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The Development of German Language Learning Mobile Application for Beginners

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Abstract: German is one of the international languages that is being encouraged to learn by people all around the world. However, most of the existing German learning applications available are lacking some important features such as German grammar, quizzes, and the function to verify the learners' pronunciation. Thus, Learn German From Scratch mobile learning application is developed on the Android mobile platform to overcome these problems by integrating the features and adopting Speech Recognition technology as its unique features. The information is obtained from the German international language course offered by UTHM for undergraduate students. The Multimedia Mobile Content Development methodology is used to develop the application. User acceptance testing has been conducted involving 30 target users and gained positive results as more than 70% of them are highly satisfied with the developed application. In conclusion, the application has a high user acceptance level and it is suitable to be used as a reference not only for the student in German language class at UTHM but other German beginners who learn German from scratch.

Keywords: German Language, Speech Recognition, Mobile Learning Application

1.   Introduction

According to the study, proficiency in multiple languages is an added value to a person because it not only facilitates the interaction between humans but also opens more job opportunities for the people [1]. As one of the international languages, German is the best choice to be learned. Due to the growth of mobile learning techniques, it is no longer difficult to learn a foreign language. There are a lot of German mobile learning applications available online and they will be useful tools for learners to self-study and get a better understanding of the German language. However, there are some problems found in several reviewed existing German learning applications. Some of them did not provide enough information as they are just taught about German vocabulary without introducing the basic grammar such as the alphabet, pronouns, and articles. Some of them lack quizzes provided. This may be an imperfection for the application as a quiz is significant for the users to test their level of understanding of what they have learned. Also, it is rare to find a German language learning application that has the

function to verify the learners' pronunciation. Pronunciation is a key to producing effective communication with others. Hence, beginners have to learn to speak proper pronunciation.

To overcome the problems, a German mobile learning application, namely Learn German From Scratch is developed. The objectives of this project are to design the content of Learn German From Scratch by implementing a visual auditory learning style, develop an interactive learning application by implementing speech recognition technology, and perform functional testing and user acceptance test on the developed application to the target user. The Subject Matter Expert for this project is Madam Nur Zakiah Binti Amir Hamzah, a German language lecturer at Universiti Tun Hussein Onn Malaysia (UTHM) and the target user is the students of the German language class of UTHM. There are two modules in the application which are Learn module and the Quiz module. The application is expected to provide basic knowledge of the German language such as grammar, vocabulary, and phrases. In addition, the application could be proposed to be used by the students to practice and improve their pronunciation through the speech recognition function.

The following sections of the paper are organized as follows. Section 2 presents the Related Work which consists of the study domain, technique used, and the study of existing applications. Next, Section 3 discusses the Multimedia Mobile Content Development methodology used in this project and the outcomes in each phase of the methodology. Section 4 reveals the result and discussion of the testing process of the application. Lastly, Section 5 is the conclusion which is to summarize the objective achievements, advantages, limitations, and future works of the project.

2. Related Work

2.1 German International Language

According to Malaysia Education Blueprints 2013-2025, the ministry encouraged all the students to learn at least three international languages so that they can communicate effectively in today's rapidly globalizing world [2]. The German language is one of the international languages that is suggested to be learned by the students. German is the official language of Germany and Austria, and it is also one of the official languages of Switzerland [3]. In addition, Germany is one of the countries that offer many scholarships and provide free courses to international students and exchange students who were able to speak German. Proficient in the German language will be easier for those who wish to travel or find a job in the countries such as Europe, Germany, and other countries which speak German as the main language so that they can be easier to socially involve themselves in the new environment and able to communicate fluently and confidently with the native speaker. Universiti Tun Hussein Onn Malaysia (UTHM) also offered German language courses for the students to learn basic German. The students will be trained in their listening, reading, speaking, and writing skills in the German language through real daily situations and tests.

2.2 Speech Recognition

Speech Recognition, also known as Automatic Speech Recognition (ASR) is a technology or digital communication method that allows the transformation of human speech into a readable text format [4]. This technology has greatly contributed to education especially language learning. This is because it can be applied to language learning applications that can recognize accented or mispronounced speech and also give an evaluation of the pronunciation [5]. In learning a foreign language, it is significant that the beginners can learn the pronunciation so that they can speak the language accurately as the pronunciation is a key to producing effective communication with others. Thus, the learners can also check and correct their pronunciation using the speech recognition application. Nevertheless, the technology does not guarantee the perfection of recognition accuracy. It may affect by the background noise that will reduce the performance of the technology in the applications. In addition, the performance of the technology is also not ideal enough when interpreting the speech produced by low-proficiency learners [4].

2.3   Comparison of Application

This section discusses the comparison between the three reviewed applications, Learn German Phrases German Translator [6], Learn German for Beginners [7], Learn German Vocabulary-Kids [8], and the developed application, Learn German From Scratch based on several features. The comparison is tabulated in Table 1.

Table 1: Comparison between reviewed applications and developed application

Features	*Learn German Phrases / German Translator*	*Learn German for Beginners*	*Learn German Vocabulary-Kids*	*Learn German From Scratch,* the developed application
Language used	Support multi-language	English	Support multi-language	English
Target user	4 years old and above	4 years old and above	6 to 8 years old	18 years old and above
Platform	- Android 4.4and above (Google Play Store) - iOS	- The android version varies with the device (Google Play Store) - iOS	- Android 4.4and above (Google Play Store) - iOS	- Android 4.4 and above (APK) - Android 11 and above (Google Play Store)
Speech recognition technology used	No speech recognition technology used	No speech recognition technology used	No speech recognition technology used	Speech recognition technology is used
Lessons	Vocabulary and phrases	Alphabet, grammar, vocabulary, and phrases	Alphabet and vocabulary	Alphabet, grammar, vocabulary, and phrase
Quiz and Game	No quiz provided	Listening and reading quizzes	Mini-games such as matching and memory games	Listening quiz, reading quiz, speaking quiz, and quiz game
Pronunciation	Pronunciation provided	Pronunciation provided	Pronunciation provided	Pronunciation provided
Strength	- Can be used offline - Voice recording function provided - Provides search engine for words or phrases - Can choose to display the vocabulary in flashcards or list	- Free to use - Provides translator with text-to-speech function	- Can be used offline - Interfaces and buttons are clear and easy to control - Can choose to display the vocabulary in flashcards or list	- Free to use - Function to verify pronunciation is provided - Can choose to display the vocabulary in flashcard or list form
Weakness	- Not all contents are free	- Requires internet connection	- Not all contents are free	- Only cover the German basics - Requires internet connection

Some improvements have been performed on Learn German From Scratch based on the imperfections found in the review applications. Speech recognition technology does not apply in the three reviewed applications. Therefore, the developed application adopted the technology in the topic of German Vocabulary and Phrases to recognize mispronounced speech and give direct feedback on it [5]. The application also provided an integrated learning package that includes the German basics.

3. Methodology

Multimedia Mobile Content Development (MMCD) methodology has been chosen for developing the Learn German From Scratch mobile learning application. For the MMCD methodology, two main aspects will be focused on at the early stages of the development process which are the object design and navigational control design [9]. This methodology has been tested on several similar projects and the results show that MMCD can facilitate the application development process and ensure the optimization of the mobile processing usage as well as the data usage [9]. The methodology consists of 5 components, including the application idea creation stage, structure analysis stage, process design stage, main function development stage, and testing stage. Figure 1 shows the adapted Multimedia Mobile Content Development (MMCD) methodology model diagram.
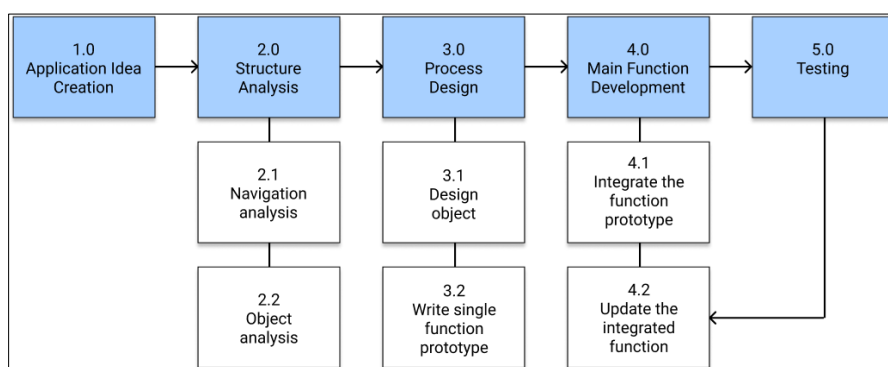

Figure 1: Adapted MMCD methodology model diagram [9]

3.1 Application Idea Creation

In this stage, the developer has defined the project title and determined the initial requirements such as problem statement, objectives, project scope, project significance, and the expected result. Then, the user requirements and system requirements are identified. The application idea creation checklist and user analysis are tabulated in Tables 2 and 3.

Table 2: Application idea creation checklist

Item	Note
Type of application	Mobile Learning
Target device	Android mobile platform
Target users	Student of German language class of UTHM
Subject Matter Expert (SME)	Madam Nur Zakiah Binti Amir Hamzah, German language lecturer of UTHM
GUI (Graphical user interface)	Splash screen, main menu, Learn module, Quiz module
Images	Images of German Alphabet, verbs, vocabulary, and icons
Video	None
Animation	Self-introduction in German, quiz game preview
Audio	Pronunciation of German words, background music
Application synopsis	Learn German From Scratch is a mobile learning application that provides basic German such as alphabets, grammar, vocabulary, and phrases with the adoption of speech recognition technology.

Table 3: User Analysis

Stakeholder Category	Role in product	Design implications	Actions needed
Subject Matter Expert (SME)	Content consultant expert in German language learning	Based on the interview, Content design	• Include alphabet, greetings, self-introduction, vocabulary, and pronunciation • The content can refer to the German note that used in class • Make sure the spelling of all the German words are correct
		Interface design	• Include some German-related elements such as using German flag colors • Design a young girl or boy
General user	End-user of the application	Based on the survey, Content design	• Focus on German vocabulary, phrases, and grammar • It shall provide a quiz and display score after completed • The lessons shall display in both German and English
		Provide functionality that can train and verify their German pronunciation	• Adopt speech recognition technology • Immediate feedback should be provided to the users
		Easy to access	• Button and interfaces are easy to control and navigate • Clear instructions are given to show how to use the functions

3.2 Structure Analysis

To structure the content of the developed application, navigational analysis and object analysis have been conducted in this phase. As mentioned earlier, navigation and objects are the two main aspects of the MMCD methodology. An object checklist is produced as shown in Table 4. The structure of the application is presented in the form of a navigational structure, and flowcharts are attached in Appendix A.

Table 4: Object checklist

Item	Note
Layers design	Layer 1: Background images Layer 2: Content Layer 3: C# Script
Menu and Navigation	Menu button, Back button, and Home button
Image	German Alphabet, Verb, Vocabulary, Splash screen, and images that were used in the quiz question
Number of main GUI	Application logo
Audio	Pronunciations of the German words and phrases
Animation	Self-introduction in German Animation, quiz game preview
Typography	Different text styles

3.3 Design Process

There are two components included in this stage which are design objects and single function prototype scripting. The items listed in Table 4 are designed and prepared using design software such as Procreate, Adobe Photoshop, Canva, Adobe Animate, Wondershare Filmora 9, and so on. The button design of the application is tabulated in Table 5. At the end of this process, a single function prototype is produced in terms of the object and interface designs as shown in the storyboards attached in Appendix B.

Table 5: Button design

| Button	Description	Button	Description
QUIZ	• This button is used to navigate to the Quiz module.	Alphabet	• This button is used to navigate to the Grammar topics.
	• This button is used to navigate to Learn module.	Aa [a:]	• This sound button is used to play the pronunciation of the Alphabet.
GO	• This button is used to navigate to the topics of the Grammar, Vocabulary, and Phrase lesson.	⊗	• This button is used to close the panels in the article lesson.
🍎	• This button is the selection of the vocabulary and phrases.	♪	• This button is used to mute or unmute the background music of the Quiz Game.
🏠	• This button is used to navigate to the Main Menu.	🔊	• This is the sound button that plays the pronunciations.
START	• This button is used to start the quiz and quiz game. • This button is the choice of the answers in the quiz	☰	• This button is used to navigate to the flashcard form of vocabulary and phrases.
↻	• This button is used to retry the quizzes.	☰	• This button is used to navigate to the list of vocabulary and phrases.
🧽	• This button is to remove the selected answer in Quiz Game.	🎤	• This button is used to record the input voice.
♻	• This button is to clear the selected answer in Quiz Game.	↻	• This button is to replay the quizzes.
💡	• This button is to display hints in Quiz Game.	‹	• This button is used to navigate back to the previous interface.

3.4 Main Function Development

There are 2 modules in the application which are the Learn module and the Quiz module. In this phase, all the modules were developed with the scripting to produce the functionality. After all the modules have been developed, the modules were integrated and the navigational control has been developed in between the modules. The main function development stage consists of three parts which are Development of Assets, Implementation of System, and Build APK for Android.

3.4.1 Development of Assets

Some assets have been created to be used to develop Learn German From Scratch such as graphics, audio, and animations. Figure 2 shows one of the images that is developed for quiz questions by using Procreate illustration application.
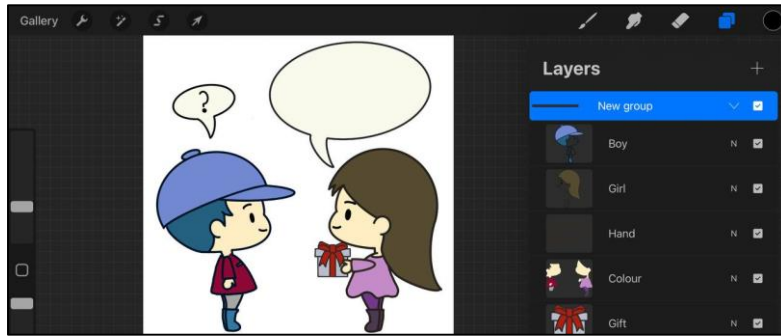
Figure 2: Development of graphic for quiz question using Procreate

Besides, the avatar that is used to develop the animation about Self-introduction in German was created using Adobe Photoshop and it is then imported to Adobe Animate to develop the short animation as shown in Figure 3.

Figure 3: Self-introduction animation using Adobe Animate

Figure 4 presents the recording process of German pronunciations of the vocabularies and phrases. All the pronunciations are recorded by SME who is a German lecturer at UTHM by using the voice recorder application as shown in Figure 4. The recorded pronunciation is then imported into the computer to continue to be edited by using Wondershare Filmora 9 such as background noise removal and adjusting the volume and amplitude.
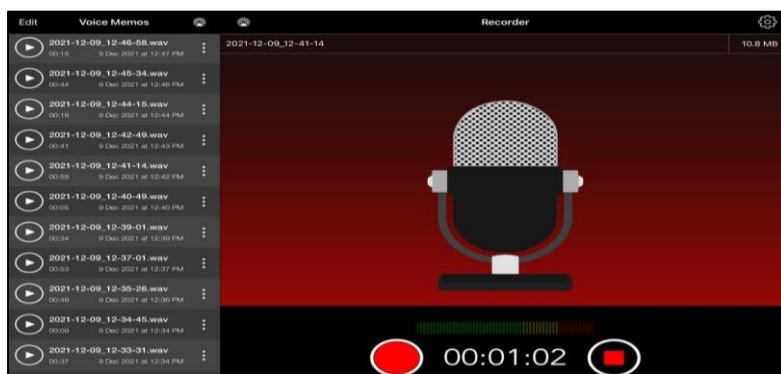
Figure 4: Recording pronunciations using voice recorder application

3.4.2   Implementation of System

The main function of Learn German From Scratch is the speech recognition function which is adopted in Vocabulary and Phrases lessons to verify the learner's German pronunciation as shown in Figures 5(a), 5(b), and 5(c). Users are required to record their pronunciation to check whether they are pronounced the German word correctly or wrongly.

Figure 5(a): Ask for permission to record audio

Figure 5(b): Interfaces of Vocabulary and Phrases lesson

Figure 5(c): Interface when starting recording

Figure 5(a) shows the pop-up message to request permission of recording audio. Figure 5(b) shows that there is an instruction 'Press once to record', and it will change to 'Stop Recording' when the Record button is clicked as displayed in Figure 5(c).

```
1    using System;
2    using UnityEngine;
3    using System.Collections;
4    using System.Collections.Generic;
5    using UnityEngine.UI;
6    using UnityEngine.SceneManagement;
7    using KKSpeech;
```

Figure 6: Library used in speech recognition scripting

Based on line 7 in Figure 6, to implement the speech recognition function in Learn German From Scratch, a speech-to-text extension asset named KKSpeech is used and referenced.

```
34          SpeechRecognizer.SetDetectionLanguage("de-DE");
35
36          //To check if the current device supports Speech Recognition
37          if (SpeechRecognizer.ExistsOnDevice())
38          {
39              SpeechRecognizerListener listener = GameObject.FindObjectOfType<SpeechRecognizerListener>();
40              listener.onAuthorizationStatusFetched.AddListener(OnAuthorizationStatusFetched);
41              listener.onAvailabilityChanged.AddListener(OnAvailabilityChange);
42              listener.onErrorDuringRecording.AddListener(OnError);
43              listener.onErrorOnStartRecording.AddListener(OnError);
44              listener.onFinalResults.AddListener(OnFinalResult);
45              listener.onPartialResults.AddListener(OnPartialResult);
46              listener.onEndOfSpeech.AddListener(OnEndOfSpeech);
47              SpeechRecognizer.RequestAccess();
48          }
49          else
50          {
51              answerText.text = "This device doesn't support speech recognition";
52              startRecordingButton.enabled = false; //Cannot press on the recording button (disabled the button)
```

Figure 7: Part 1 of the code segment of the speech recognition function

Figures 7 and 8 reveal the parts of the code segment of the speech recognition function in Learn German From Scratch. Line 34 of the Start() function in Figure 7 shows the setting the language that needs to be detected is German with the language id "de-DE". Then, an if-else statement is used to check if the current device supports speech recognition through the ExisOnDevice() function. As referred to the line 47 in Figure 7, if the devices contain a Speech Recognizer, there will be a pop-up

message to ask for permission to record audio as shown in Figure 5(a). While if the device does not contain a Speech Recognizer, there will be a message 'This device doesn't support speech recognition' displayed in the feedback box below the Record button.

```
142    public void OnStartRecordingPressed()
143    {
144        answerText.text = " ";
145        if (SpeechRecognizer.IsRecording())
146        {
147 #if UNITY_IOS && !UNITY_EDITOR
148            SpeechRecognizer.StopIfRecording();
149            startRecordingButton.GetComponentInChildren<Text>().text = "Stopping";
150            startRecordingButton.enabled = false;
151 #elif UNITY_ANDROID && !UNITY_EDITOR
152            SpeechRecognizer.StopIfRecording();
153            startRecordingButton.GetComponentInChildren<Text>().text = "Start";
154 #endif
155        }
156        else
157        {
158            SpeechRecognizer.StartRecording(true);
159            startRecordingButton.GetComponentInChildren<Text>().text = "Stop Recording";
160            resultText.text = "Say something!";
```

Figure 8: Part 2 of the code segment of the speech recognition function

The OnStarRecordingPressed() function shown in Figure 8 is attached to the Record button. When the Record button is pressed, the SpeechRecognizer will start to record the input from the users. It will automatically stop recording once it detects the user has stopped speaking or users can simply click again on the Record button to stop the recording function.

```
79    public void OnFinalResult(string result)
80    {
81        startRecordingButton.GetComponentInChildren<Text>().text = "Press once to record";
82        resultText.text = result;
83
84        if (result == vocDataScriptable.vocabulary[currentVoc].correctPronunciation)
85        {
86            answerText.text = "CORRECT";
87            answerText.color = Color.green;
88        }
89        else
90        {
91            answerText.text = "TRY AGAIN";
92            answerText.color = Color.red;
93        }
94        startRecordingButton.enabled = true;
95    }
```

Figure 9: Scripting of the feedback function

Figure 9 display the scripting of the feedback function. If the pronunciation recognized matches the corresponding vocabulary or phrase, a 'CORRECT' text in green color will be shown while in contrast, a 'TRY AGAIN' text in red color will appear.

3.4.3   Build APK for Android

The last step in the development phase is to build an APK file of Learn German From Scratch for Android platforms. Based on Figure 10, to build the application, click the File option on the navigation bar and choose Build Setting. It is important to make sure that the platform chosen for this application is Android and all the scenes must be added to the Scenes in Build box before proceeding to build.
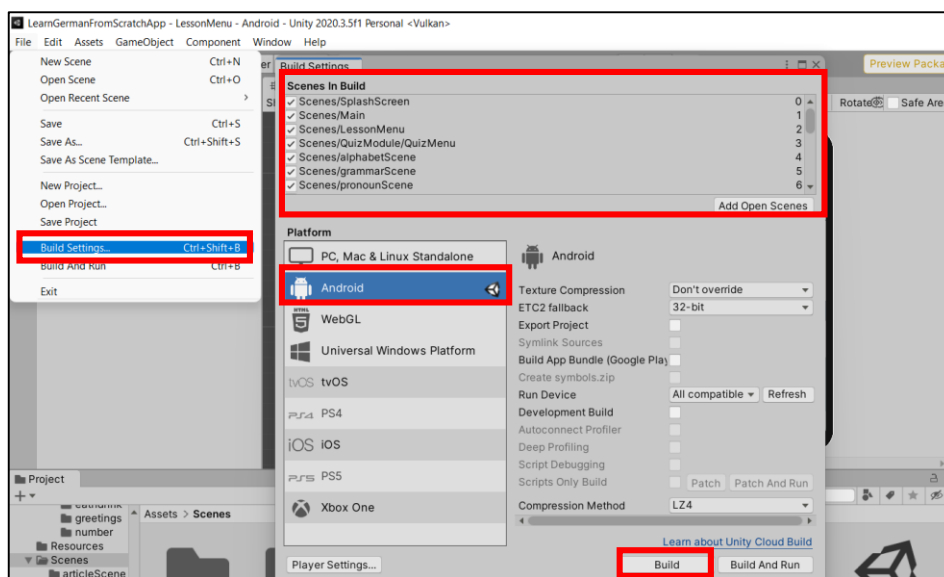
Figure 10: Build setting of Learn German From Scratch

3.5 Testing

After the application is developed, the next step is to ensure the application's functionality and user acceptance by conducting functional testing and user acceptance testing. Functional testing was performed by the developer throughout the development process to identify whether there is a problem or bug in the application. Through this process, there may have some improvements and updates to the application. Table 6 reveals the functional testing of the buttons and features of the application.

Table 6: Result of functional testing

Test	Expected Result	Actual Result
Start button	Navigates to Main Menu.	Works well as expected.
Learn Module button	Navigates to Learn Module.	Works well as expected.
Quiz Module button	Navigates to Quiz Module.	Works well as expected.
Lesson buttons	Navigate to the lessons in Learn Module.	Works well as expected.
Quiz buttons	Navigate to the quizzes in Quiz Module.	Works well as expected.
Return button	Return to the previous scene.	Works well as expected.
Pronunciation button	Play the associated audio clip.	Audio clips overlapped if clicked more than once.
Play button	Play the animation.	Works well as expected.
Pause button	Pause the animation.	Works well as expected.
Stop button	Stop the animation.	Works well as expected.
Record button	Record user's input voice.	Works well as expected.
Retry button	Replay the quiz.	Works well as expected.
Home button	Navigates to Main Menu.	Works well as expected.
Quiz answer buttons	Invoke the function in the script to check whether it is the correct answer for the question.	Works well as expected.
Character button	Insert the associated character into the box in Quiz Game.	Works well as expected.
Music button	Mute or unmute the background music.	Works well as expected.
Hint button	Display the hint for 2 seconds in Quiz Game.	Works well as expected.
Erase button	Erase the selected characters one-by-one in Quiz Game.	Works well as expected.
Clear button	Clear all the selected characters in Quiz Game.	Works well as expected.
Quiz score	Calculate the score correctly and able to display it on the result panel.	Works well as expected.
Speech recognition feedback	Return CORRECT or TRY AGAIN feedback on users' input voice.	Works well as expected.

As referred to the results of functional testing on Learn German Fron Scratch tabulated in Table 6, most of the buttons and features worked well as expected and there is no corrective action required except for the pronunciation button that will play the audio clips overlapping when it is being pressed more than once. Hence, corrective action has been taken to make sure that the audio clip will not be played overlapped.

Besides, to test the user acceptance level towards the developed application, a questionnaire was created based on the constructs of the Technology Acceptance Model (TAM) and has been distributed to 30 target users along with the APK file of the application to collect the users' reflection. The collected results of the testing will be analyzed and discussed in Section 4, Result and Discussion. Learn German From Scratch also has been released on Google Play Store to collect feedback from the users. The application can be downloaded for free and it is only compatible with Android version 11(API Level 30) and above. The reviews gained on the Google Play Store are attached in Appendix C.

4.   Results and Discussion

The user acceptance test has been carried out and 30 target users who are a student of German language class UTHM were involved in this test. To measure the user acceptance level towards Learn German From Scratch, Technology Acceptance Model (TAM) is adopted to collect the users' reflections after using the application based on the constructs introduced by Davis [10]. This model will predict the technology acceptance and adoption in the proposed application, and evaluate the user's perception and behavioral intention to use the proposed application [11]. TAM consists of four constructs, including Perceived Ease of Use (PEOU), Perceived of Usefulness (PU), User Satisfaction (US), and Attribute of Usability (AU) [12].

To conduct the user acceptance test, the APK file of Learn German From Scratch is released to 30 target users via Google Drive and WhatsApp together with a questionnaire in Google Form. A five-point Likert scale which is ranging from "Strongly agree" to "Strongly disagree" was used in the questionnaire and the questions is created based on the four constructs of the TAM model. The questionnaire is divided into 6 parts, which are Demographic Background of Respondent, Level of Understanding of German Basics, Perceived Ease of Use (PEOU), Perceived of Usefulness (PU), Attribute of Usability (AU), and User Satisfaction (US).

The first part of the questionnaire is the demographic background of the respondents. There are two questions included which are gender and German language background. Figure 11 shows the gender analysis of the 30 respondents who are involved in the testing process of Learn German From Scratch. The result founds that 18 out of them (60%) are female and another 40% (12 respondents) are male.
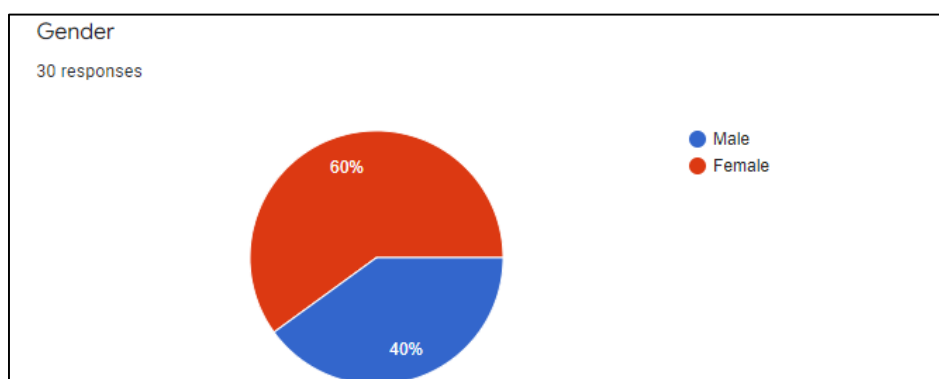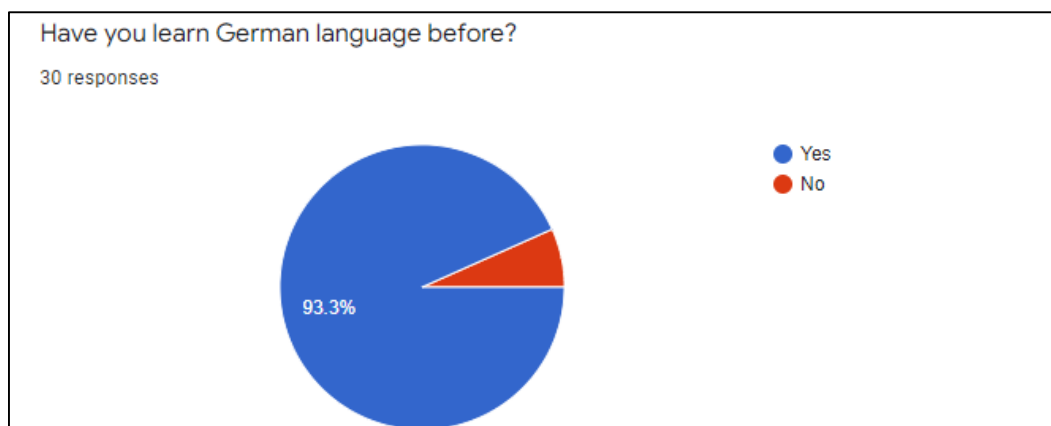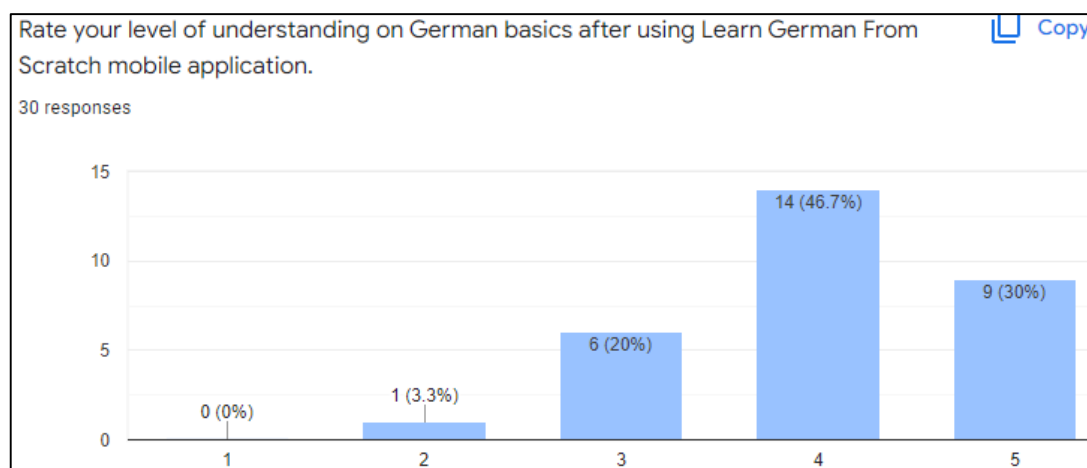

Figure 11: Gender analysis of respondents

Figure 12 displays the analysis of the German-language background of the respondents. From the responses, most of them (93.3%) have learned German before while there only two respondents (6.7%) have never learned this language before.

Figure 12: German language background of respondents

The second part of the questionnaire is to ask about the respondents' level of understanding of German basics after using Learn German From Scratch. The analysis result is shown in Figure 13. A linear scale is used to indicate the level of understanding which is rated from 1 (Extremely poor) to 5 (Excellent).

Figure 13: Analysis of the level of understanding of respondents on German basics

Based on Figure 13, most of the respondents rated their level of understanding of German basics after using the application at 3 and above. There are 6 respondents (20%) rated for 3, 14 of them (46.7%) rated for 4, and 9 of them (30%) rated for 5. Only 1 out of the 30 respondents (3.3%) rated 2. Hence, it can be concluded that the German basic knowledge of the target users can be improved after using Learn German From Scratch.

Perceived Ease of Use (PEOU) refers to the level of easiness of using Learn German From Scratch. There are 4 measured items included in the section of Perceived Ease of Use (PEOU) construct in the questionnaire as shown in Figure 14. From the survey, the level of easiness to use Learn German From Scratch falls at a satisfying level. The majority of the respondents strongly agreed with the four statements. For PEOU 1, 27 out of 30 respondents think that the application is easy to use and only one respondent rated neutral to this statement. For PEOU 2, 25 respondents strongly agreed and 5 respondents agreed that the application has provided clear guidance on how to use it. PEOU 3 is about the navigation through the application is simple and direct. This statement is strongly agreed by 27 respondents and agreed by 3 respondents. The last statement in PEOU is 'I can understand the use of all the buttons in the application'. 25 respondents strongly agreed and 5 out of 30 respondents agreed with this statement.
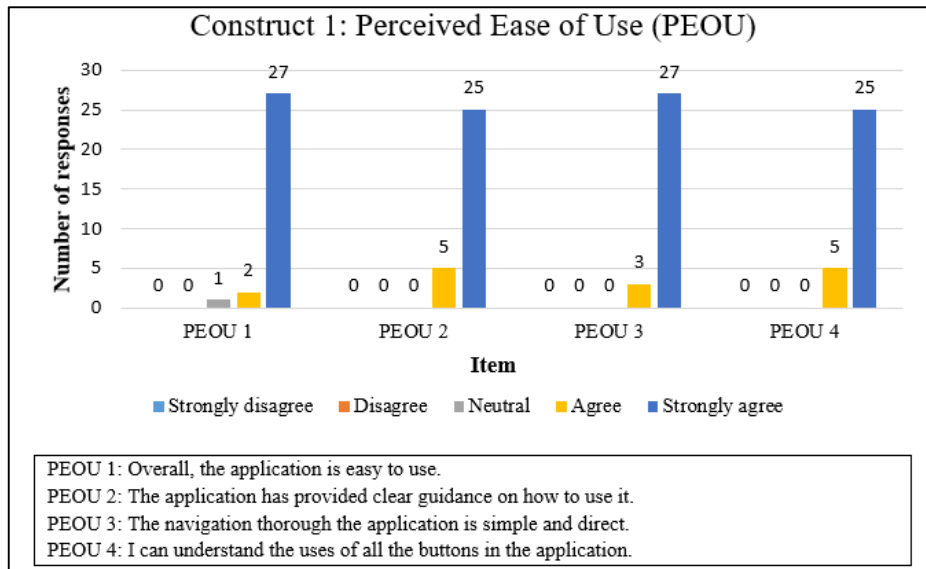
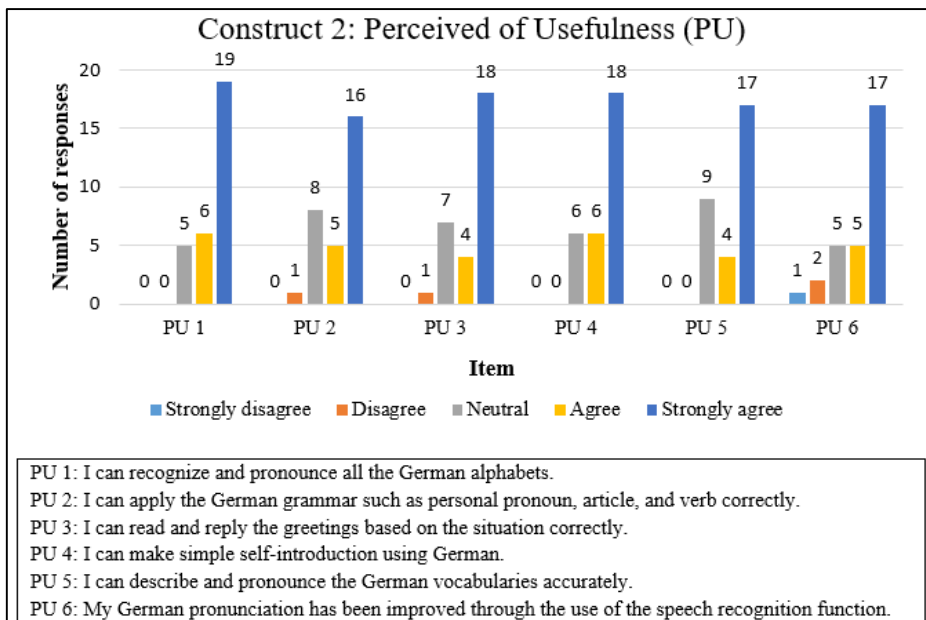**Figure 14: Analysis of Perceived Ease of Use (PEOU) on Usability**

Figure 15: Analysis of Perceived of Usefulness (PU) on Information

The second construct in TAM is Perceived of Usefulness (PU). This construct is to collect users' perceptions on whether the information provided in the application can improve their German basics. There are 6 measured items included as shown in Figure 15. For PU 1, 19 respondents strongly agreed and 6 respondents agreed with the statement 'I can recognize and pronounce all the German alphabets' while there are 5 of them shows neutral responses. For PU 2, 16 respondents strongly believe and 5 respondents believe that they can apply the German grammar correctly. For PU 3 and PU 4 which are about 'I can read and reply to the greetings based on the situation correctly' and 'I can make simple self-introduction using German' respectively, both of them are strongly agreed by 18 respondents. However, there is one respondent who disagrees with the statement of PU 2 and PU 3 For each PU 5 and PU 6, 17 respondents strongly agreed that they can describe and pronounce the German vocabulary accurately and their pronunciation also has been improved through the use of speech recognition function. Nevertheless, a respondent strongly disagreed and 2 respondents disagree with PU 6 which indicates that the speech recognition function could not help them to verify their German pronunciation. This is because the speech recognition function may not support by all devices.
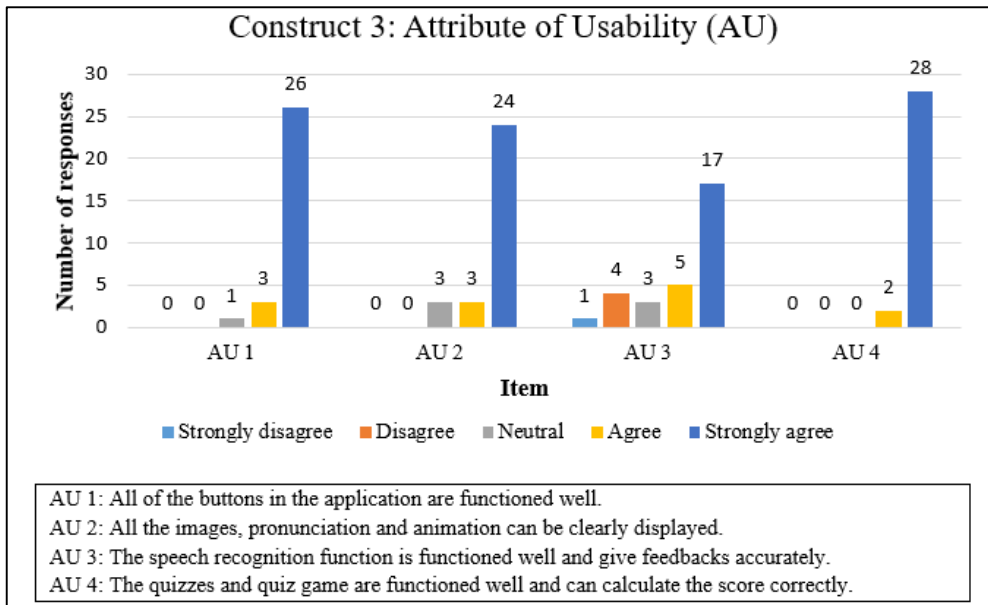
Figure 16: Analysis of Attribute of Usability (AU) on Functionality

Figure 16 shows the analysis result of Construct 3 which is Attribute of Usability (AU). This construct is to collect the user's perception of the functionality of the application. There are 4 measured items involved in this construct. It can be concluded that the 30 respondents are satisfied with the application in terms of functionality. As shown in Figure 16, AU 1, AU 2, and AU 4 are strongly agreed by 26 respondents, 24 respondents, and 28 respondents respectively. This result indicates that all the buttons and quizzes can function well, and all the images, pronunciations, and animations can be displayed. While for AU 3, 17 respondents give strongly agreed responses to the statement 'The speech recognition function functioned well and gives feedback accurately'. However, there are 1 respondent strongly disagreed and 4 respondents disagreed with this statement. There may have two reasons that lead to getting this result. One of the reasons is that speech recognition is not compatible with all devices as some of the devices may have no Speech Recognizer. Another reason is the function does not provide feedback accurately due to the environmental noise that will affect the performance of the speech recognition function.
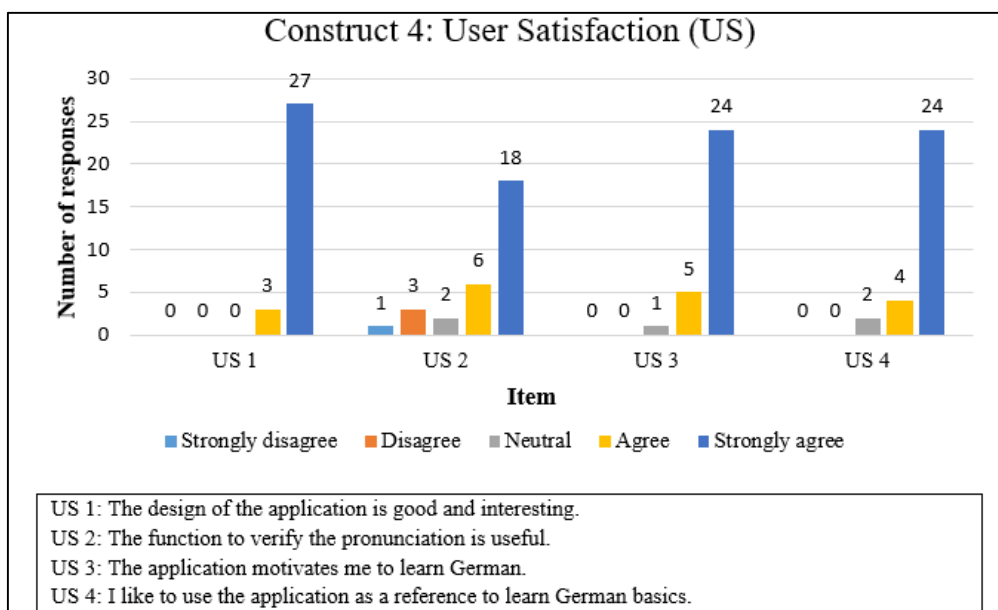
Figure 17: Analysis of User Satisfaction (US) on Performance

Figure 17 displays the analysis result of Construct 4, User Satisfaction (US). This construct is to observe the user's satisfaction level with the application. There are 4 measured items included. For US 1, 27 out of 30 respondents strongly agreed and 3 respondents agreed that the design of the application is good and interesting. For US 2, 18 respondents strongly agreed and 6 respondents agreed that the function to verify the pronunciation is useful. Only 2 respondents show neutral responses to this statement. There is one respondent and three respondents gave strongly disagree and disagreed responses to US 2. As discussed in the section earlier, this result may be due to the incompatible speech recognition function and lack of performance of the function caused by the background noise. For both US 3 and US 4, 24 respondents strongly agreed that the application motivates them to learn German and they like to use the application as a reference to learn German. Therefore, it can be concluded that most of the respondents are satisfied with the application in terms of design and functionality.
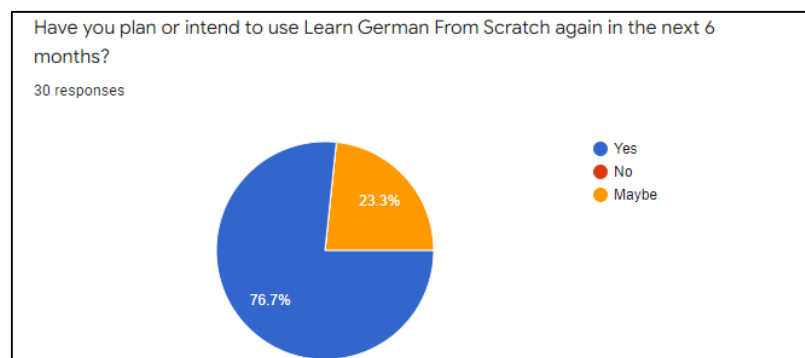
Figure 18: Analysis of respondent's behavioral intention on using the application

The last question in the questionnaire is to ask about the respondent's behavioral intention on using the application. The result collected as shown in Figure 18 states that 76.7% of them plan or intend to use the application again in the next 6 months and another 23.3% of the respondent may probably use the application in the future.

5. Conclusion

From the analysis of the results collected from the testing phase, it is found that more than 70% of the 30 respondents strongly agreed and agreed with each statement of the TAM constructs. Therefore, the feedback shows that the developed application has met the user requirements and has gained a high user acceptance level. It can be concluded that the development of Learn German From Scratch has successfully reached an end and the objectives of this project have been accomplished including the content of the application is designed in a visual auditory learning style, a speech recognition technology is adopted, and the functional testing and user acceptance test were performed on the developed application with a positive result gained.

Learn German From Scratch brings advantages as it is among the few existing Android application in the market today that provides the speech recognition function that can detect users' input voice and verify their German pronunciation. This function can improve the accuracy of their German pronunciation. The application also provides a comprehensive learning package that has included lessons about the German basics and quizzes that are suitable for those German beginners.

As coins have two sides, Learn German From Scratch has its limitations such as it only covers the German basics and only one set of questions is provided in each quiz. Therefore, the suggestion for the future improvement of the application is to provide more lessons such as an introduction to the history of German, and the dialogues or phrases in different scenarios. Also, it is suggested to provide different sets of questions in each quiz and make them randomly displayed so that the users will not do the same questions every time they play the quizzes. Lastly, it is hoped that this application can be continuously enhanced and can be used as a reference for the student in German language class.
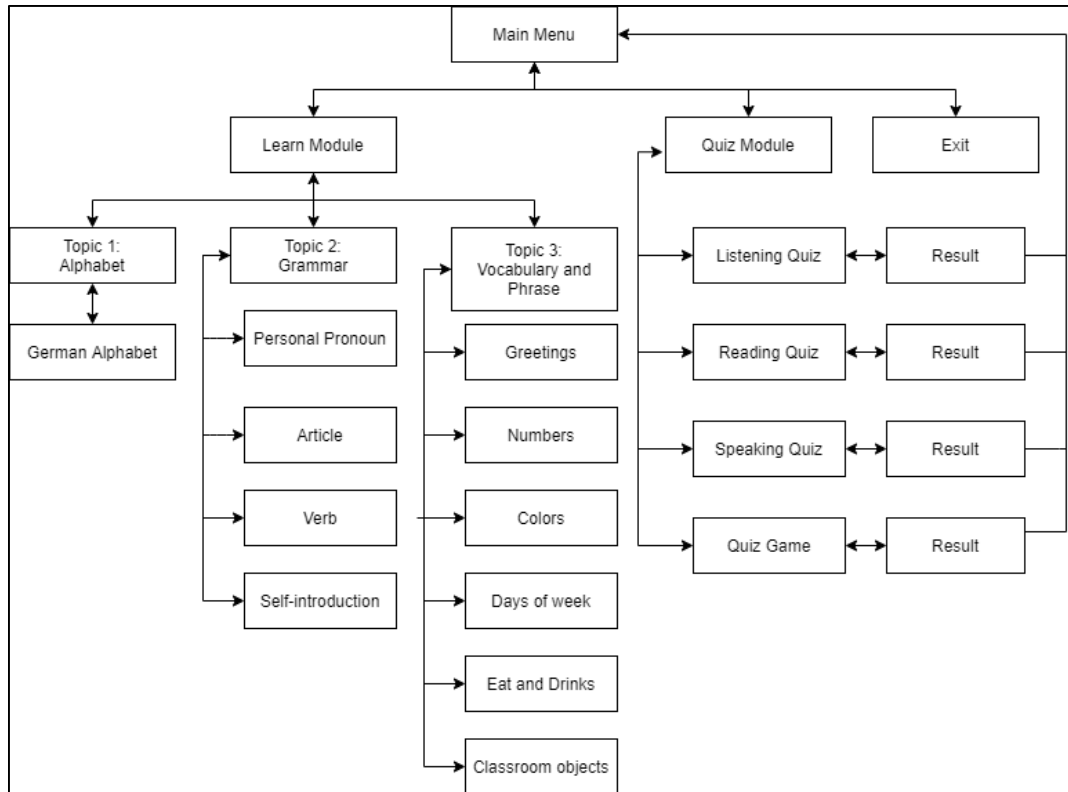
Acknowledgment

Appendix A

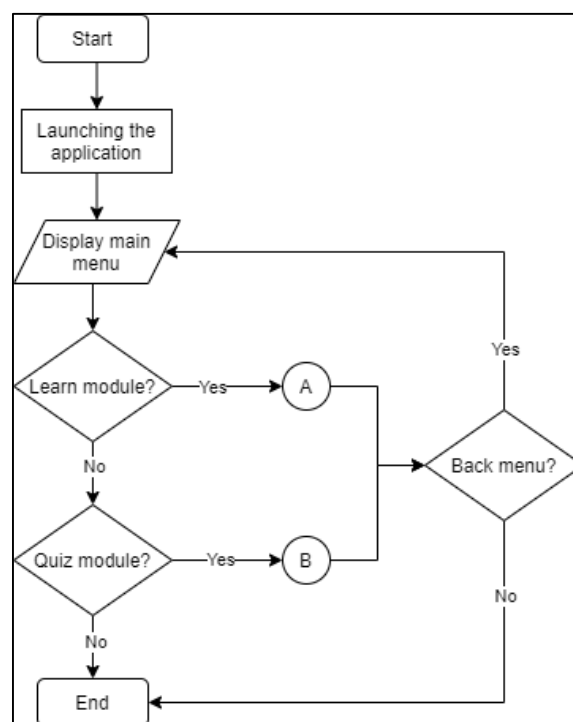**Figure 1: Navigational Structure**

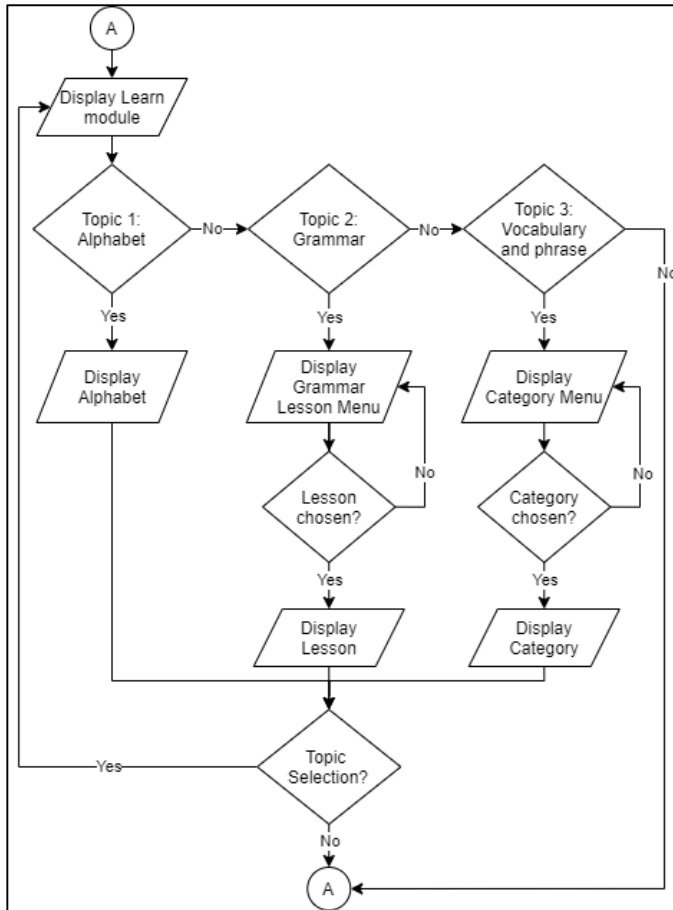

Figure 2(a): Flowchart of overall application
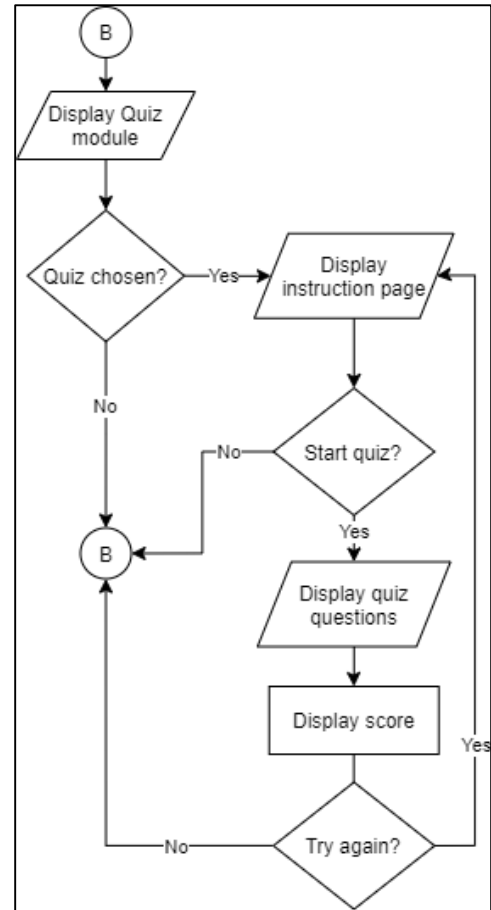
Figure 2(b): Flowchart of Learn Module

Figure 2(c): Flowchart of Quiz Module
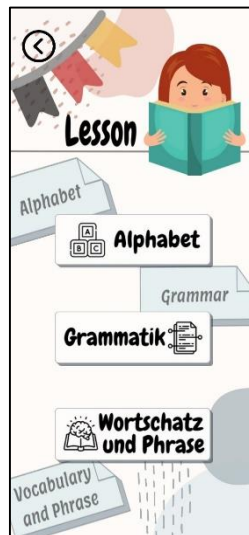
Appendix B
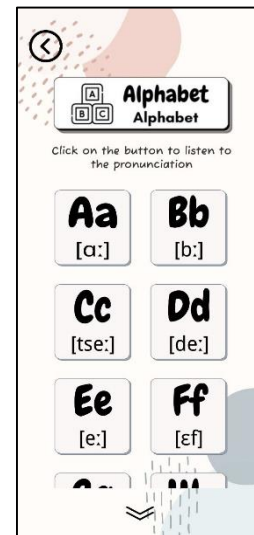

Figure 3: Main Menu

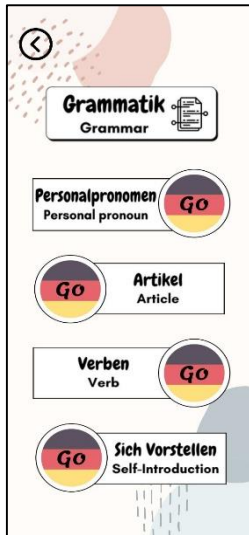Figure 4: Menu of Learn module

Figure 5: Alphabet lesson

Figure 6: Menu of Grammar lesson

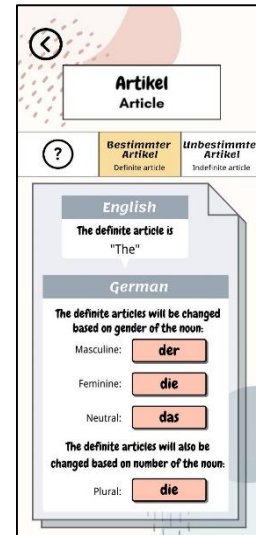**Figure 7: Topic 1 of Grammar lesson**

Figure 8: Topic 2 of Grammar lesson
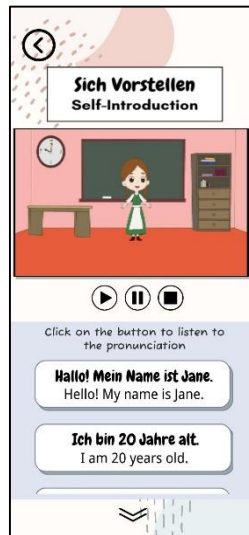

Figure 9: Topic 3 of Grammar lesson

Figure 10: Topic 4 of Grammar lesson

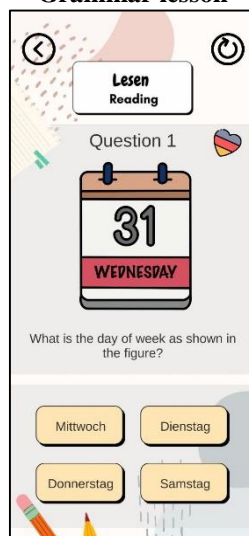**Figure 11: Vocabulary in flashcard form**

Figure 12: Vocabulary in list form
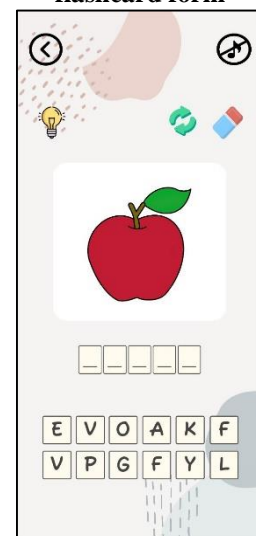

Figure 13: Quiz Question

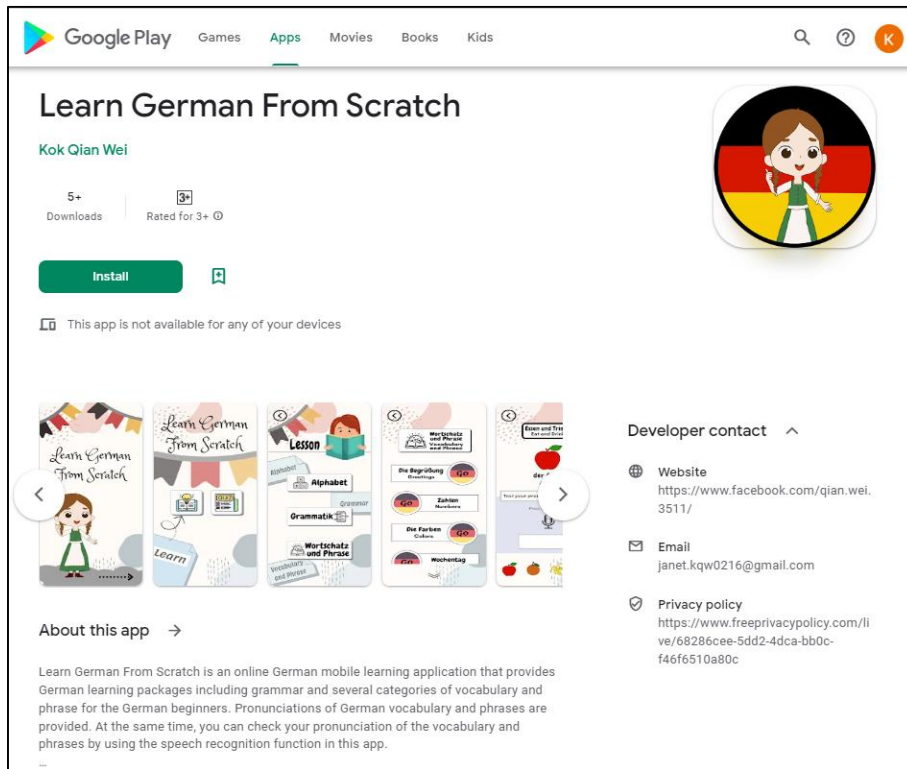**Figure 14: Quiz Game**

Appendix C

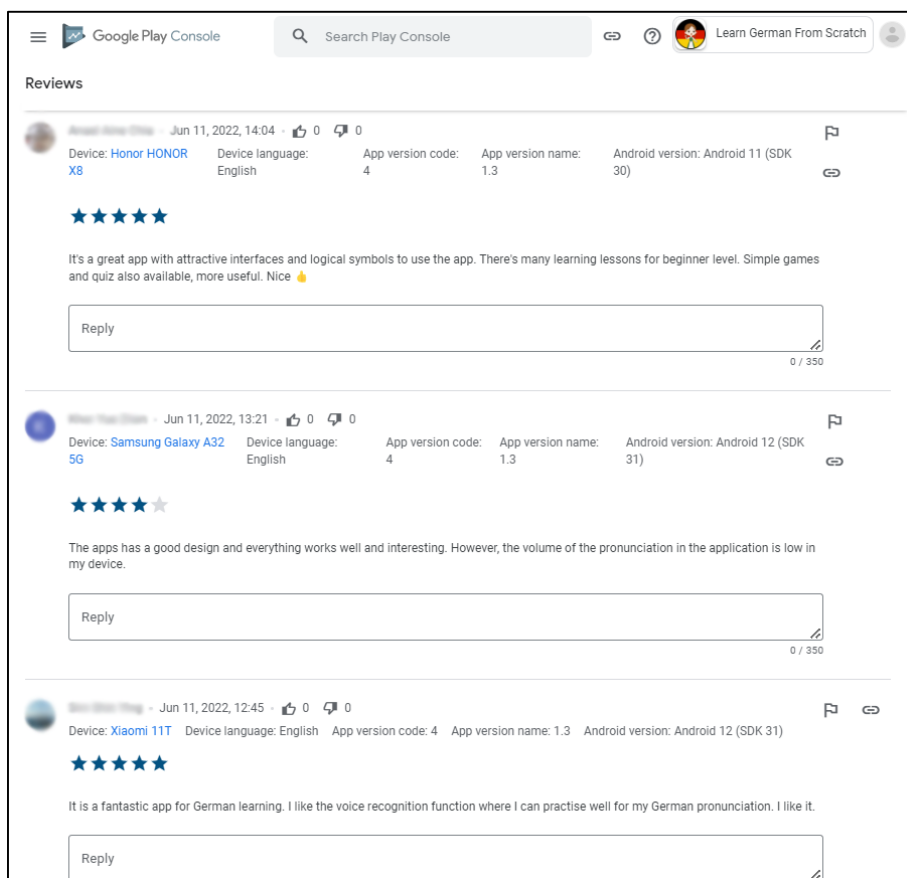**Figure 15: Learn German From Scratch on Google Play Store**

Figure 16: Users' reviews of Learn German From Scratch on Google Play Store

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