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A Mobile Game-Based Application for Learning Collective Nouns of Animals: Nounimals

Nur Alya Batrisyia Baharoddin[1], Che Samihah Che Dalim[1]*

[1] *Fakulti Sains Komputer dan Teknologi Maklumat,*
Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

*Corresponding Author: samihah@uthm.edu.my
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Abstract

Game-based learning enhances engagement by combining educational content with interactive play. Traditional methods of teaching collective nouns for animals often lack interactivity, and existing apps with static visuals and text-based quizzes make it difficult for primary school students to learn this knowledge. Hence, Nounimals is a mobile application that uses game-based learning technology has been developed by using a Multimedia Mobile Content Development methodology. The app targets primary school students, offering 2D visualizations, gamified quizzes, and real-time feedback to make learning collective nouns more engaging. The System Usability Scale (SUS) was used to evaluate user acceptance, resulting in a positive usability score of 71.5, which is above the average benchmark of 68 and indicates good usability and user satisfaction. Thus, Nounimals are suitable to be implemented in learning collective nouns of animals is expected.

1. Introduction

Educational gaming apps enhance learning by making it interactive, fun, and goal-oriented, unlike traditional methods. An educational game learning application is a digital platform that combines academic content with game-based elements to create an engaging and interactive learning experience [1]. When it comes to making learning more fun, interactive games and storytelling are encouraged by enabling peer social interaction and fostering the development of collaborative abilities. Teachers aware of these advantages can create classes that incorporate these in significant ways, allowing the students to acquire language skills and develop an appreciation for their richness.

The development of a mobile learning application focused on animal collective nouns addresses a gap in the current English curriculum for non-native primary school learners, where such vocabulary is often excluded due to time constraints and syllabus priorities. While not essential for functional communication, collective nouns enrich vocabulary, enhance semantic understanding, and introduce students to the creative and cultural aspects of the English language. However, challenges remain, such as limited interactivity, a lack of teacher training in digital tools, and the need for more engaging content. Many existing educational apps offer static content or simple quizzes, which may not sustain students' attention or support long-term retention [2]. Additionally, most are not tailored to diverse learning needs or topics beyond textbooks, causing disengagement, especially among young learners who benefit from interactive, visually rich environments. This highlights the need for more immersive and engaging educational applications. Therefore, this project is aimed at designing an interactive mobile game-based application, Nounimals, for learning collective nouns of animals using a game-based approach, developed on the Android platform using Unity, and performing tests on its functionality and usability on primary school students. Initially, the proposed application is designed for standard 4 primary school students to help them expand their vocabulary and improve their cognitive skills. Moreover, it will also be developed on a mobile Android platform with interesting modules

such as learning modules, game modules, and a main module, and in the English language. Besides, the Multimedia Mobile Content Development (MMCD) methodology has also been implemented in this project. By addressing current issues, the Nounimals application is expected to provide an engaging and interactive learning experience, bright and cute backgrounds, and offer four interactive games, which are a mix-and-match, word guess, card pairing, and a crossword puzzle. Not only that, but the proposed application could also be used as an alternative to help the teachers to potentially improve students' interest and excitement and shortly after as a self-learning tool for the students.

By leveraging interactive, gamified learning, the app promotes engagement, self-paced exploration, and language retention outside the classroom, which is especially valuable in contexts with limited English exposure. By introducing animal collective nouns, a vocabulary area is frequently left out of the English curriculum due to time restrictions and syllabus priorities.

The rest of the paper is arranged as follows: Section 2 covers the domain of study, the technology used, and the result of the comparative analysis. Section 3 describes the MMCD methodology that has been chosen to be used in this project, as well as the output of the analysis and design phases of this project. Furthermore, Section 4 discusses the results and discussion, while Section 5 states the conclusion of the current progress.

2. Related Work

This section discusses the domain background, collective nouns, the technology used, and the result of the comparative analysis.

2.1 Educational Learning

Since 1957, Malaysia has made a huge step in implementing the increasing use of educational technology, such as multimedia technology [3]. Educational technology refers to a variety of technology-based programs or applications that help deliver learning materials to improve academic learning goals. The Malaysian government has actively promoted digital learning through initiatives such as the 1BestariNet, which provides schools with high-speed internet access, and the Digital Educational Learning Resources (DEL) portal [4]. Additionally, the Malaysian government has also encouraged the adoption of various technology-enhanced learning tools, including e-learning platforms, virtual classrooms, and multimedia-rich content, to create more engaging and effective learning experiences. In the meantime, Malaysia's education system reflects a strong commitment to adaptability and keeping up with technological advancements, ensuring that students acquire the essential skills needed to succeed in an increasingly digital world [5]. Thus, the technologies for learning applications have been widely introduced, including Augmented Reality (AR), Virtual Reality (VR), and Game-Based learning, in enhancing students' education delivery.

2.2 Game-Based

Considering most mobile devices, particularly smartphones and tablets, can run user-friendly mobile applications named mobile game-based learning has come into being as a new trend in education [6]. The term Game-Based Learning (GBL) refers to the use of video games and elements related to game reality, content, subject and images in the educational process [7]. Some researchers agree that game-based learning can stimulate students' interest because it helps in engaging students in conversations and teaching them conversational skills, solving the problem of the lack of authentic conversation strategies in textbooks, and providing a relaxed atmosphere. Moreover, game-based learning is divided into two major categories: digital game-based learning (DGBL) and the use of non-digital games in technological learning contexts (NDGTLC) [8]. Therefore, GBL was equally beneficial for both cognitive and non-cognitive outcomes. This shows that GBL can help students develop both cognitive and non-cognitive abilities, such as engagement and motivation.

2.3 Comparative Analysis

This part includes the comparison of the proposed application, Nounimals, with three existed applications identified in Fig 1, namely Flock Of, Collective Nouns Colosseum, and Collective Nouns Quiz. As indicated in Table 1, the key areas of concern in the comparison are the technology involved, navigation, and visual design, interactivity, user-friendliness, consistency, and the UI responsiveness.



(a)	(b)	(c)

Fig. 1 *(a) Flock Of [9] (b) Collective Nouns Colosseum [10] (c) Collective Nouns Quiz [11]*

Table 1 *Applications comparison*

Features/ Application	Flock Of	Collective Nouns Colosseum	Collective Nouns Quiz	Nounimals
Technology Used	Game-Based	Quiz	Game-Based	Game-Based with Gamification
Navigation	Poor (no instruction, possibly unclear)	Basic (simple UI, but not engaging)	Simple but may be confusing (no tutorial)	Good (clear, engaging, multi-module flow)
Visual Design	Uses graphic, audio, text but lacks instruction	Text only, simple, less engaging	Text only, fewer multimedia elements	Rich & engaging (videos, icons, buttons, animations)
Interactivity	Learning and game module	Quiz module	Multiple-choice quizzes	Learning, and four games module
User-friendliness	Low (lacks guidance)	Moderate (simplicity)	Moderate (Relaxing but no tutorial)	High (Engaging UI, well-designed experience)
Consistency	Unclear	Minimalist UI	Simple structure	Unified design
UI Responsiveness	Poor	Good	Good	Excellent

3. Methodology/Framework

The Nounimals application has been developed by using the Multimedia Mobile Content Development (MMCD) methodology. The methodology consists of five stages, which are the application idea creation stage, the structure analysis stage, the process design stage, the main function development stage, and the testing stage. Figure 2 shows the structure of MMCD [12].

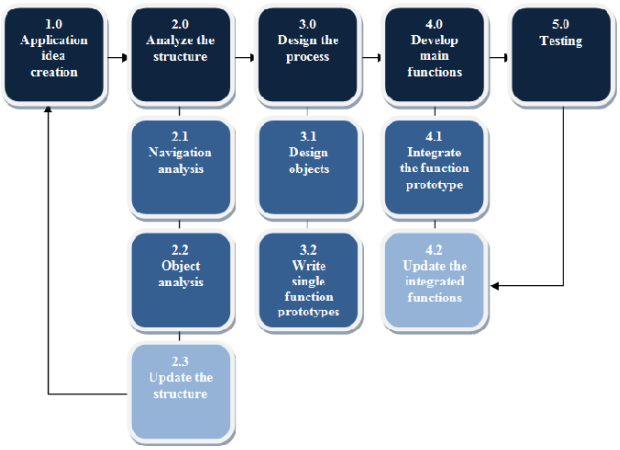


Fig. 2 *Multimedia Mobile Content Development structure (MMCD)*

3.1 Application Idea Creation Stage

In this stage, the idea of the Nounimals application will be introduced. This phase involves determining the application's objectives, target users, and key features to be included in the application. The initial requirement analysis and user requirements of the application will be identified as well, based on literature reviews and input from Subject Matter Experts (SMEs). An interview session was conducted at Sekolah Kebangsaan Pintas Raya, Parit Raja, Batu Pahat, Johor with Madam Siti Nurhuda binti Sarman, an English teacher from the school.

Table 2 *Initial requirement checklist*

Item	Description
Type of application	Educational learning application
Platform	Android
Target users	Standard 4 primary school students
Graphical user Interface	Main, Learning, Games, and navigational interface
Assets	2D images, buttons, pop-up window, animal sounds, Graphic, audio, text, animation, video
Synopsis	Nounimals is an application that help students in understanding collective nouns of animals via game-based approach with interactive learning modules

Table 3 *User requirements*

Stakeholder category	Role in produce	Design Implication	Action needed
Subject Matter Expert	Content consultant expert in the related field	Clear navigation and user-friendly	Buttons what action they need to take. should have short, clear labels that make it easy for users to understand
			The buttons should be precise and consistent on every interface
		Simple yet attractive design for primary school students	Avoid any color or style that does not suit the primary school students' preference
			Each interface should be colorful and striking to attract the students' attention.
		Children-friendly learning module	Learning modules should include realistic photos of animals instead of text.
			Include buttons that can make them listen to animal sounds
			Less wordy, straightforward content but more graphically.

3.2 Structure Analysis Stage

The second phase involves analysing the structure. This phase includes the analysis of the object and navigation analysis. Functional requirements describe what needs to be done by identifying tasks, actions, or activities that must be accomplished in the developed application. Non-functional requirements, on the other hand, describe the attributes or qualities of the application. During this phase, the content structure, navigation structure, and application flowcharts are also drawn, which can be found in Appendices B to D. Tables below show the functional and non-functional requirements.

Table 4 *Functional requirements*

Functional requirement	Module/Scene	Description
Autonomous system activity	Game Modules	Every wrong pair, 2 seconds will be deducted from timer.
		Every wrong pair, 2 seconds will be deducted from timer.
		Timers are counting when users are playing a game
		Once users complete a level, another level will unlock. If they cannot complete the previous level, another level remains locked.
		The first level of the Mix-and-Match game will always be unlocked and available to start.
		Background music is playing while users are on the application.

Table 4 *(continued)*

		The win panel will show up when users pass the current level and lose panel shows up when users do not pass the current level.
		An unlock video will play once users complete the final level of the current game.
	Learning Module	A video of animals will play by its own when users click the 'click me' button in the learning module.
		A quick tutorial of hand gestures in learning module
		A quick guide panel shows up in each level 1 button of games when users are playing for the first time.
		Game questions load to next question when users answer the current question correctly.
User interaction	Main Menu	The application should have an information button on the main menu.
		The application should provide users with the ability to exit the application with a quit button on the main menu.
		The application should have a setting button to adjust the volume of background music and mute video from the learning module.
		The application should have a play button to let users to go to the game modules.
		A learn button should be included to allow users to navigate to the learning module.
	Learning Module	The application should have buttons that allow users to play the sound button of animal sounds and pronunciations.
		The application has a 'click me' button to display informative video of animal.
		Users must first scroll through a list of 15 animals before accessing the dedicated learning page for each one.
	Game Modules	The application allows users to input the answer to the question.
		The application should allow users to go back to the main menu from the game module.
		The application should have a retry button to replay the game if they fail

Table 5 *Non-functional requirements*

Non-functional requirement	Description
Performance	• The application can operate offline. • The application shall have high response time to ensure smooth experience for the users.
Compatibility	• The application should be able to operate on an Android mobile device with Android version 7 or newer.
Usability	• Users must adapt and understand the application within 15 minutes • The design and layout must ensure a consistent visual style across the application. • Users should be notified of successful messages or failures after playing game modules.
Optional	• An image of animals shall be displayed inside of the learning module.
Legal	• All images and content included in the application must adhere to copyright laws.

3.3 Process Design Stage

The process design phase is one of the most important and critical stages of development. This phase includes designing objects and writing the single-function prototype. In terms of designing objects, it focuses on game design by determining the type of game, fun factors, and game elements contained within the game design. Therefore, four games included in the Nounimals with 3 different difficulty levels will help the students understand and learn about the collective nouns of animals. However, the role of game-based learning becomes more transparent, as each game completed by the students will reward them with achievements. The process design also integrates multimedia elements and programming to ensure a smooth and effective learning experience. Additionally, this design includes information within the application that will guide students through each interface. Once the game design documentation is completed, a prototype will be developed to evaluate the game's overall concept. Table 6 shows the button design, followed by the other game buttons and interface design in Appendices E and F.

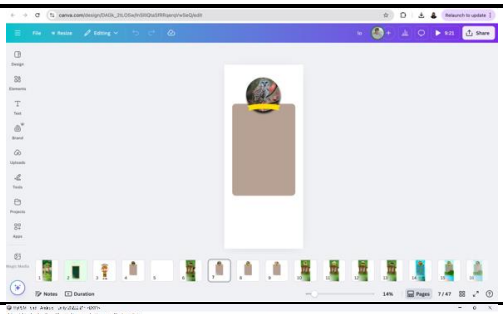
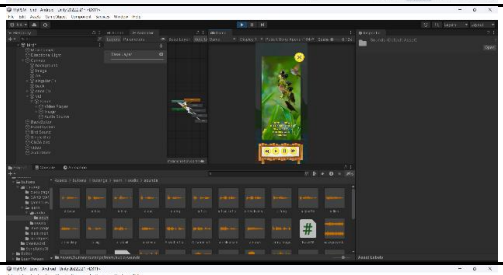
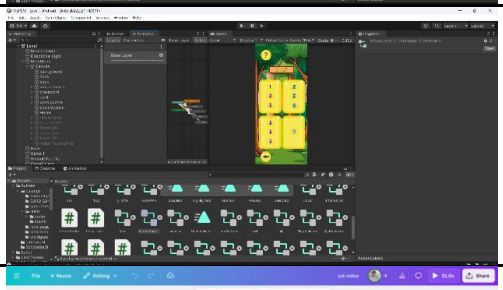
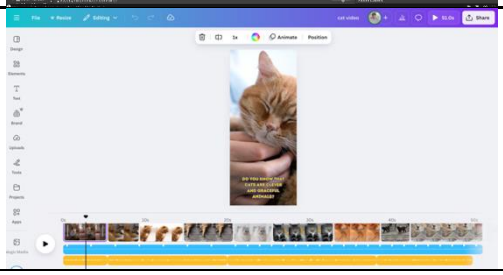
Table 6 *Button design*

Button	Description	Button	Description
	Users can go to the learning module by clicking this button		Users will go to game modules
	An exit confirmation appears when users click on this button		When users fail to complete the current level, they can retry again the game
	Users can click on levels they have unlocked in the game module		One of the game buttons that users have the option to choose what type of game they would like to play.
	Allow users to go to the next level of game		Confirm button to exit the application
	Volume adjustment of background music can be found in settings		By clicking this, users can read information on how to use the application
	Users can go back from the current page to previous page		Cancelation of exit the application. It navigates back to Main Menu
	Volume adjustment button for background music		Users can listen to animals' sound
	Users can listen to pronunciation audios		Users can rewind or fast forward video
	Cancel button for certain action		Pause and Play video
	Reset letters arrangement		Delete a letter
	Enter the animals' scene		Display games rule bubble text

3.4 Main Function Development Stage

In this phase, the main functions of the proposed application were developed. This included creating multimedia assets and integrating them into Unity software. A total of four multimedia elements were developed as application assets, consisting of graphics, audio, animation, and videos, as outlined in Table 7.

Table 7 *Application assets development*

Assets	Development	Description
Graphics		The Canva website was utilized to design and integrate storyboards and background elements for the Nounimals application. In addition, user interface components such as buttons and icons were crafted using Adobe Illustrator, ensuring a consistent visual identity across the application.
Audios		Audio for Nounimals' game pronunciations was recorded using children's voices to enhance engagement. Additionally, animal sounds were sourced from copyright-free content on YouTube, and some pronunciation audio was generated using the AI platform ElevenLabs.
Animation		The button animation is created using Unity's Animator component, where the button slightly enlarges across four keyframes to enhance interactivity. Additionally, some buttons use sprite switching to reflect different states such as click.
Videos		The videos were edited by Canva with video assets sourced from Freepik and Canva's media library. Adjustments were made to the video to ensure smooth flow and appropriate pacing. Each video includes on-screen text and voice-over narration.

Subsequently, C# scripting was implemented to ensure the main functions of the application operate smoothly. These functions include game lock system, timer counting, scene transitions, background music control, game management, and video mute in the learning module, as outlined in Table 8.

Table 8 *Integration in Unity*

Functions	C# scripts	Description

Mix-and-Match game mechanism	`void CheckMatch(int selectedIndex)`
	`{`
	`  if (selectedAnimal != null && selectedNoun != null)`
	`  {`
	`  if (IsCorrectPair(selectedAnimal, selectedNoun))`
	`  OnCorrectMatch(selectedIndex);`
	`  else`
	`  OnWrongMatch();`
	`  }`
	`}`
		This function is central to the Mix-and-Match game. It checks if the selected animal and noun form a correct pair based on their indices. Correct matches disable the buttons and award points, while incorrect ones reduce the remaining time. It also controls the game's progression to a win or game over.

Card Pairing game mechanism	`bool IsMatch(Sprite first, Sprite second)`
	`{`
	`  return (puzzlePairs.ContainsKey(first) && puzzlePairs[first] == second) ||`
	`  (puzzlePairs.ContainsKey(second) && puzzlePairs[second] == first);`
	`}`
		In the card memory game, this function determines if two chosen cards make an actual matching pair. Regardless of the order of selection, it searches the puzzlePairs dictionary to determine whether one sprite maps to the other. This brief check is an essential component of the

Table 8: *(continued)*

		game's main logic since it establishes whether the player has made a correct match.

Word Guess game mechanism	`public void CheckAnswer()`
	`{`
	`string playerAnswer = new string(currentAnswer.ToArray());`
	`if (playerAnswer == correctAnswer)`
	`{`
	`correctAnswersCount++;`
	`score += scorePerCorrectAnswer + Mathf.FloorToInt(remainingTime);`
	`UpdateScore();`
	`StartCoroutine(ShowCorrectPopupThenLoadNext());`
	`}`
	`else`
	`{`
	`remainingTime = Mathf.Max(0, remainingTime - 2f);`
	`ClearAnswer();`
	`}`
	`}`
		The fundamental gameplay logic that determines whether the player's constructed response that made up from chosen letter with matches the right answer for the current quiz question is this function. If it is right, a brief correct popup appears before the next question loads, and the score and number of right answers rise. If incorrect, the response field is cleared, and time is lost. The player's progress and quiz round result are determined by this logic.

Crossword Puzzle game mechanism	`for (int i = 0; i < clue.answer.Length; i++)`
	`{`
	`int x = clue.startX + (clue.isVertical ? 0 : i);`
	`int y = clue.startY + (clue.isVertical ? i : 0);`
	`if (crosswordGrid.GetSlot(x, y) is PuzzleSlot slot)`
	`{`
	`slot.SetHighlightColor(new Color(1f, 0.647f, 0f));`
	`activeClueSlots.Add(slot);`
	`}`
	`}`
	`if (activeClueSlots.Count > 0)`
	`SetActiveSlot(activeClueSlots[0]);`
	`}`
		This function updates the UI and gameplay logic to reflect the currently selected clue. It highlights all puzzle slots that belong to the current clue (across or down), displays the clue text to the player, and sets the first slot in the sequence as the active one. It is central to how players navigate and interact with the crossword puzzle, linking the clue data to its visual and interactive representation on the grid.

3.5 Testing Stage

In multimedia mobile content development, the testing phase is the final and crucial stage to ensure that the application functions as intended. This phase involves evaluating the application's overall performance, the accuracy of its content, and the effectiveness of its multimedia elements. As outlined in Table 9, functional testing is conducted to verify that all features operate correctly. Additionally, as discussed in Section 4, the System Usability Scale (SUS) is used to evaluate the application's usability and user experience, and the testing was conducted at SK Pintas Raya involving 30 Standard 4 students from the same school. The testing process is carried out through several iterations to identify and resolve any issues, ensuring the application is thoroughly refined before release.

Table 9 *Functional testing*

Test	Expected Result	Actual Result	Corrective Action
Play button	Navigates to games module	Works well as expected	No needed
Learn button	Navigates to learn module	Works well as expected	No needed
Quit button	Display exit game panel	Works well as expected	No needed
Information button	Display information panel	Works well as expected	No needed
Settings button	Display settings panel	Works well as expected	No needed
Mute video button	Mute videos in Learn module	Works well as expected	No needed
Volume button	Adjust background music loudness	Works well as expected	No needed
Question mark button	Display game rules bubble text	Works well as expected	No needed
Game choices card buttons	Flip card to show level buttons	Works well as expected	No needed
Level buttons	Go to game scenes	Works well as expected	No needed
Back button	Go back to Level Scene	Works well as expected	No needed
Retry button	Replay the game scene	Works well as expected	No needed
Home button	Go to Main Menu scene	Works well as expected	No needed

Table 9: *(continued)*

Trash button	Delete a letter button	Works well as expected	No needed
Rewind button	Clear up letters in answer slots	Works well as expected	No needed
Animals button	Mix-and-Match game answer	Works well as expected	No needed
Nouns button	Mix-and-match game answer	Works well as expected	No needed
Letters button	Word guess game answer	Works well as expected	No needed
Cards button	Match cards with its pair (animal and noun)	Works well as expected	No needed
Clue button	Move to next clue question	Works well as expected	No needed
Home button in final level	Display unlock video	Works well as expected	No needed
Start button	Navigates each animal scene	Works well as expected	No needed
Speak button	Play pronunciation audios	Works well as expected	No needed
Play button in Learn module	Play animals' sounds	Works well as expected	No needed
'Click me' button	Play animals' video	Works well as expected	No needed
Pause and Play button	Pause and play animals' video	Works well as expected	No needed
Fast forward button	Fastening animals' video in 5 seconds	Works well as expected	No needed
Rewind video button	Replaying animals' video in 5 seconds	Works well as expected	No needed
Cancel button	Close panel	Works well as expected	No needed
Animals' buttons	Swipe right to choose animals	Works well as expected	No needed
Yes button	Exit game	Works well as expected	No needed
No button	Navigates to Main Menu	Works well as expected	No needed

4. Results and Discussion

The data and analysis from the System Usability Scale (SUS) test are presented in this section, and the corresponding test image is also provided in Appendix H for reference. The main purpose of the testing is to obtain feedback and opinions on the developed application. From these, the application developer can understand the target users' acceptance and satisfaction with the proposed application. The SUS comprises 10 standardised questions designed to capture users' perceptions of ease of use and satisfaction [13], with the full list of questions available in Appendix G. There are a total of 10 questions with the Likert Scale. On a scale of 1 to 5, the respondents must indicate how much they agree with each statement they read. 5 means they strongly agree, while 1 means they strongly disagree. From Figure 3, we can see that there are a total of 10 questions. All these questions are used to evaluate the usability of the proposed application, Nounimals. From the left side of the bar chart, the first question is "I think that I would like to use this system frequently." Most respondents answered "strongly agree" because they found that the interfaces of the application are kid-friendly and beneficial for their needs. They would like to use the applications to improve their language skills. For the second question, the least number of respondents answered "strongly agree" to the statement "I found the system unnecessarily complex" because they found that the applications are straightforward and easy to navigate. An easy-to-use interface, concise instructions, and clearly marked buttons all add to a positive user experience. For the third question, "I thought the system was easy to use," most respondents answered "strongly agree" because users find the application has less response time and quick performance, which contributes to the application being accessible and convenient. For the fourth question, most respondents answered "neutral" to the statement, "I think that I would need the support of a technical person to be able to use this system." Based on observations, the majority of students who answered "neutral" on the quiz were likely new users of some of the game mechanics, such as Mix-and-Match and Word Guess, and they may not have understood the question. For the fifth question, the statement "I found the various functions in this system were well integrated" recorded that half of the respondents answered "agree." From the observation, the contributing factors to why students answer "agree" are that they feel that the various tools and features of the application function well together to let them move smoothly without running into fragments or being inconsistent. For the sixth question, the majority of respondents selected "strongly disagree" when asked if they thought there was too much inconsistency in this application. It is because the entire user interface is designed consistently, with standardised button locations, colour schemes, and icons that improve navigability. For the seventh question, "I would imagine that most people would learn to use this system very quickly," the majority of respondents answered "strongly agree." Observations suggest that most of the students who gave "strongly agree" to this statement did so because user-friendliness was a priority in the application's design. Due to the reasonable layout, clear instructions, and intuitive interface of the application, users can easily understand and navigate the application. For the eighth question, the fewest respondents answered "strongly agree" to the statement "I found the system very cumbersome to use" because they perceive the application to be user-friendly and efficient. A quick panel is prepared for each module, and an information panel as well, so that users can quickly understand the access method and be guided step

by step. For the ninth question, "I felt very confident using the system," recorded, the highest of the respondents answered "agree." As a result, the logical feature organisation, clear labelling functions, and easy-to-understand iconic buttons contribute to building user confidence. Users are capable and can navigate the application with confidence. For the last question, most respondents answered "Neutral" to the statement "I needed to learn a lot of things before I could get going with this system." According to the observation, the majority of the respondents have no experience with a few of the game mechanics, and they might need some time to explore. Besides that, the other possible reason to contribute to this result is the language barrier. Since the education system at Sekolah Kebangsaan Pintas Raya uses Malay, the respondents might be a bit weak in understanding English.

After analysing the results, some of the calculations will be used to determine the usability of the proposed application. The overall usability value score for Nounimals is displayed in Table 10. The average user acceptance score for a usability test is determined using the System Usability Scale (SUS).

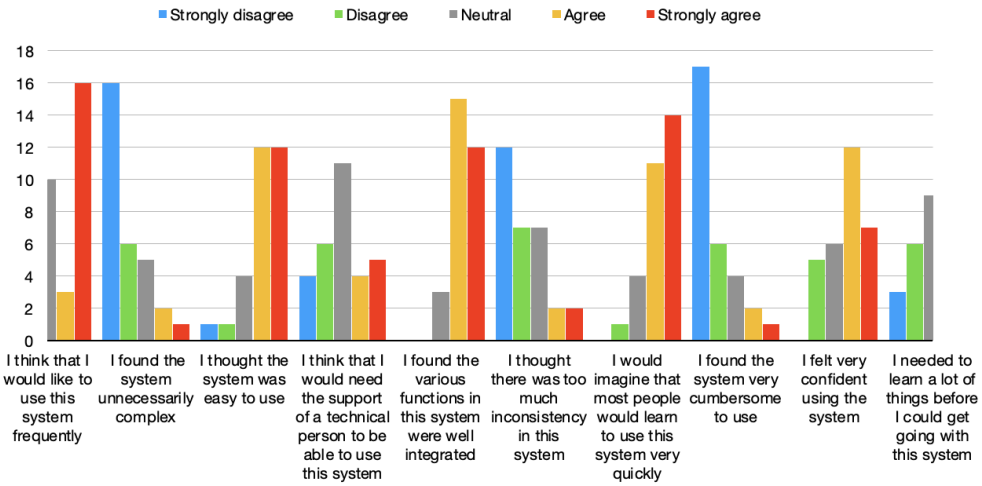


Fig. 3 *Analysis of System Usability Scale(SUS)*

The following formula was applied to get usability results based on the SUS:

$$Total\ score = (odd\ items + even\ items) \times 2.5 \quad (1)$$

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

$$Total\ score = (odd\ items + even\ items) \times 2.5$$

$$Odd\ items\ (Q1, Q3, Q5, Q7, Q9) = contribution - 1$$

$$Even\ items\ (Q2, Q4, Q6, Q8, Q10) = 5 - contribution$$

Therefore, the average score is

$$\frac{70 + 50 + 70 + 57.5 + 75 + 55 + 67.5 + 65 + 82.5 + 72.5 + 67.5 + 75 + 75 + 90 + 80 + 85 + 77.5 + 75 + 60 + 72.5 + 67.5 + 85 + 60 + 62.5 + 80 + 57.5 + 75 + 77.5 + 70 + 87.5}{30}$$

$= 71.5$

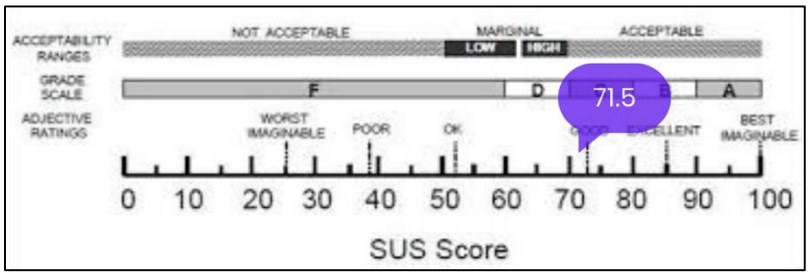


Fig. 4 *The scale of the SUS Score [14]*

By using the formula, the average usability value score, which is 71.5 according to the SUS score scale shown in Figure 4, is within an acceptable range. With a score of 71.5, which is higher than the average of 68, users may find the Nounimals to be both accessible and usable. The application may be relatively straightforward for users to learn and use, providing a generally positive user experience. However, the score is not in the excellent range (80–90). The primary contributing factor to this score is that there is a language barrier between respondents and

the application's content. Therefore, this strong result reflects the effectiveness of the design and its alignment with user expectations.

Table 10 *Respondent's score*

Respondent	*Item Score*										Total Score
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	
R01	3	2	4	2	5	2	4	2	4	4	70
R02	3	5	4	4	4	5	5	1	2	3	50
R03	4	3	3	3	5	1	5	3	4	3	70
R04	3	2	3	5	4	3	5	1	2	3	57.5
R05	3	1	4	3	4	4	5	1	5	2	75
R06	3	2	1	2	4	4	5	1	3	5	55
R07	5	3	4	3	4	3	4	3	5	3	67.5
R08	3	4	5	3	4	1	2	1	4	3	65
R09	5	1	4	3	4	1	5	2	4	2	82.5
R10	5	2	4	5	4	2	4	2	5	2	72.5
R11	4	1	5	2	4	3	4	5	4	3	67.5
R12	3	1	5	3	3	1	5	1	3	3	75
R13	5	1	5	5	4	1	5	1	4	5	75
R14	5	1	5	5	5	1	5	1	5	1	90
R15	5	1	5	4	5	2	4	4	4	5	80
R16	5	1	5	3	5	1	5	1	5	5	85
R17	3	1	4	2	5	2	4	1	3	2	77.5
R18	5	1	5	3	5	3	3	1	4	4	75
R19	3	2	2	3	4	2	3	2	3	2	60
R20	5	1	4	2	4	3	5	1	4	5	72.5
R21	4	3	4	3	5	2	4	2	3	3	67.5
R22	5	1	4	1	4	2	3	2	5	1	85
R23	3	3	4	4	5	1	5	3	2	4	60
R24	5	3	3	5	5	1	4	3	4	4	62.5
R25	5	1	5	1	5	3	5	4	5	4	80
R26	5	4	3	2	4	5	3	1	2	2	57.5
R27	5	1	4	1	3	1	4	1	2	4	75
R28	5	1	5	3	3	1	4	1	4	4	77.5
R29	1	1	5	4	4	1	4	1	4	3	70
R30	5	2	5	1	5	3	5	1	3	1	87.5
										Average Score	**71.5**

5. Conclusion

In conclusion, the Nounimals application is successfully developed, which involves the development of a mobile game-based learning application, designed specifically for Standard 4 primary school students to enhance their understanding of collective nouns of animals. Developed using the Multimedia Mobile Content Development (MMCD) methodology, the application delivers an engaging and interactive learning experience by combining educational content with multimedia elements and game-based mechanics.

Nounimals runs on the Android platform and features three main modules: Learning, Games, and Main Menu. The Learning Module presents animal-related vocabulary through visuals, audio, and videos, while the Games Module includes four interactive games which are Mix-and-Match, Word Guess, Card Pairing, and Crossword Puzzle where each designed with increasing difficulty to reinforce knowledge and maintain engagement. The application also includes animations, cute 2D graphics, animal sounds, and real-time feedback, making it attractive and suitable for young learners.

To evaluate the usability of the application, a beta testing phase was conducted using the System Usability Scale (SUS), a widely accepted tool that measures user experience through ten standardised questions. Based on responses from 30 participants, Nounimals achieved a SUS score of 71.5, surpassing the average benchmark of 68 and indicating good usability. This score reflects that users found the app intuitive, effective, and enjoyable. Although the app was well-received, some feedback indicated that the text layout in certain parts of the Learning Module could be refined for readability.

In conclusion, Nounimals has successfully met all project objectives and is fully developed with complete modules. It stands as a promising educational tool that blends multimedia and gamification to support vocabulary learning in a fun, interactive, and age-appropriate way.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

This journal requires that all authors take public responsibility for the content of the work submitted for review. The contributions of all authors must be described in the following manner:

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Nur Alya Batrisyia Baharoddin, Che Samihah Che Dalim;* ***data collection:*** *Nur Alya Batrisyia Baharoddin, Che Samihah Che Dalim;* ***analysis and interpretation of results:*** *Nur Alya Batrisyia Baharoddin, Che Samihah Che Dalim;* ***draft manuscript preparation:*** *Nur Alya Batrisyia Baharoddin, Che Samihah Che Dalim. All authors reviewed the results and approved the final version of the manuscript.*

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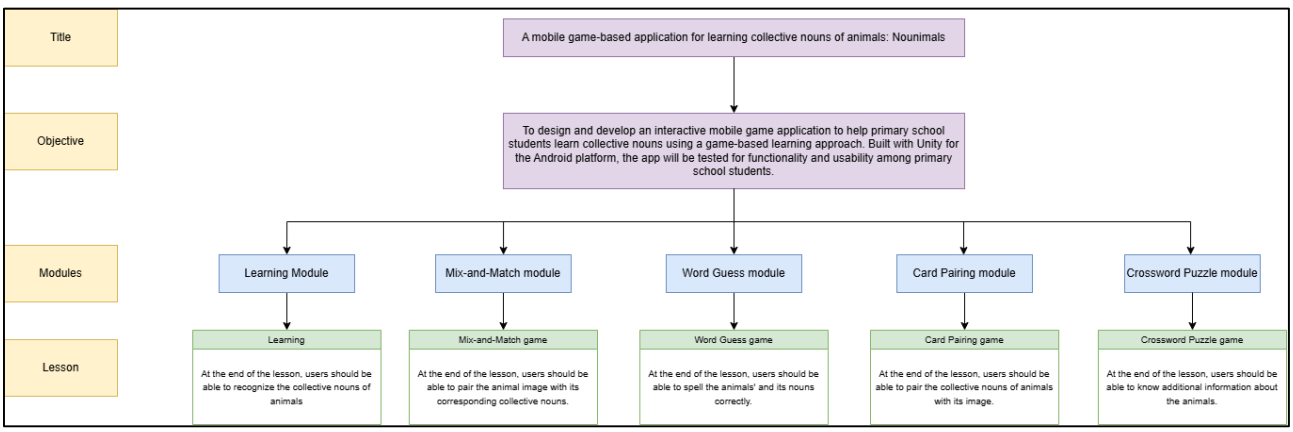
Appendix A: Application Development Workflow

Phase	Activity	Output
Application Idea Creation Stage	Identify issues, objectives and scope.	Project background, problem statement, objectives and project scope.
	Identify initial requirements for the developed application from Subject Matter Expert (SME).	User Requirements
	Carry out user analysis	Hardware and software requirements
	Set the project timeline	User analysis results
		Gantt Chart for FYP 1 and FYP 2
Structure Analysis Stage	Analyze the navigation of the application	Content structure checklist
	Analyze the objects/components of the application	Object analysis checklist
	Identify the design, menu and navigation and graphics user interfaces of the application	Content structure, navigation structure and system flowcharts
	Analyze the functional and non-functional requirements	Storyboard
		Functional and non-functional requirements
Process Design Stage	Design the objects/components such as buttons and multimedia elements.	Design of navigation buttons, 2D graphics, videos, and animation
	Write a single function prototype to test individual component	Scripts for screen navigation and 2D game objects to function.
Main Function Development Stage	Integrate the function prototype	User interface and system function
	Integrate main function for the learning module	Navigation buttons to navigate from scene to scene
	Integrate main function for the game module	Volume scrolling bar to control the background music
		Lock systems for each game module making sure it is related to one another
		Game module to display correct, wrong answers, and scores
		Exit panel navigates to quit whole application
		An .apk file and publish on Android platform
Testing	Carry out the functional testing and user acceptance testing	User acceptance level on the usability of the application
		User acceptance level on the functionality of the application

Appendix B: Content Structure



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Appendix C: Flowcharts

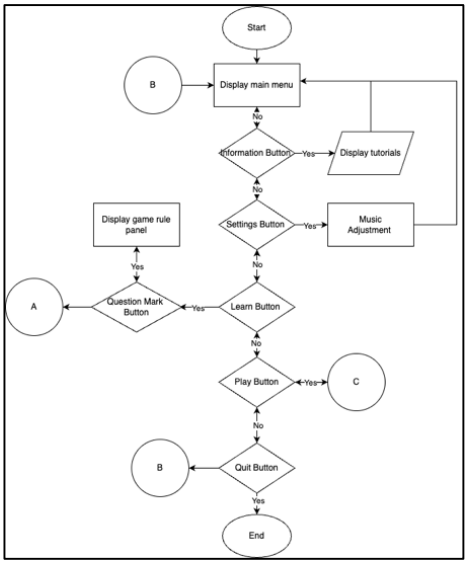

Fig. 5 *Main Menu flowchart*

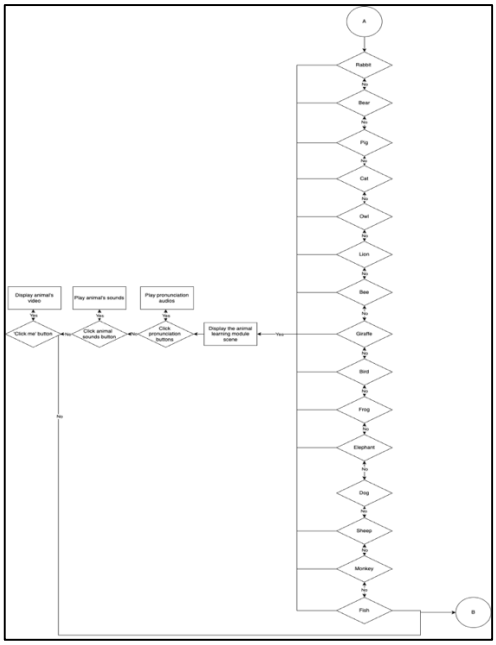

Fig. 6 *Flowchart of Learning module*

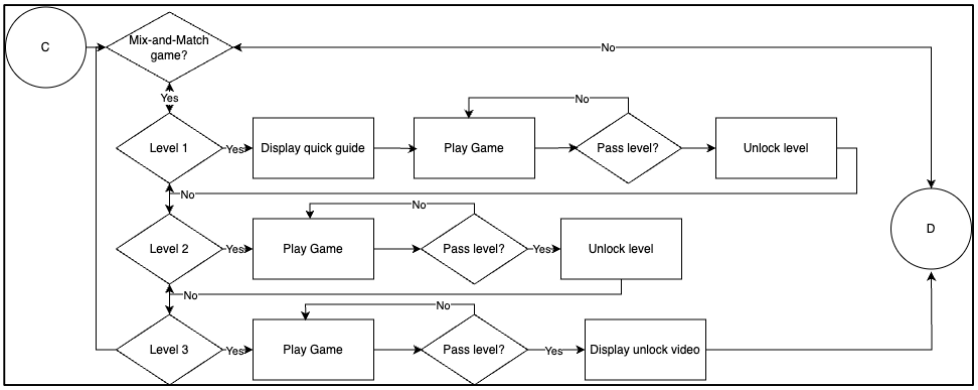

Fig. 7 *Flowchart of Mix-and-match*

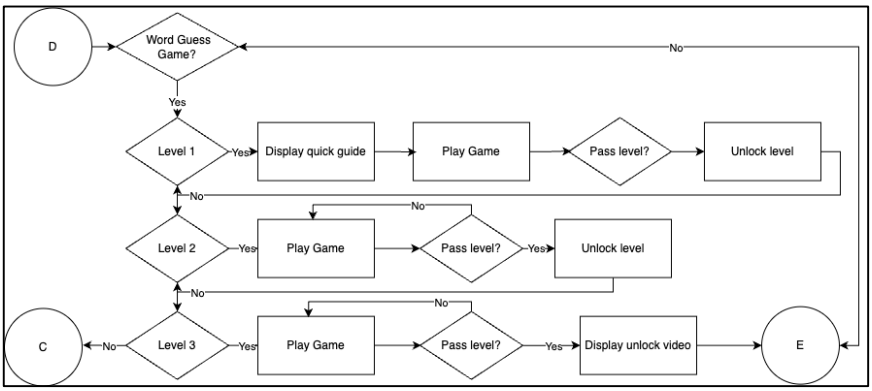

Fig. 8 *Flowchart of Word Guess*

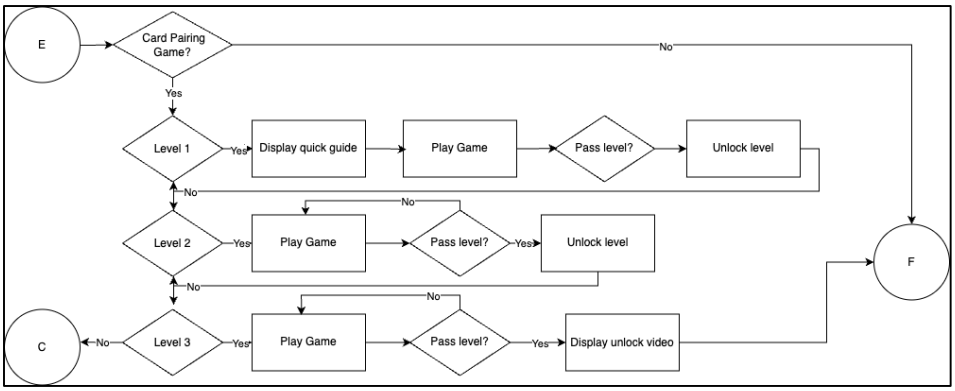

Fig. 9 *Flowchart of Card Pairing*

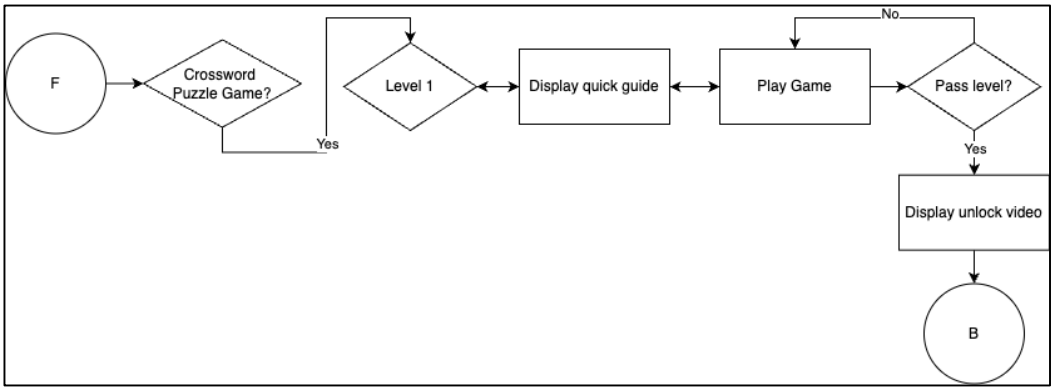

Fig. 10 *Flowchart of Crossword Puzzle*

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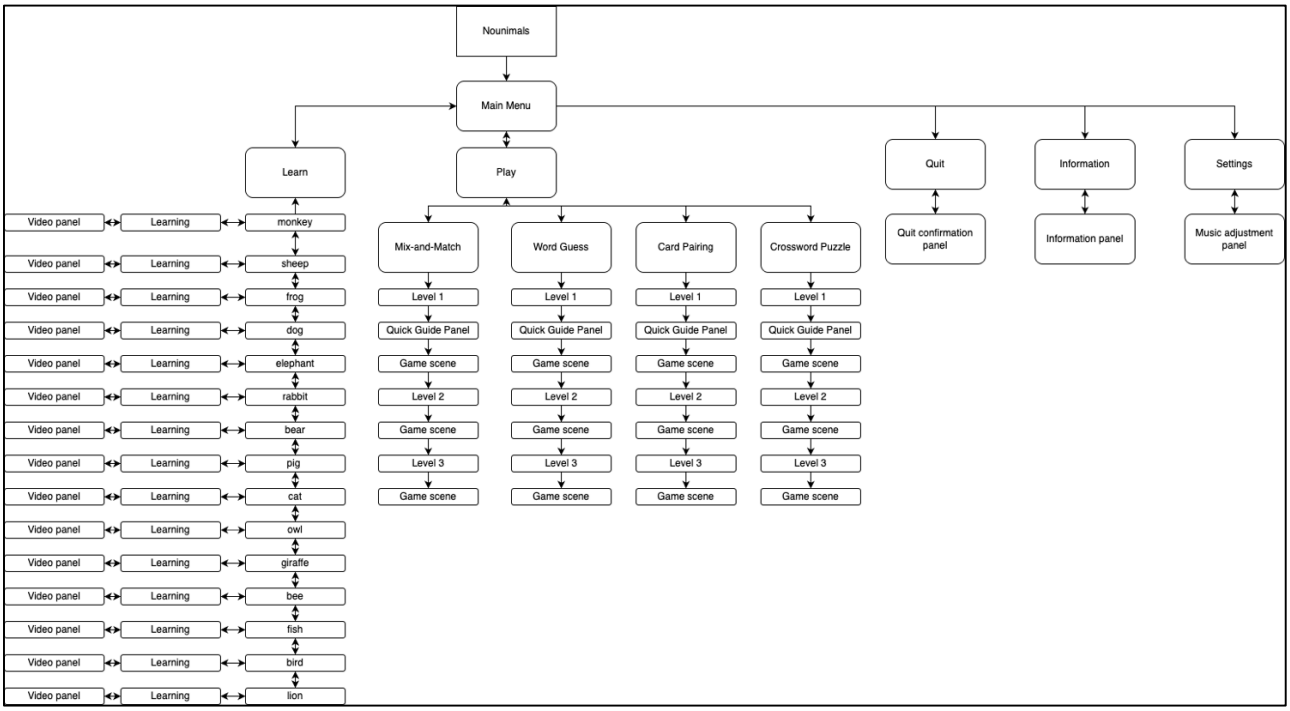
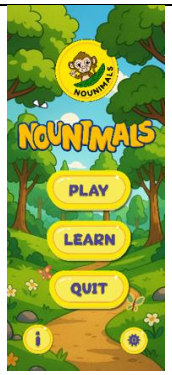
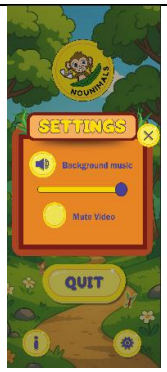
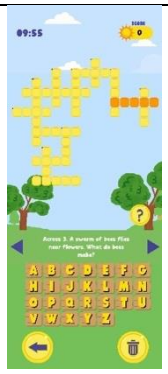
Appendix D: Navigation Structure



Appendix E: Other game buttons

Appendix F: Interface Design

Interface	Description	Interface	Description
	Main menu of Nounimals consists of three main buttons and two sub buttons.		Entering the learning module where users can choose fifteen buttons of animals to go to its learning interface.
	Every animal has the same learning interface where they can see a 2D image of an animal, and four clickable buttons including a 'Click Me' button that navigates to video scene.		Once users click on play button, they will be navigated to game modules to choose game type.
	A game over pop-up panel if users fail to complete the level by getting 10 points. Each game has different style.		A congratulations pop-up panel is shown to show that users are succeeded to pass the current level.
	Users must complete each level to unlock the next. Game progression is sequential, meaning unlocking one game allows access to the following one.		Information pop-up panel on how to understand the navigation in this application via information button on top of the main menu page.

	Exit confirmation is shown when users click on the quit button.		Mix-and-match game interface. Each level has the same game style
	Volume adjustment of background music and mute video from learning module.		Card Pairing game interface. Each level has the same theme but different number of cards. The harder the level, the more is the card.
	Quick guide panel is shown when user is playing for the first time for the game. Mostly this panel will show when user clicks Level 1 button.		Word Guess game interface which the question can be switched whether asking the noun or the animal.
	Crossword Puzzle game interface. This game is the final game module with the highest difficulty.		The unlock video scene will be displayed every time user passes a game.

Appendix G: SUS questionnaires

System Usability Scale

	Strongly disagree				Strongly agree
1. I think that I would like to use this system frequently	1	2	3	4	5
2. I found the system unnecessarily complex	1	2	3	4	5
3. I thought the system was easy to use	1	2	3	4	5
4. I think that I would need the support of a technical person to be able to use this system	1	2	3	4	5
5. I found the various functions in this system were well integrated	1	2	3	4	5
6. I thought there was too much inconsistency in this system	1	2	3	4	5
7. I would imagine that most people would learn to use this system very quickly	1	2	3	4	5
8. I found the system very cumbersome to use	1	2	3	4	5
9. I felt very confident using the system	1	2	3	4	5
10. I needed to learn a lot of things before I could get going with this system	1	2	3	4	5

Appendix H: Students from SK Pintas Raya Involvement in Testing