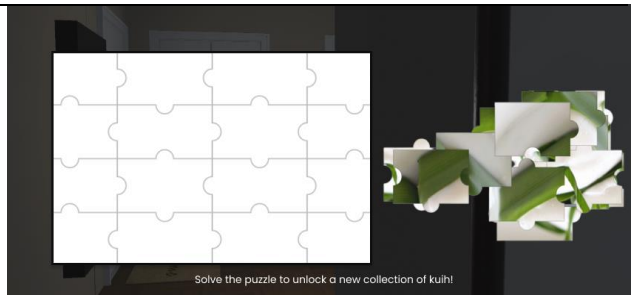
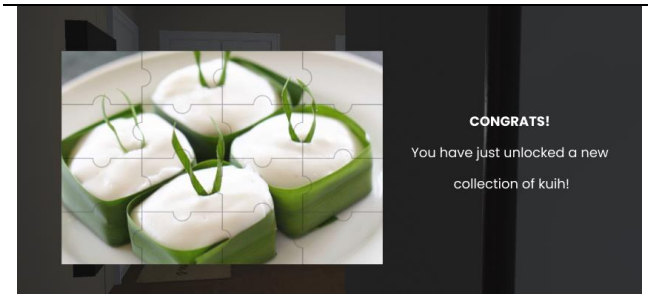
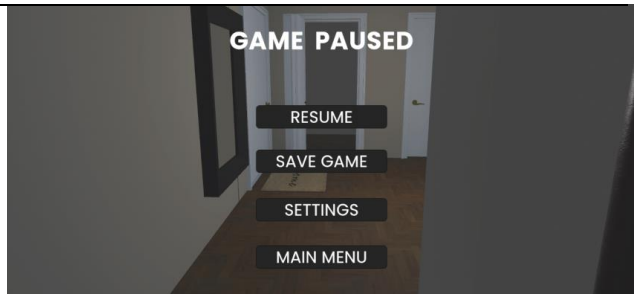
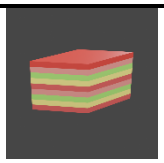
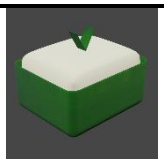
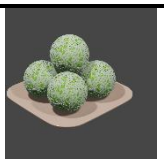
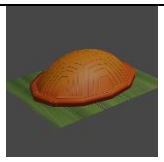
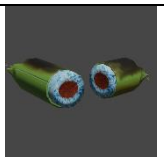
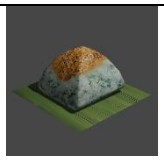
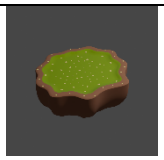
Interface	Interface
	
This is the main menu of Kuih Escapade.	This is the settings menu when the player selects the "Settings" button in the main menu.
	
This is the gameplay interface where players are allowed to click on the kuih they encounter to collect it.	This is the kuih collection book before the player collects the kuih. It is accessible when the player presses the 'I' key.
	
This is the kuih collection book after the player collects the kuih, the detailed information will be unlocked and displayed.	This is the puzzle game interface before the player has solved it.
	
This is the puzzle game interface after the player has solved it.	This is the pause menu accessible when the player presses the 'Esc' key during gameplay.

Table 7 *3D models of traditional Malaysian kuih*

3D models	Name	3D models	Name	3D Models	Name
	Kuih Lapis		Kuih Tako		Onde-onde
	Angku Kuih		Karipap		Pulut Undang
	Pulut Inti		Kuih Ketayap		Bika Ambon
	Kuih Kukus		Kuih Puteri Ayu		Kuih Lumpur
	Kuih Bakar				

3.3 Develop Phase

The development phase, also known as the iteration phase, is where coding is essential to turn all the requirements and design documentation into an actual product. This critical phase involves writing code for the implementation of specific features such as character movement controls, interactive gameplay scripts, user interfaces, in-game challenges, audio integration, and progression systems. The programming language used is mainly C#, written in the software program called Visual Studio Code. Table 8 describes the integration of several functions like player movement and control, object interactions, and game logic within Unity using C# scripting.

Table 8 *Integration within Unity using C# Scripting*

Functions	C# Script	Description

Player Movement and Controls (PlayerMotor.cs)	void Update(){
	isGrounded = controller.isGrounded;
	}
	public void ProcessMove(Vector2 input){
	Vector3 moveDirection = Vector3.zero;
	moveDirection.x = input.x;
	moveDirection.z = input.y;
	isWalking = (input.magnitude > 0);
	controller.Move(transform.TransformDirection(moveDirection)* currentSpeed* Time.deltaTime);
	playerVelocity.y += gravity * Time.deltaTime;
	if (isGrounded && playerVelocity.y < 0)
	playerVelocity.y = -2f;
	controller.Move(playerVelocity * Time.deltaTime);
	}
	public void Jump(){
	if (isGrounded) {
	playerVelocity.y = Mathf.Sqrt (jumpHeight * -3.0f * gravity);
	}
	}
	public void SetSpeed (float speed) {
	currentSpeed = speed;
	}
		The code snippet of PlayerMotor.cs script that controls the player's movement and actions within the game by utilizing Unity's Character Controller to handle movement and physics. It includes methods to process player input for movement, apply gravity, manage jumping and adjust the player's speed.

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Table 8 *Integration within Unity using C# Scripting (continued)*

Functions	C# Script	Description

Player Movement and Controls (PlayerController.cs)	`void Awake(){`
	`  playerControls = new PlayerControls();`
	`  playerActions = playerControls.Player;`
	`  motor = GetComponent<PlayerMotor>();`
	`  playerActions.Jump.performed += ctx => motor.Jump();`
	`  playerActions.Sprint.started += ctx => StartSprinting();`
	`  playerActions.Sprint.canceled += ctx => StopSprinting();`
	`}`
	`private void StartSprinting(){`
	`  isSprinting = true;`
	`  motor.SetSpeed(isSprinting ? sprintSpeed : motor.defaultSpeed);`
	`}`
	`private void StopSprinting(){`
	`  isSprinting = false;`
	`  motor.SetSpeed(isSprinting ? sprintSpeed : motor.defaultSpeed);`
	`}`
	`void FixedUpdate(){`
	`  motor.ProcessMove(playerActions.Move.ReadValue<Vector2>());`
	`}`
		The code snippet of PlayerController.cs script which is responsible for managing player input using Unity's Input System. This script handles various player actions such as movement, jumping, and sprinting. It sets up input events, processes movement inputs, and adjusts the player's speed for sprinting by calling methods in PlayerMotor.cs script.

Interactions with kuih (CollectAngku.cs)	`private void OnMouseDown(){`
	`  gameObject.SetActive(false);`
	`  kuihStatus = true;`
	`  finalGate.totalFound ++;`
	`  if (finalGate.totalFound < 13){`
	`  audioS9.Play();`
	`  textMeshPro.text = "Whooo! Another addition to my growing kuih collection. This journey just got a whole lot sweeter.";`
	`  Invoke("ClearTextAfterDelay", 7f);`
	`  }`
	`  else{`
	`  audioS12.Play();`
	`  textMeshPro.text = "There it is, the final piece of kuih.";`
	`  Invoke("ClearTextAfterDelay", 4f);`
	`  }`
	`  kuihPanel.SetActive (true);`
	`  kuihAnimation.CollectKuih();`
	`}`
		The code snippet of CollectAngku.cs which is responsible for enabling players to interact and collect kuih objects in the game environment, handling kuih collection status, triggering narration voiceovers, and displaying narration text.

Interactions with key (CollectKey1.cs)	`private void OnMouseDown(){`
	`  UnlockDoor doorScript = FindObjectOfType<UnlockDoor>();`
	`  gameObject.SetActive(false);`
	`  doorScript.unlockDoor();`
	`  key1status = true;`
	`}`
		The code snippet of CollectKey1.cs which allows players to obtain keys necessary for unlocking doors and triggers door unlocking events upon key collection.

Interactions with doors (UnlockDoor.cs)	`public void unlockDoor(){`
	`  locked = false;`
	`  audioS3.Play();`
	`  textMeshPro.text = "I found a key. I wonder if this can unlock the door.";`
	`  Invoke("ClearTextAfterDelay", 4f);`
	`}`
	`void OnMouseOver(){`
	`  if (Player){`
	`  float dist = Vector3.Distance(Player.position, transform.position);`
	`  if (dist < 15) {`
	`  if (open == false && !locked){`
	`  if (Input.GetMouseButtonDown(0)){`
	`  StartCoroutine(opening());`
	`  doorunlocked.Play();`
	`  }`
	`  }`
	`  else if (locked == true){`
	`  if (Input.GetMouseButtonDown(0)){`
	`  doorlocked.Play();`
	`  audioS2.Play();`
	`  textMeshPro.text = "The door is locked. I have to find a way out.";`
	`  Invoke("ClearTextAfterDelay", 3.5f);`
	`  }`
	`  }`
	`  else{`
	`  if (open == true) {`
	`  if (Input.GetMouseButtonDown(0)){`
	`  StartCoroutine(closing());`
	`  }`
	`  }`
	`  }`
	`  }`
	`  }`
	`}`
	`IEnumerator opening(){`
	`  openandclose.Play("Opening");`
	`  open = true;`
	`  yield return new WaitForSeconds(.5f);`
	`}`
	`IEnumerator closing(){`
	`  openandclose.Play("Closing");`
	`  open = false;`
	`  yield return new WaitForSeconds(.5f);`
	`}`
		The code snippet of UnlockDoor.cs which manages door interaction by checking for locking status and handling door animations while providing audio feedback and text prompts to inform players about door status.

Table 8 *Integration within Unity using C# Scripting (continued)*

Functions	C# Script	Description

Puzzle mechanics (DragAndDrop_.cs)	`void Update(){`
	`  if (Input.GetMouseButtonDown(0)) {`
	`  RaycastHit2D hit = Physics2D.Raycast(Camera.main.ScreenToWorldPoint(Input.mousePosition), Vector2.zero);`
	`  if (hit.transform.CompareTag("Puzzle")){`
	`  if (!hit.transform.GetComponent<piceseScript>().InRightPosition) {`
	`  SelectedPiece = hit.transform.gameObject;`
	`  SelectedPiece.GetComponent<piceseScript>().Selected = true;`
	`  SelectedPiece.GetComponent<SortingGroup>().sortingOrder = OIL;`
	`  OIL++;`
	`  dragsfx.Play();`
	`  }`
	`  }`
	`  }`
	`  if (Input.GetMouseButtonUp(0)) {`
	`  SelectedPiece.GetComponent<piceseScript>().Selected = false;`
	`  SelectedPiece = null;`
	`  dropsfx.Play();`
	`  }`
	`  if (SelectedPiece != null) {`
	`  Vector3 MousePoint = Camera.main.ScreenToWorldPoint(Input.mousePosition);`
	`  SelectedPiece.transform.position = new Vector3(MousePoint.x,MousePoint.y,0);`
	`  }`
	`  if (PlacedPieces == 36) {`
	`  EndMenu.SetActive(true);`
	`  showHint.SetActive (false);`
	`  title.SetActive (false);`
	`  if (!victorySoundPlayed){`
	`  victorysfx.Play();`
	`  victorySoundPlayed = true;`
	`  }`
	`  PlayerPrefs.SetInt("IsKuihTakoFound", 1);`
	`  }`
	`}`
		The code snippet of DragAndDrop_.cs script that handles the functionality for dragging and dropping puzzle pieces, managing the game's state as pieces are placed correctly, and triggering events upon the puzzle's completion. It also includes sound effects for interactive feedback and methods to handle game progression.

Spot the difference game mechanics (SpotDiff.cs)	`public void foundDiff(){`
	`  differencesFound++;`
	`  correctsfx.Play();`
	`  if (differencesFound <= mag.Length){`
	`  mag[differencesFound - 1].SetActive(true);`
	`  }`
	`}`
	`void Update(){`
	`  if (differencesFound >= totalDifferences){`
	`  panel.SetActive(true);`
	`  if (!victorySoundPlayed){`
	`  victorysfx.Play();`
	`  victorySoundPlayed = true;`
	`  }`
	`  PlayerPrefs.SetInt("IsKuihKetayapFound", 1);`
	`  }`
	`}`
	`public void ResumeGame(){`
	`  SceneManager.LoadScene("Apartment");`
	`  PlayerPrefs.SetInt("IsResumed", 1);`
	`  if (PlayerPrefs.GetInt("IsKuihKetayapFound") == 1) {`
	`  int totalFound = PlayerPrefs.GetInt("TotalFound", 0);`
	`  totalFound++;`
	`  PlayerPrefs.SetInt("TotalFound", totalFound);`
	`  }`
	`  PlayerPrefs.Save();`
	`}`
		The code snippet of SpotDiff.cs script which is responsible for managing the core mechanics of the game, including tracking found differences, updating the game state and handling sound effects to enhance player feedback.

3.4 Testing Phase

The testing phase is the most vital phase in the Agile methodology in which a couple of tests are conducted to ensure the code is free from bugs and errors. During the testing phase, alpha and beta testing are conducted to ensure the functionality, usability, and performance of the game. Functional testing is conducted to verify that all aspects of the game work well as expected. Moreover, User Acceptance Testing (UAT) is conducted using the System Usability Scale (SUS) with target users to validate that the application meets user requirements before finalizing the production of the game application. Any bugs and issues identified during this phase will be solved promptly. Regular testing cycles ensure that the game remains stable, and any necessary adjustments are integrated into subsequent sprints.

3.5 Deployment Phase

The deployment phase in Agile involves releasing the game after testing and fixing all defined bugs. In this phase, the early access version is finalized and distributed to a selected group of the target audience to gather user feedback. User feedback collected during this phase is crucial for refining and further improvements of the game. After confirming all features functioned as intended, the final build of Kuih Escapade is created as a Windows package and uploaded to Google Drive for public access.

3.6 Review Phase

In the Agile methodology, the final phase known as the review phase, is where the entire development process will be reflected in evaluating the success of the development process and implemented features. This phase involved reflecting on user feedback collected from user acceptance testing (UAT) to identify areas for improvement and finalize the game application, ensuring that the game meets user requirements and expectation. During this stage, future iterations or updates are planned and decided based on the user feedback and project outcomes. This phase may be iterative to ensure that the game can be developed based on ongoing reviews and continuous improvement in order to meet its objectives and user needs.

3.7 Application Development Workflow

The workflow for developing the proposed game is structured into six phases according to the Agile model. The detailed overview of the tasks and outputs for each activity that must be done during each phase is presented in Table 9.

Table 9 *Tasks and outputs of each phase*

Phase	Tasks	Outputs
Requirement analysis phase	• Determine the initial requirements for the proposed application • Determine user analysis and requirements • Review similar existing applications	• Defined problem statement, objectives, project scope, project significance, and expected result. • Recommendations and feedback from SME • Comparison table between reviewed applications and proposed application
Design phase	• Determine system requirements • Determine hardware and software requirements • Create navigation structure • Create content structure • Create system flowchart • Design storyboard • Design the layout of 3D apartment • Create 3D models • Create the animation to be used • Create UI elements for the user interface • Select audio and music to be used	• Functional and non-functional requirements • Hardware and software requirements • Navigation structure • Content structure • Flowchart representing the game processes • Storyboard with user interface, and buttons • Layout designs for the 3D apartment • 3D models of Malaysian traditional kuih and other game assets • Object animations • User interface design elements • Chosen audio and music for the game
Develop phase	• Implement character movement controls • Develop gameplay scripts for object interaction • Develop user interfaces and menus • Develop narrative elements • Develop in-game challenges • Develop a progression system • Integrate audio and music	• Character movement controller • Object interactions with the game objects • User interfaces and menus • Narrative elements • In-game challenges and obstacles • Kuih collection book system • Integrated audio and music
Testing phase	• Perform alpha testing • Perform beta testing • Perform user acceptance testing	• Bugs and issues are identified and solved • User feedback, bug reports and overall system performance • Validation of user requirements
Deployment phase	• Build and distribute the game	• Deployed game application for distribution
Review phase	• Evaluate user feedback • Review and finalize the game application	• Analysis of user feedback and suggestions • Finalized version of the game application

4. Result and Discussion

This section presents the results of both functional testing and user acceptance testing. Functional testing is conducted by systematically checking each feature and functionality within the game to ensure they perform correctly without errors. The result of the functional testing is tabulated in Table 10.

Table 10 *Result of functional testing*

Function	Expected Output	Actual Output	Corrective Action
Character movement	Character moves smoothly in all directions using control inputs.	Character moves smoothly in all directions.	No corrective action is needed.
Object interactions	Character can interact with objects.	Character interacts correctly with objects.	No corrective action is needed.
User progress tracking	User progress is accurately tracked and updated in the game.	User progress is accurately tracked and updated.	No corrective action is needed.
Drag-and-drop puzzle game	Puzzle pieces can be dragged and dropped correctly into place.	Puzzle pieces function as expected.	No corrective action is needed.
Spot-the-difference game	Differences can be correctly identified and marked.	Differences are identified and marked correctly.	No corrective action is needed.
New game button (main menu)	Starts a new game.	New game starts correctly.	No corrective action is needed.
Resume button (main menu)	Resumes the current game.	Game resumes correctly.	No corrective action is needed.
Settings button (main menu)	Navigates to the settings menu.	Settings menu is accessible.	No corrective action is needed.
Exit button (main menu)	Exits the game.	Game exits correctly.	No corrective action is needed.
Resume button (pause menu)	Resumes the game from the pause state.	Game resumes correctly from the pause state.	No corrective action is needed.
Save game button (pause menu)	Saves the current game state.	Game state saves correctly.	No corrective action is needed.
Settings button (pause menu)	Navigates to the settings menu from the pause menu.	Settings menu is accessible from the pause menu.	No corrective action is needed.
Main menu button (pause menu)	Returns to the main menu.	Game returns to the main menu correctly.	No corrective action is needed.
General settings button	Navigates to the general settings interface.	General settings are accessible.	No corrective action is needed.
Controls settings button	Navigate to the controls settings interface.	Controls settings are accessible.	No corrective action is needed.
Graphics settings button	Navigates to the graphics settings interface.	Graphics settings are accessible.	No corrective action is needed.
Audio settings button	Navigates to the audio settings interface.	Audio settings are accessible.	No corrective action is needed.
Scene navigation	Navigations between different scenes are smooth and error-free.	Scene navigations are smooth and error-free.	No corrective action is needed.
Audio playback	Background music and sound effects play at appropriate times.	Audio playback is correct and timely.	No corrective action is needed.

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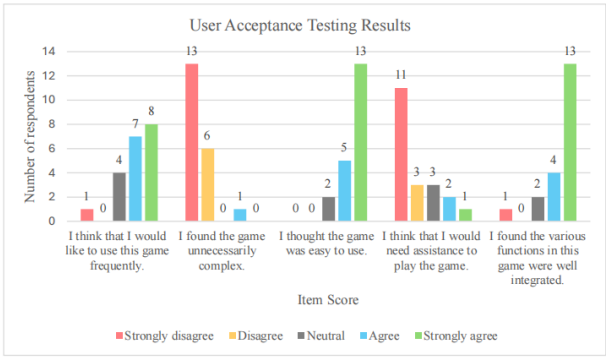
Table 10 *Result of functional testing (continued)*

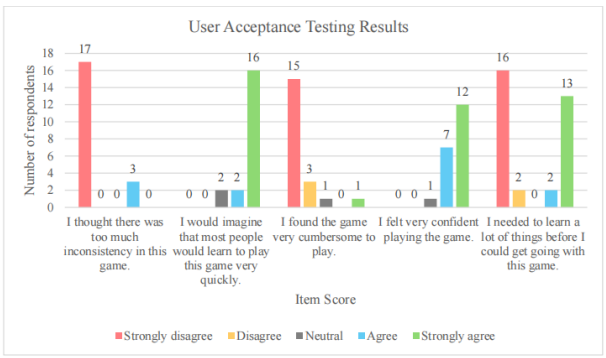
Function	Expected Output	Actual Output	Corrective Action
Narration voiceovers	Voiceovers play correctly during relevant scenes.	Narration voiceovers sometimes overlap.	Ensure only one voiceover plays at a time by using a function to check if another audio source is playing and stop it if necessary.
Data saving and loading	Game progress can be saved and loaded accurately.	Capsule or character location did not load correctly at the previously saved location.	Disable the character controller when updating the position to avoid physics issues.

According to the result of functional testing in Table 10, the game performed well in most aspects. However, two issues were identified during the testing which are overlapping narration voiceovers and incorrect character position loading. These issues are resolved by implementing corrective actions, such as checking for active audio sources before playing new ones and temporarily disabling the character controller during position updates respectively.

Furthermore, User Acceptance Testing (UAT) is conducted to gather feedback from potential users on the overall usability and user experience of Kuih Escapade using System Usability Scale (SUS). The questionnaire includes ten questions rated on a five-point Likert scale, covering various aspects of the game such as ease of use, learnability, and overall satisfaction. The item scores from questions 1 to 5 are visually represented as a bar chart in Figure 5(a), while scores from questions 6 to 10 are illustrated in Figure 5(b). The overall SUS score of this testing is then calculated and tabulated in Table 11.



(a)



(b)

Fig. 5 *Item scores from (a) questions 1 to 5 of the SUS questionnaire;* **(b)** *from questions 6 to 10 of the SUS questionnaire*

Based on the results from these item scores, the overall SUS score for the testing is calculated using the formula shown in Figure 6. This score is then tabulated in Table 11.

The formula used to obtain usability results based on the SUS is:

Total score = (odd items + even items) x 2.5

$$\text{Average score} = \frac{\text{Total score}}{\text{Total respondents}}$$

Where:

Odd items (Q1, Q3, Q5, Q7, Q9) = contribution – 1
Even items (Q2, Q4, Q6, Q8, Q10) = 5 – contribution

Fig. 6 *SUS score calculation formula [25]*

Table 11 *Result of User Acceptance Test*

Respondent	Item Score										Odd Items	Even Items	SUS score (/100)
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10			
R01	3	2	5	1	5	1	5	1	5	1	18	19	92.5
R02	5	1	4	4	3	4	3	3	4	4	14	9	57.5
R03	5	1	5	2	5	1	5	1	5	2	20	18	95
R04	4	4	3	4	4	4	4	2	4	4	14	7	52.5
R05	4	2	3	3	5	1	5	1	5	1	17	17	85
R06	5	2	5	2	5	1	5	1	4	1	19	18	92.5
R07	4	2	5	1	5	1	5	1	4	1	18	19	92.5
R08	5	1	5	3	5	1	5	1	3	1	18	18	90
R09	3	1	5	1	5	1	5	1	4	1	17	20	92.5
R10	1	1	4	1	3	4	3	2	5	1	11	16	67.5
R11	5	2	4	3	4	1	4	2	4	2	16	15	77.5
R12	5	1	5	1	5	1	5	1	5	1	20	20	100
R13	3	1	4	1	4	1	5	1	5	1	16	20	90
R14	5	1	5	1	5	1	5	1	5	1	20	20	100
R15	3	1	5	2	5	1	5	1	5	1	18	19	92.5
R16	4	2	4	1	4	1	5	1	4	1	16	19	87.5
R17	4	1	5	1	5	1	5	1	5	1	19	20	97.5
R18	4	1	5	5	1	1	5	5	5	1	15	12	67.5
R19	5	1	5	1	5	1	5	1	5	1	20	20	100
R20	4	1	5	1	5	1	5	1	5	1	19	20	97.5
											Average Score		86.375

According to the result of user acceptance testing in Table 11, the SUS scores collected from twenty respondents through Google Forms presented a range from 52.5 to a perfect 100, with the average SUS score being 86.375. The highest scores of 100 were obtained from respondents R12, R14, and R19, which indicates an excellent user perception of the game's usability. Similarly, respondents R03, R06, R07, R15, R17, and R20 rated near-perfect scores of 97.5 and 95, which further reflects very positive feedback regarding the game's ease of use and overall satisfaction.

On the other hand, the lowest SUS score was 52.5, recorded from respondent R04, followed by a score of 57.5 from respondent R02. These lower scores suggest that some users encountered usability issues or were less satisfied with certain aspects of the game.

Overall, the high average SUS score of 86.375 indicates that the game Kuih Escapade generally meets user expectations for usability and provides a satisfactory user experience, corresponding to an "A" grade on the SUS scale. The few lower scores highlight areas where further improvements could enhance the game's usability for all users. The feedback obtained through this testing will be used in refining and optimizing the game to better meet user needs and preferences.

5. Conclusion

In conclusion, the development of the interactive PC game Kuih Escapade has been successfully completed within the expected timeframe using Agile methodology. The game has met its objectives and user requirements by providing a fully functional and engaging platform to educate players about traditional Malaysian kuih through interactive and immersive experiences. These key achievements include Kuih Escapade was designed as an interactive PC game to educate players about traditional Malaysian kuih through narrative and gameplay elements, such as drag-and-drop puzzles and spot-the-difference mini-games and features a kuih collection book with detailed information. Secondly, the game was developed with a first-person character controller using Unity by integrating movement mechanics, camera controls, and an expansive game environment featuring hidden object challenges that encourage exploration and discovery. Lastly, alpha testing was conducted to ensure the stability of game features and mechanics, while beta testing was conducted with target users through the System Usability Scale (SUS) to evaluate and refine the overall user experience.

Other than that, Kuih Escapade has several advantages in terms of education value, entertainment, and user experience. It serves as an effective educational tool that effectively educates players about traditional Malaysian kuih through interactive gameplay, an informative kuih collection book and various 3D models of traditional Malaysian kuih to explore. The game also provides engaging gameplay with puzzle and mini-games that keep players entertained while they learn. Additionally, its user-friendly interface is accessible to players, as supported by positive feedback from user acceptance testing with target users.

Moreover, several suggestions for future improvements have been identified, including adding more kuih models and recipes, implementing a multiplayer mode, integrating additional cultural elements, and localizing the game into multiple languages. These future enhancements will further enrich the game's content, features, and accessibility to reach a wider audience.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design**: Tan Wei Chin, Mohd Farhan; **data collection**: Tan Wei Chin; **analysis and interpretation of results**: Tan Wei Chin, Mohd Farhan; **draft manuscript preparation**: Tan Wei Chin. All authors reviewed the results and approved the final version of the manuscript.

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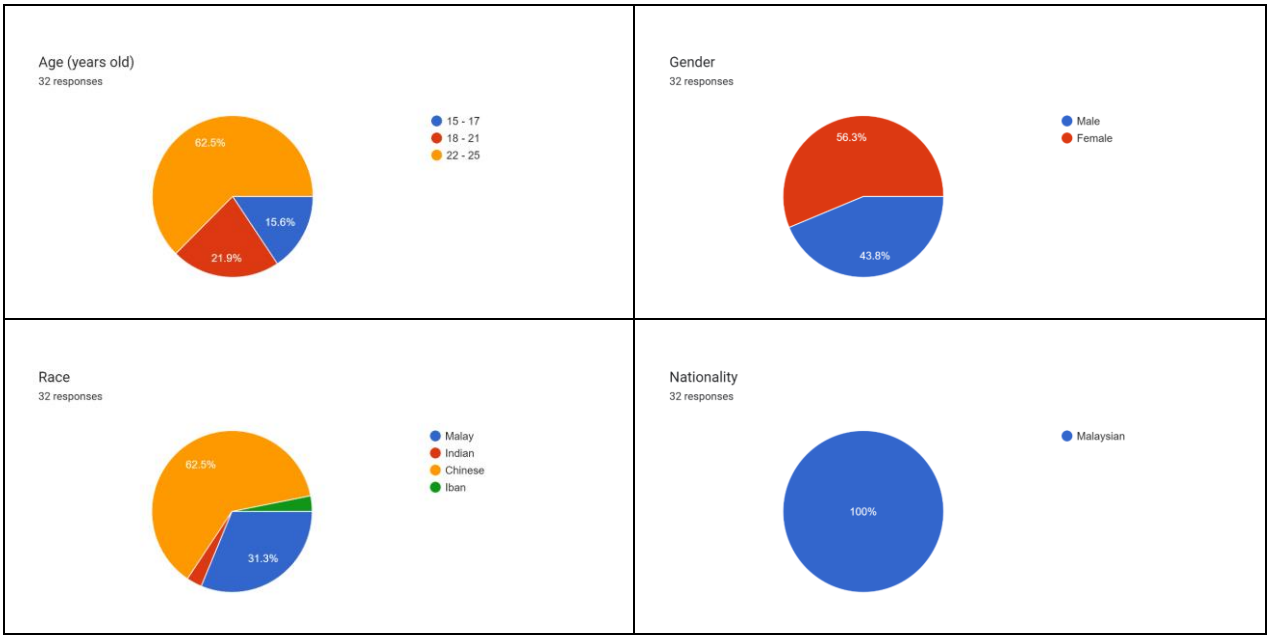
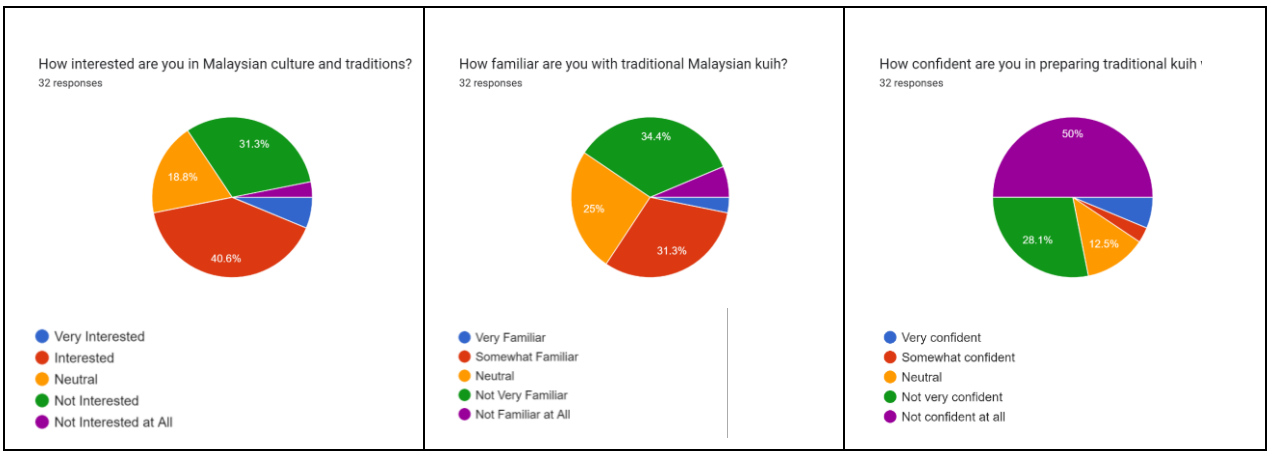
Appendix A

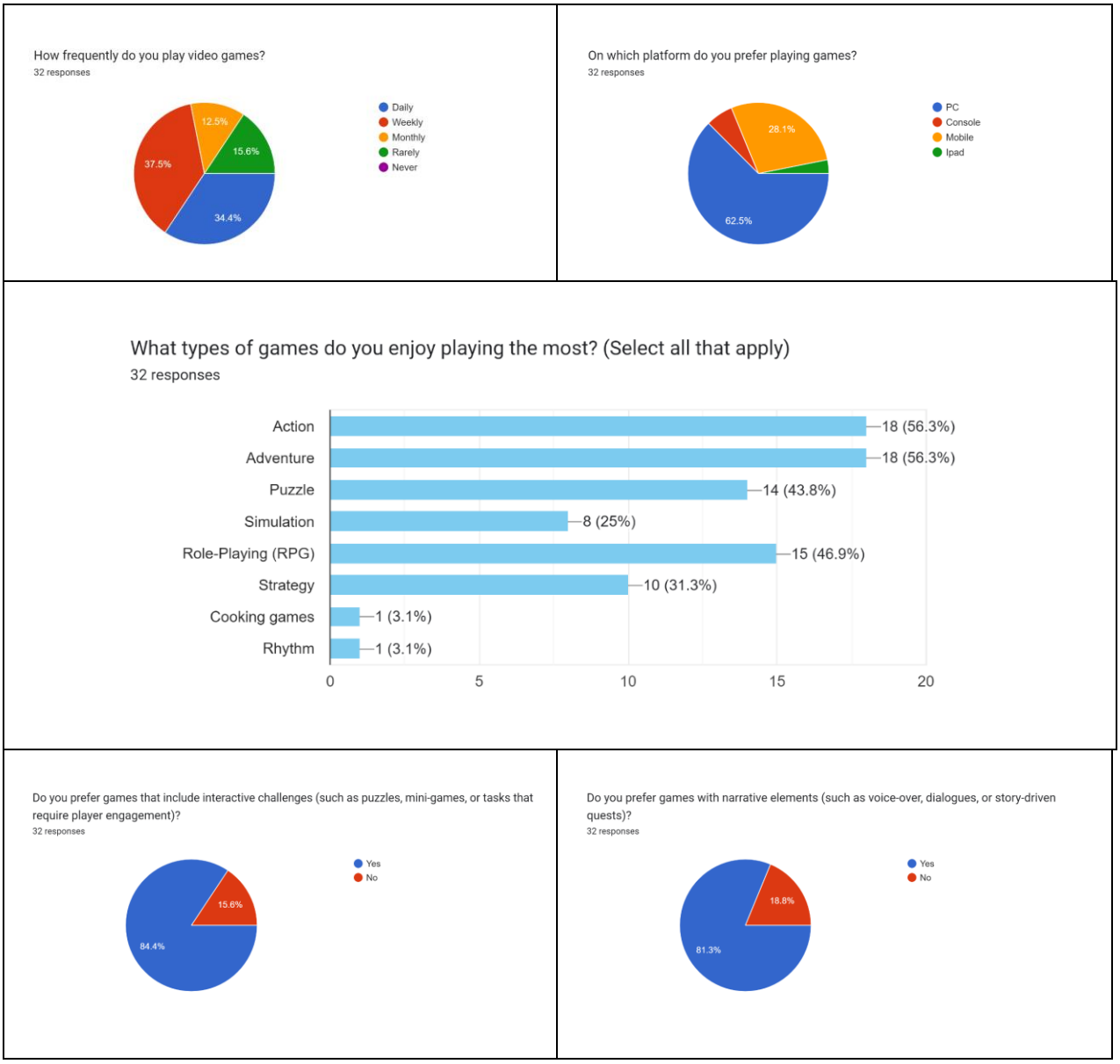
According to the study involving 32 respondents aged 15 to 25, about 40.6% showed interest in Malaysian culture, while 31.3% lacked interest. In terms of familiarity with traditional Malaysian kuih, 34.4% were not familiar, and 50% felt not confident at all in preparing traditional kuih independently. Gaming preferences showed target audiences' preference for PC gaming (62.5%), with action and adventure games being the most popular (56.3%). User feedback indicates a desire for interactive challenges and narrative elements in the proposed game. A comparative analysis of existing applications and the proposed "Kuih Escapade" highlighted strengths in exploration, interactivity, and engaging gaming experiences without in-game advertisements.



(a)



(b)



(c)

Fig. 3*(a) Demographics of respondents; (b) Respondents' knowledge about Malaysian culture; (c) Gaming preferences of respondents*