



## Development of an Android-Based Educational Game Using Voice Recognition for German Vocabulary Pronunciation Training

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### Abstract

German language learning at SMA Negeri 1 Rindi Umalulu faces several challenges. Teaching methods remain conventional, focusing on reading and writing vocabulary from textbooks followed by group repetition, with minimal individual practice. As a result, many students lack confidence in pronouncing vocabulary independently due to fear of making errors. Supporting facilities such as language laboratories, audio-visual media, and interactive applications are very limited, making it difficult for teachers to provide accurate pronunciation models. Consequently, students often imitate vocabulary with incorrect intonation. In addition, learning motivation is low because vocabulary learning is seen as memorization rather than understanding proper pronunciation. This condition leads to weak speaking skills, especially in pronouncing basic German vocabulary such as greetings. This study used the Multimedia Development Life Cycle (MDLC) method to develop an interactive learning medium. The Fisher–Yates Shuffle algorithm was applied to randomize questions, and voice recognition technology was used to train pronunciation. The results showed an improvement in students' pronunciation ability, with the average score increasing from 62.18 to 74.37. Black Box Testing achieved a 100% success rate, and the System Usability Scale (SUS) score reached 82.7, categorized as excellent.

*Keywords:* German Language, Voice Recognition, Fisher–Yates Shuffle (FYS), Multimedia Development Life Cycle (MDLC), SMA Negeri 1 Rindi Umalulu

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### 1. Introduction

Technology is the result of the development of science and human innovation, which has now become an inseparable part of everyday life. Technological advancements have not only affected the industrial, communication, and health sectors, but have also brought significant changes to the field of education. The presence of technology in education has helped both teachers and students create learning processes that are more effective, efficient, and engaging. In the past, learning focused solely on textbooks and lecture-based methods; today, technology enables the use of various digital media to support the learning process. One of the most widely used forms of technology in education is multimedia, which is a combination of text, images, sound, animation, and video that can present learning materials in a more interactive and easily understood manner. Multimedia not only serves as a visual aid but also helps create a more enjoyable learning atmosphere and increases students' motivation. Among the various types of multimedia, one of its applications in education is educational games.

Through the implementation of educational games in education, students can learn various types of knowledge and skills, including foreign language vocabulary and pronunciation skills. Educational games are an attractive option because they can transform learning activities that are usually monotonous into more interactive and challenging experiences. Through educational games, students can not only expand their vocabulary but also practice correct pronunciation through direct feedback from the system. In addition, educational games encourage students to be more active, allowing their language skills, including pronunciation, to develop gradually. Therefore, the use of educational games as part of multimedia in education can serve as an innovative strategy to improve foreign language proficiency in the digital era. However, many students still face difficulties in the process of learning foreign languages, one of which occurs at SMA Negeri 1 Rindi Umalulu.

Based on interviews conducted with teachers at SMA Negeri 1 Rindi Umalulu, the teaching and learning process of the German language still faces several serious challenges. The results indicate that most students do not yet have a good understanding of the material, particularly in terms of German vocabulary pronunciation. To date, there has been no specific examination for German pronunciation. Pronunciation assessment is only conducted through observation during classroom conversations or dialogues, while official examinations are written in nature. Based on the written German language examination scores obtained from 32 students, the average score was 81.18,

with scores ranging from 73 to 88. To obtain a clearer picture of students' pronunciation abilities, a German pronunciation test was conducted by assessing five indicators: vowel accuracy, intonation, pronunciation accuracy, correct letter order, and speaking fluency. Based on the results of this assessment, the average score was 41.40 out of a maximum score of 100, with most students scoring between 25 and 45 and only a few reaching a score of 50. The significant difference between the written examination scores and the pronunciation test results indicates that students' theoretical knowledge is better than their practical speaking skills. This condition occurs due to the conventional teaching methods still being used, where teachers primarily rely on textbooks as the main learning resource. Teachers usually read and write vocabulary from the book, after which students repeat it together without individual pronunciation practice. As a result, many students lack confidence when asked to pronounce vocabulary independently due to fear of making pronunciation errors.

In addition, supporting facilities for foreign language learning, such as language laboratories, audio-visual equipment, or interactive applications for pronunciation practice, are still very limited. This makes it difficult for teachers to provide varied examples of correct pronunciation, causing students to often imitate with incorrect intonation. Another issue is the low level of students' motivation to learn German. The learning process tends to be monotonous because there is no media that can make students more active and enthusiastic. Consequently, the learning objectives of German language instruction, which should emphasize oral communication skills, have not been optimally achieved at SMA Negeri 1 Rindi Umalulu.

## **2. Previous Research**

### **2.1. Game**

The term game originates from the English language, and in the Indonesian dictionary, the term game is defined as a form of play or competition. A game can be interpreted as a structured or semi-structured activity that is generally carried out for entertainment and is sometimes used as a learning tool. Over time, games have evolved beyond mere entertainment and now serve various functions, such as improving thinking skills, training strategic abilities, and strengthening teamwork [1].

### **2.2. Educational Games**

Educational games are games specifically designed to stimulate thinking skills, improve concentration, and assist in the problem-solving process. Such games are not only entertaining but also provide significant cognitive benefits, especially for early childhood learners who have a high level of curiosity about their surrounding environment [2].

### **2.3. Language**

Language is a communication tool used by humans in social interactions. Through language, individuals are able to express feelings, thoughts, and opinions, as well as respond to various phenomena occurring in their surrounding environment. Language also serves as an essential means for building relationships, conveying information, and transmitting cultural values from one generation to the next [3].

### **2.4. API**

An Application Programming Interface (API) is an interface used to access applications or services from a program by calling functions through the Hypertext Transfer Protocol (HTTP) and receiving responses in the form of JavaScript Object Notation (JSON) or Extensible Markup Language (XML). APIs enable developers to utilize functions that are already available in other applications or services [4].

### **2.5. Voice Recognition**

Voice recognition, also known as speech recognition, is the development of techniques and systems that allow computers to receive input in the form of spoken words and convert them into recognizable data or commands [5].

### **2.6. Multimedia Development Life Cycle (MDLC)**

The Multimedia Development Life Cycle (MDLC) method is an appropriate approach for designing and developing multimedia applications that combine various media elements such as images, audio, video, animations, and others. The MDLC method consists of six stages: Concept, Design, Material Collecting, Assembly, Testing, and Distribution [6].

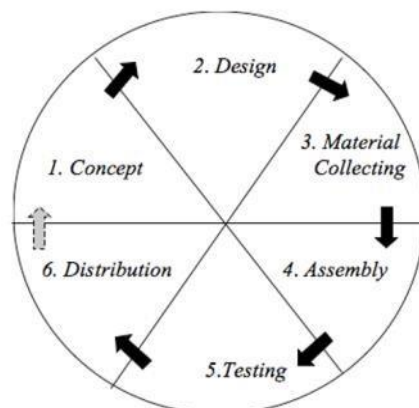


Fig. 1: Multimedia Development Life Cycle (MDLC)

The Multimedia Development Life Cycle (MDLC) consists of six stages, as follows:

1. **Concept**  
This is the initial stage, which aims to formulate the basic idea of the application, identify the target users, and analyze the system requirements.
2. **Design**  
This stage involves defining the structure and workflow of the application in more detail. The main outputs of this stage include user interface design, storyboards, and navigation design.
3. **Material Collecting**  
At this stage, all multimedia elements are collected to support the application content, such as learning material texts, images, and audio.
4. **Assembly**  
The assembly or development stage involves integrating all the collected materials based on the design created in the previous stage, following the storyboard and navigation structure of the application.
5. **Testing**  
This stage involves testing the application after all materials have been integrated during the assembly stage. The testing process is conducted to determine whether the developed application functions properly.
6. **Distribution**  
The distribution stage is the final stage, which aims to deliver the application to end users through digital platforms so that it can be accessed and used effectively.

## 2.7. Fisher–Yates Shuffle algorithm

The Fisher–Yates Shuffle algorithm is widely regarded as an optimal algorithm for generating truly random and unbiased permutations. The shuffling process of the Fisher–Yates algorithm is highly efficient in terms of time complexity, as illustrated in its algorithmic flowchart, and it does not require a large amount of memory storage capacity [7].

The Fisher–Yates Shuffle algorithm generates random permutations sequentially, ensuring that questions that have already appeared will not reappear within the same session. This prevents repetition, making the game less monotonous and more challenging for users. The shuffling process of the Fisher–Yates Shuffle algorithm is illustrated using a flowchart in Figure 2.

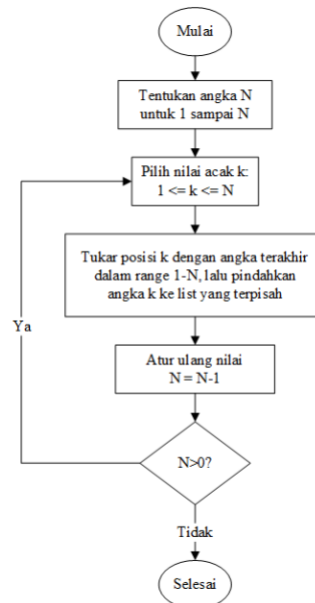


Fig. 2: Fisher-Yates Shuffle Algorithm

### 3. Results And Discussion

Data collection methods are systematic processes used to obtain relevant information to support the implementation and analysis of a study. In this research, data were collected to support the development and evaluation of a German language educational game based on the Fisher-Yates Shuffle (FYS) algorithm. The data collection methods employed include observation, interviews, documentation, and literature review.

#### 1. Observation

Observation was conducted at SMA Negeri 1 Rindi Umalulu to obtain an overview of the German language learning process for Grade XII students, particularly in vocabulary learning. The results showed that teaching was still dominated by lecturing and the use of textbooks without interactive learning media, causing students to be passive, less enthusiastic, and to experience difficulties in completing German language exercises.

#### 2. Interview

Interviews were conducted with the Grade XII German language teacher, Mrs. Adriyati May Nggiri, S.Pd. The results indicated that many students experienced difficulties in understanding German vocabulary and felt bored with monotonous teaching methods. The teacher emphasized the need for more interactive learning media to improve students' motivation and comprehension, which became an important basis for designing the educational game.

#### 3. Documentation

The documentation method was used to collect supporting data in the form of students' learning outcomes and teaching materials. The teaching material used was the textbook *Super Deutsch 2* for Grade XII SMA/MA, with a focus on Lektion 1, 2, and 3, namely *Kleidung* (Clothing), *Hobbys* (Hobbies), and *Freizeitbeschäftigung* (Leisure Activities). This textbook was selected because it is an official learning resource aligned with the curriculum and the basic competencies of German language learning at the senior high school level.

#### 4. Literature Review

The literature review was conducted by examining books, journals, scientific articles, and previous studies relevant to the development of German language educational games. This activity aimed to obtain a strong theoretical foundation related to German vocabulary learning, educational games, the Fisher-Yates Shuffle (FYS) algorithm, and the Multimedia Development Life Cycle (MDLC) development method, as well as to strengthen the originality and contribution of this research.

## 4. Implementastion and Testing

### 4.1. Implementation of Game Development Using Unity

At the implementation stage, the Android-based educational game was developed using Unity as the main development platform. Unity was chosen for its ability to integrate multimedia elements and support interactive Android applications. It enables the combination of text, images, audio, and animations, while using C# to manage game logic, user interaction, navigation, and learning evaluation features.

The development process began by creating a new 2D project in Unity Hub, with screen resolution set to  $720 \times 1280$  and portrait orientation to ensure optimal performance on Android devices. The application interface was organized into panels, including the main menu, learning menu, gameplay, final score, instructions, about, and exit panels, making navigation structured and easy to manage.

The learning menu provides German vocabulary materials categorized into clothing, hobbies, and activities. Each category presents visual content with images, text, and audio pronunciation, and includes vocabulary quizzes to reinforce learning. The game also features three difficulty-based levels designed to gradually increase learning motivation and pronunciation skills.

Speech recognition technology is used to train pronunciation. Users pronounce displayed German vocabulary, which is recorded via the Android device's microphone and processed through a speech recognition service using an API key. The recognized speech is matched with the target vocabulary to determine accuracy. All audio processing, matching, scoring, and feedback are handled using C# scripts, providing immediate feedback and final scores to users.

Navigation between panels is controlled through C# scripts linked to navigation buttons such as next, back, audio, replay, and exit. The final implementation stage involves building the application into an APK file using Unity's Build Settings, making the educational game ready for installation and use on Android devices as an interactive learning medium for German vocabulary pronunciation.

## 4.2. Implementation of The Fisher–Yates Shuffle Algorithm

```
void GenerateUrutanSoalFisherYates()
{
    urutanSoal = new int[totalSoal];
    for (int i = 0; i < totalSoal; i++) urutanSoal[i] = i;
    for (int i = totalSoal - 1; i > 0; i--)
    {
        int r = UnityEngine.Random.Range(0, i + 1);
        (urutanSoal[i], urutanSoal[r]) = (urutanSoal[r], urutanSoal[i]);
    }
}
```

Fig. 3: Implementation of The Fisher–Yates Shuffle Algorithm

Figure 3 shows the implementation of the Fisher–Yates Shuffle algorithm used to randomize the order of questions fairly and uniformly. This algorithm aims to generate a random permutation of a set of question indices without repetition, ensuring that each question has an equal chance of appearing in any position. The process begins with the initialization of an array named `urutanSoal`, whose length corresponds to the total number of questions (`totalSoal`). Each element of the array is filled with sequential index values starting from 0 to `totalSoal - 1`. Next, the shuffling process is performed using the Fisher–Yates Shuffle algorithm by iterating from the last index to the first. In each iteration, the system selects a random index (`r`) within the range of 0 to the current index (`i`), then swaps the values at index `i` and index `r`. The implementation of this algorithm ensures an unbiased shuffle, as every possible order has an equal probability of being generated. Therefore, applying the Fisher–Yates Shuffle algorithm in this game increases the variation in question presentation and reduces the likelihood of users becoming bored with the same question sequence.

## 4.3. Application Implementation

The research results are obtained from the study conducted according to the defined research steps and stages, producing outputs in the form of an educational game and its testing results. The Android-Based Educational Game Using Voice Recognition to Train German Vocabulary Pronunciation at SMA Negeri 1 Rindi Umalulu was designed to address existing problems and improve students' ability to pronounce German vocabulary. After the educational game was fully developed, black box testing was conducted to ensure that each function operated as expected. In addition, the System Usability Scale (SUS) method was used to evaluate the usability level of the application based on user perceptions. To measure students' abilities before and after using the learning application, pre-test and post-test evaluations were also conducted.

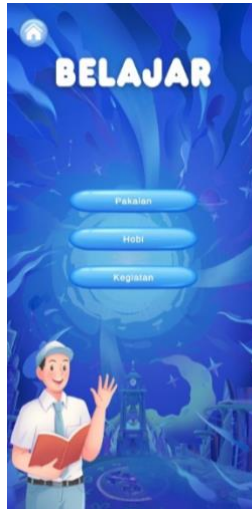
### 1. Main Page



Fig. 4: Main Page

Figure 4 shows the main page of the educational game, which displays the game title at the top and five main buttons: the Learn button to access learning materials, the Play button to access game levels, the Instructions button to display usage guidance, the About button to show application information, and the Exit button to close the application.

## 2. Learning Menu Page



**Fig. 5:** Learning Menu Page

Figure 5 shows the Learning Menu page of the German language educational game. This page presents three learning material options: Clothing, Hobbies, and Activities. Each button represents a different vocabulary category, allowing users to select one according to the desired topic.

After selecting a category, users are directed to the learning page, which displays a list of vocabulary items along with audio pronunciations. This feature enables students to practice their listening skills and improve their ability to pronounce the words correctly.

## 3. Learning Material Page



**Fig. 6:** Learning Material Page

Figure 6 shows the learning material page displaying German vocabulary along with images and a button to play the pronunciation audio. In the top-left corner, there is a Home icon to return to the Learning Menu page. Additionally, left navigation buttons are provided to move to the previous material, while right navigation buttons are used to proceed to the next material.

#### 4. Level Page



Fig. 7: Level Page

Figure 7 shows the level menu page of the educational game, which displays three difficulty levels: Level 1, Level 2, and Level 3. Initially, only Level 1 is unlocked, while Level 2 and Level 3 are locked. After completing Level 1 and achieving a score of 70, Level 2 becomes unlocked. Similarly, Level 3 is unlocked after completing Level 2 with a score of 80. In the top-left corner, a Home icon is provided, allowing users to return to the main page at any time. The Fisher–Yates Shuffle (FYS) algorithm is activated immediately after the player selects a game level and before the questions are displayed. The algorithm is used to randomize the order of questions from the available question bank and operates in the background each time the game presents a new question, whether in Level 1, Level 2, or Level 3.

#### 5. Gameplay Page



Fig. 8: Gameplay Page

Figure 8 shows the gameplay page available in Level 1, Level 2, and Level 3. On this page, the Home icon is located at the top-left corner to return to the Level menu, the Score is displayed at the top-right corner to show the current score, a timer is placed in the center to track the time for answering questions, and the question number appears below the Home button. For each level, students are presented with an image and the corresponding German vocabulary text that they must pronounce. Each level contains 10 questions that are randomized using the Fisher–Yates Shuffle (FYS) algorithm to ensure the question order differs across game sessions. Students are required to press the record button and pronounce the displayed vocabulary. To answer a question, the student clicks the record button (speaker icon) until the text "Recording" appears. After speaking, they click the record button again until "Processing Speech" is displayed. The system records and analyzes the student's voice to determine whether the pronunciation is correct. Correct answers receive 10 points, while incorrect answers receive no points. Immediate feedback is provided below the record button: correct answers are displayed in green text with audio of the correct pronunciation, while incorrect answers are displayed in red with the correct audio pronunciation. Each level has different difficulty settings in terms of time and vocabulary complexity. In Level 1, students are given 5 seconds to pronounce short and simple words. In Level 2, 10 seconds are provided for more challenging vocabulary. Level 3 allows 15 seconds to pronounce longer words with higher pronunciation difficulty.

## 6. Final Score Page

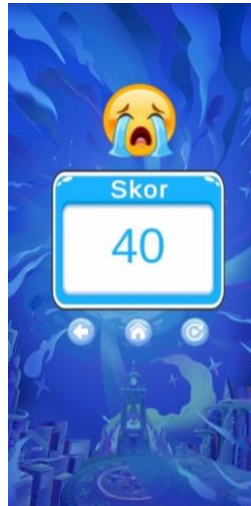


Fig. 9: Final Score Page

Figure 9 shows the Final Score page of the game, which displays the results after the user completes a level. This page also includes a Home icon to return to the main page, a Play Again icon to restart the game, and an arrow icon to go back to the Level menu.

## 7. Instructions Menu Page



Fig. 10: Instructions Menu Page

Figure 10 shows the Instructions page, which serves as a guide for users to play the German educational game. A Back button is provided at the bottom, allowing users to easily exit the instructions page.

## 8. About Menu Page



Fig. 11: About Menu Page

Figure 11 shows the About page, which provides information about the purpose and developers of the educational game. A Back button at the bottom allows users to exit the About page and return to the main page.



10.	3	4	3	3	4	3	3	4	4	3	34	85
11.	4	3	3	3	4	4	4	4	4	3	36	90
12.	2	2	3	3	3	3	3	3	3	3	28	70
13.	4	4	3	4	4	4	4	4	3	4	38	95
14.	4	4	3	3	3	3	3	3	4	3	33	82.5
15.	4	3	4	4	4	4	4	3	4	4	38	95
16.	3	2	3	3	3	3	3	3	3	3	29	72.5
17.	4	4	4	3	4	4	4	4	4	4	39	97.5
18.	3	3	4	4	3	4	3	3	4	4	35	87.5
19.	4	4	4	3	4	3	4	3	4	3	36	90
20.	3	2	3	3	3	3	3	2	3	3	28	70
21.	4	4	4	4	4	4	4	4	4	4	40	100
22.	3	3	4	4	3	3	2	3	4	4	33	82.5
23.	4	3	4	3	4	3	4	3	4	3	35	87.5
24.	3	2	3	3	3	3	3	3	3	3	29	72.5
25.	4	4	4	4	4	4	4	3	3	4	38	95
26.	3	3	4	4	3	3	3	4	4	3	34	85
27.	4	3	4	3	4	3	4	3	4	3	35	87.5
28.	3	2	3	3	4	3	3	2	4	3	30	75
29.	4	4	4	4	4	4	4	4	4	4	40	100
30.	3	3	3	3	3	3	3	3	3	3	30	75
31.	4	3	3	4	4	3	4	3	4	2	34	85
32.	3	2	3	3	3	3	3	3	3	3	29	72.5
33.	4	4	4	4	4	4	4	4	4	4	40	100
34.	3	3	3	3	3	3	3	3	3	3	30	75
35.	4	3	4	4	4	4	4	3	4	4	38	95
Total											2895	

The total SUS score from all respondents was 2895, as shown in Table 2. To calculate the average SUS score, the total score was divided by the number of respondents, as expressed in definition 1:

$$\bar{x} = \frac{2895}{35} = 82,7 \tag{1}$$

**Definition 1:** Average SUS score

The results show an average SUS score of 82.7. Based on this average, the system’s usability is evaluated according to the SUS grading system, as illustrated in Figure 13.

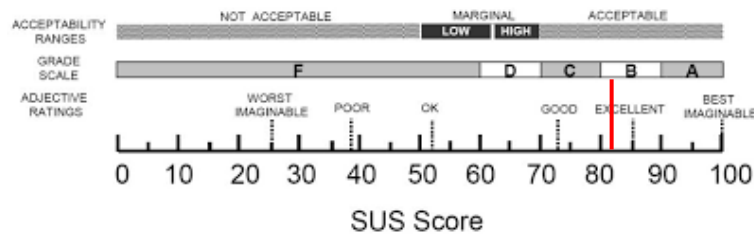


Fig. 13: SUS Score

The determination of Acceptability Ranges, Grade Scale, and Adjective Rating is used to measure user satisfaction with the educational game. With an average score of 82.7, the system is categorized as “Acceptable”. In the grade scale, it falls into category B, and in the adjective rating, it is considered “Excellent”. The score being above average indicates that the system received a high level of user satisfaction.

#### 4.6. Pre-test and Post-test

The testing in this study used pre-test and post-test methods. The tests were conducted on 12th-grade students majoring in Language at SMA Negeri 1 Rindi Umalulu, consisting of 32 students. Both pre-tests and post-tests were given to the students, with the scores obtained presented in Table 3.

Table. 3: Pre-test and Post-test

No	Nama Siswa	Nilai	
		Pre-test	Post-test
1.	AGNES	70	80
2.	ALDI	80	90
3.	ANA	30	70
4.	ASTIANI	90	90
5.	DEWI	80	80
6.	ERNAWATI	40	70

7.	ESTHER	30	60
8.	FELICIA	60	80
9.	FENTRISIA	50	70
10.	IDANIL	70	60
11.	IMEL	80	90
12.	IRNA	70	80
13.	JENIFER	60	70
14.	JIALATVENIA	50	80
15.	JIHAN	80	80
16.	KRISNA	70	60
17.	MAGRETH	40	70
18.	MEKSI	30	60
19.	MELANI	70	80
20.	MELDA	80	90
21.	MERSI	60	70
22.	PUTRI	70	60
23.	RAMBU	80	80
24.	RIANTI	70	70
25.	RICARDO	50	70
26.	RONI	70	80
27.	SELBIA	30	60
28.	SISKA	60	80
29.	VERONIKA	70	70
30.	VIVILIA .N	60	80
31.	VIVILIA .H	90	90
32.	YAKOBUS	50	60
Total		<b>1990</b>	<b>2380</b>

Table 4.4 shows the results of the pre-test and post-test conducted. The total pre-test score in this study is 1,990, while the total post-test score is 2,380, as shown in Table 4.3. For the next calculation, the average score for each test is determined. The formula to calculate the average pre-test score and the average post-test score is shown below:

The calculation of the average pre-test score is shown in definition 2:

$$\begin{aligned}\bar{x}_{pre} &= \frac{1990}{32} \\ \bar{x}_{pre} &= 62.18\end{aligned}\quad (2)$$

**Definition 2:** Average Pre-test Score

The calculation of the average post-test score is shown in definition 3:

$$\begin{aligned}\bar{x}_{post} &= \frac{2380}{32} \\ \bar{x}_{post} &= 74.37\end{aligned}\quad (3)$$

**Definition 3:** Average Post-test Score

From the calculation of the students' average scores, the pre-test average is 62.18 and the post-test average is 74.37. Based on these average scores, the percentage increase in students' scores is calculated using the formula shown in definition 4:

$$\begin{aligned}\text{Percentage figure} &= \frac{74,37-62,18}{62,18} \times 100\% \\ \text{Percentage figure} &= 19,59\%\end{aligned}\quad (4)$$

Based on the pre-test and post-test results, students' scores increased by approximately 19.59% after learning and playing with the educational game. Based on these results, it can be concluded that the educational game application developed can be used to help students learn and improve their ability in pronouncing German vocabulary at SMA Negeri 1 Rindi Umalulu.

## 5. Conclusion

Based on the analysis and testing of the Android-Based Educational Game Using Voice Recognition to Train German Vocabulary Pronunciation at SMA Negeri 1 Rindi Umalulu, it was shown that the existing features functioned as expected, effectively addressing problems arising from manual learning processes, such as limited facilities and low interactivity. The trial results indicated an improvement in students' ability to pronounce German vocabulary at SMA Negeri 1 Rindi Umalulu, as evidenced by the pre-test and post-test results. The average pre-test score was 62.18, while the average post-test score increased to 74.37, with a difference of 12.19 points or an

improvement of 19.59%. This demonstrates that the use of the Android-Based Educational Game Using Voice Recognition to Train German Vocabulary Pronunciation can enhance students' understanding and engagement in the learning process. Testing using the Black Box Testing method showed a 100% success rate, indicating that the application functioned correctly according to its intended features. Meanwhile, testing with the System Usability Scale (SUS) yielded an average score of 82.7, which indicates that the application has a very good level of usability and is suitable for use. Therefore, the Android-Based Educational Game Using Voice Recognition can improve the German vocabulary pronunciation skills of 12th-grade Language Major students at SMA Negeri 1 Rindi Umalulu.

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