

## PAPER

# Design and Development of Sign Language Learning Application for Special Needs Students Based on Android Using Flutter

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## ABSTRACT

Sign language is a communication system used by individuals with hearing impairments to interact and convey messages without using verbal sounds. Sign language has its own unique grammatical structure and vocabulary, enabling sign language users to express ideas and emotions through facial expressions, hand movements, and body positions. In this research, we explore important aspects of sign language, including its uniqueness, complexity, and diversity across different countries and cultures. We also discuss the role of sign language in facilitating communication, education, and social inclusion for the deaf community. This research highlights the significance of introducing and developing sign language competence among the general public, educators, and professionals in the fields of healthcare and social services. The development of the sign language learning media utilizes the Multimedia Development Life Cycle method. The main application used in creating the sign language learning media is Flutter, along with supporting applications such as Adobe Illustrator 2020 and Adobe Photoshop CC 2019. The features included in this application are finger alphabet signs, number signs, video tutorials for numbers and letter signs, quizzes, and learning objectives.

## KEYWORDS

sign language, Flutter, Android, Adobe Photoshop, Adobe Illustrator

## 1 INTRODUCTION

Inclusive education is crucial for ensuring accessibility and equity in education for all students, including those with special needs. Students with hearing impairments often face challenges in verbal communication, and sign language serves as a vital communication tool for the deaf community. Therefore, inclusive education refers to a system of educational services that requires children with special needs to learn in their nearest schools, in regular classrooms, alongside their peers of the

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same age, This research focuses on developing an Android-based sign language learning application for letter and number recognition, utilizing the Flutter framework, specifically designed for SLB-B (Special School Part B) SLBN 2 Padang, catering to first-grade students who are deaf.

The application aims to effectively and engagingly enhance their sign language skills. Through an intuitive user interface, gradual presentation of sign language materials, and integration of features like gamification and visually appealing displays, the application aims to enrich the learning experience and promote greater participation of students with special needs in inclusive education.

## 2 THEORETICAL BASIS

### 2.1 Learning media

Instructional media is a valuable aid utilized by educators to ensure effective learning takes place. Media encompasses various tools and resources that convey messages from the sender to the receiver, stimulating the mind, emotions, attention, and interest of students in order to facilitate the learning process [1]. Instructional media can aid teachers in establishing a dynamic, non-monotonous, and engaging learning atmosphere [2]. The use of learning media is an integral and inseparable part of the learning methods used [3].

### 2.2 Sign language

Sign language is a tool used by individuals who are deaf or hard of hearing to communicate with the hearing community through hand gestures, facial expressions, and body movements that form symbols representing letters or words [4]. Sign language is a unique language, as each country has its own distinct sign language [5].

SIBI (Sistem Isyarat Bahasa Indonesia/Indonesian Sign System) is a communication medium specifically designed for individuals who are deaf or hard of hearing. It combines spoken language, sign language, facial expressions, and other movements. SIBI has been established as the official sign language by the government for use in special schools (SLB) for the deaf [6].

BISINDO (Bahasa Isyarat Indonesia/ Indonesian Sign Language) is a natural sign language that originated from the indigenous culture of Indonesia. It is easily used in the daily interactions of the deaf community. BISINDO is a sign language that is acquired naturally by deaf individuals, similar to regional languages, and it exhibits unique characteristics in different regions [7].

### 2.3 Hearing impaired

The term “tunarungu/deaf” is derived from the words “tuna,” which means lacking, and “rungu,” which means hearing. An individual, be it an adult or a child, is considered “tunarungu” if they are unable to hear or have a limited ability to hear sounds or voices [8].

DHH (Deaf and Hard of Hearing) students are a highly diverse population that differ in several aspects, including the age of onset of hearing loss, hearing thresholds, use of hearing devices (such as hearing aids vs. CI), level of access to language,

and preferred mode of communication, such as spoken language, sign language, or a combination of spoken and sign languages [9]. Educating students who are D/HH (deaf/hard of hearing) in the general education classroom can require careful considerations [10].

## 2.4 Multimedia

Multimedia learning can be defined as an interactive computer-based communication system that presents integrated learning materials. The term “computer-based” means that multimedia programs utilize computers to deliver the learning content [11].

Multimedia can serve as an effective teaching medium in delivering information because it allows teachers to present information through various media such as audio, text, animation, video, and images [12].

## 2.5 Android

Android is a mobile operating system that has flourished among the growing range of operating systems available today [13]. Android is a mobile operating system created for smartphones and tablets [14]. and Android is an operating system designed for cellphones based on Linux, including operating systems, middleware, and open source applications [15]. Android is software for mobile device covering operating system, middleware and key application [16]. Android is widely used at this time among children, adolescents and adults [17].

## 2.6 Flutter

Flutter is a high-performance SDK (Software Development Kit) used for building mobile applications for both iOS and Android platforms. It allows developers to create apps using a single codebase, saving time and effort. Flutter is an open-source framework developed by Google [18]. Flutter is a cross-platform framework that aims to develop high-performance mobile applications [19]. Flutter has been designed to streamline and accelerate the development of mobile applications that are compatible with both Android and iOS platforms, eliminating the need to learn and work with two distinct programming languages separately [20].

## 2.7 Adobe Photoshop

Adobe Photoshop is a graphic processing program that is capable of working with two types of graphics, namely, bitmap and vector [21]. It has the ability to manipulate and edit images in both bitmap and vector formats, making it a versatile tool for graphic design and editing.

## 2.8 Adobe Illustrator

Adobe Illustrator is a well-known design software that operates on vector graphics and is often referred to as an illustration design program. It is highly acclaimed

for its dependable features and tools that facilitate the creation of imaginative artwork [22]. Adobe Illustrator is the most powerful and popular vector-based graphic program [23].

### 3 RESEARCH METHOD

The aim of this research is to design and develop a specialized sign language learning application for students with special needs, which will be implemented on the Android platform using the Flutter framework. The research methodology employed is MDLC (Media Development Life Cycle), which encompasses a systematic series of stages. The stages involved include concept, design, material collection, assembly, testing, and distribution. The application will be comprehensively tested through the active participation of students with special needs to ensure its effectiveness and usefulness in the process of learning sign language. By utilizing the MDLC approach and conducting user testing involving the target audience, it is anticipated that the application will provide an optimal and beneficial learning experience for students with special needs in acquiring sign language proficiency. Figure 1 below illustrates the research method of MDLC (Media Development Life Cycle).

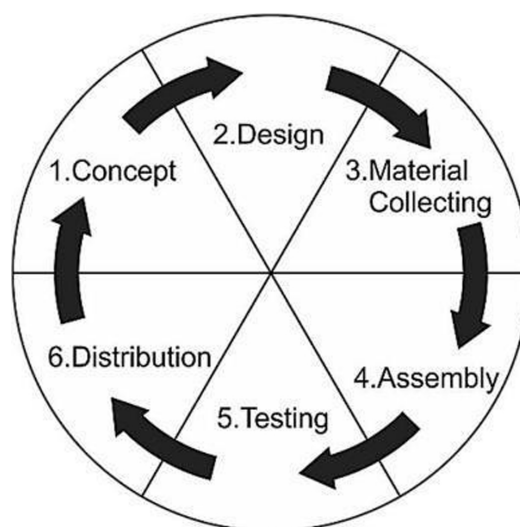
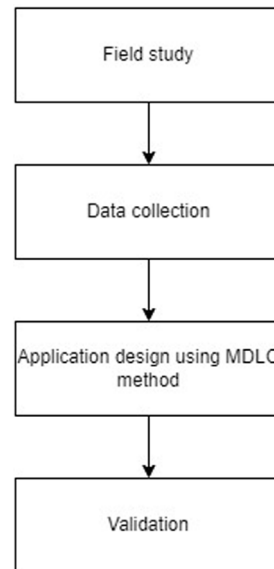


Fig. 1. Multimedia development life cycle

#### 3.1 Conceptual framework

The conceptual framework of this study includes field study, data collection, application design using the MDLC (Media Development Life Cycle) method, and validation. The field study involves gathering information and conducting observations to understand the research context. Data is collected from various sources for further analysis.

The application design follows the systematic MDLC method, considering user needs. Validation is conducted to test the functionality of the application. By following this framework, researchers can develop robust and impactful solutions. Please refer to Figure 2 below.



**Fig. 2.** Conceptual framework

### 3.2 Field study

This stage involves conducting observations at the research site to identify existing issues or problems. The research location provides insights into the current system in place and helps identify problems that can potentially be addressed through the development of software applications.

### 3.3 Data collection

The activities carried out in this stage include: (1). Observation, conducted by directly observing and examining data related to the research object. (2) Interviews, conducted by interviewing individuals who can provide relevant information related to the research object. (3) Literature review, conducted to gather information and strengthen the theoretical foundation through books, magazines, newspapers, documents, the internet, and other relevant reading materials related to the research object.

### 3.4 Application development methodology

In the process of analyzing data using the MDLC method, there are 6 stages: concept, design, material collection, assembly, testing, and distribution. This is a process or cycle consisting of a series of stages followed to design, develop, and implement multimedia projects. The Multimedia Development Life Cycle research method includes:

1. Concept, the initial phase comprises discussions with the School Principal and Student Affairs Staff to identify the specific content requirements for the application being developed. In addition, comprehensive data collection is conducted to ensure all necessary information is gathered. The selection of suitable multimedia elements, including images, animations, colour schemes, audio components, and textual content, is carefully considered. The subsequent stage involves planning

- the interface design, determining the dimensions of the application, and establishing the necessary navigation pathways to provide an optimal user experience.
2. Design, in this stage, there is a need for standard design to depict, design, and document the system model visually.
  3. Material Collecting, In this stage, the collection of materials for application design takes place, including gathering text, images, videos, and audio. This material collection aims to ensure the availability of appropriate and relevant content for application development. Each type of material is carefully collected and selected based on the needs and objectives of the designed application.
  4. Assembly, after obtaining the necessary materials for application development, the next stage is to manage and integrate these materials into a cohesive application.
  5. Testing, the testing stage is conducted after completing the assembly phase by running the application. In this testing stage, the author divides it into two phases, beta test and alpha test.
  6. Distribution, In this stage, the application will be stored in a storage media. This stage can also be referred to as the evaluation stage for the developed product to make it even better. The evaluation results can be used as input for the concept stage in the next product result and discussion.

## 4 RESULT AND DISCUSSION

### 4.1 Concept

In the concept table, there is a Sign Language Learning Application titled “Aplikasi Pembelajaran Bahasa Isyarat (Sign Language Learning Application)”. The target users of this application are individuals who are deaf. The duration or time of using the application is unlimited. The application supports various media formats, including .jpg images, .MP4 videos, and .MP3 audio files. To enhance interactivity, the application includes navigation buttons for numbers, letters, quizzes, grades, learning objectives, back, and submit. Please refer to Table 1 below for further details.

**Table 1.** Concept description

Title	Sign Language Learning Application
User	Deaf individuals
Duration or time	Unlimited
Image	.jpg
Vidio	.MP4
Audio	.MP3
Interactivity	Navigation buttons (Numbers, letters, quizzes, grades, learning objectives, back, submit)

### 4.2 Design

#### UML diagram

*Usecase diagram.* The Use Case Diagram for Sign Language Learning Media includes three actors: Admin, Teacher, and Student. The Admin is responsible for managing the system, while the Teacher utilizes the media for teaching purposes, and

the Student is the primary user for learning. The Admin has full access and control over the system, including managing users, media, content, and other settings. The Teacher can utilize the sign language learning media during instructional activities, such as playing videos, displaying images, or creating quizzes. The Student can access the media to learn sign language, interacting with videos, images, or engaging in quiz exercises. Through this diagram, the interaction between these three actors in using the sign language learning media can be observed. Please refer to Figure 3 below.

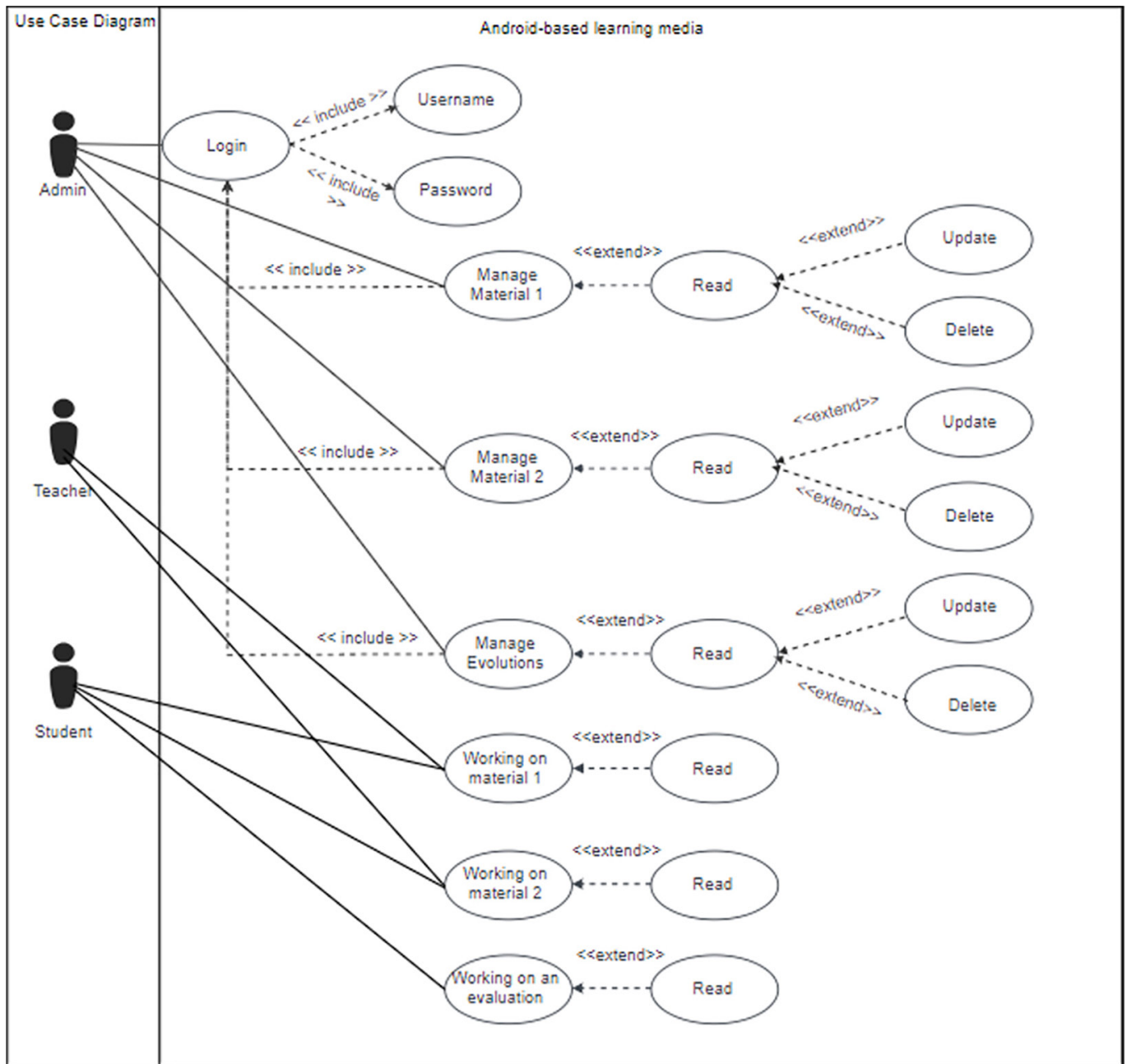


Fig. 3. Use case diagram sign language learning media

*Flowmap of a running system.* In the sign language learning system, the teacher begins by starting the process and explaining the material, followed by providing examples in sign language. Then, the student receives information in sign language.

If the student does not understand, they can ask the teacher, who will provide further explanation. The process then loops back to providing examples in sign language. If the student understands, the teacher gives an evaluation, and the student completes the evaluation. Next, the teacher checks and gives a grade, which the student receives. This process ends once all the steps are completed. Please refer to Figure 4, “The Flowmap of a Running System,” below for a visual representation of this process.

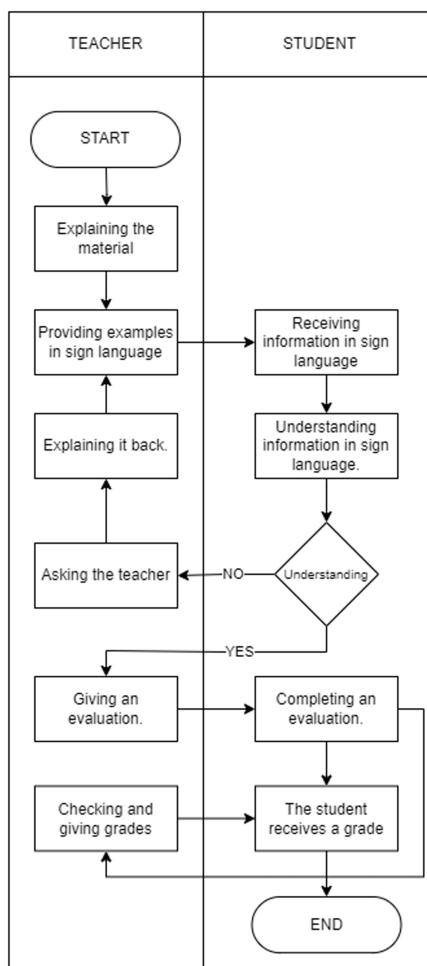


Fig. 4. Flowmap of a running system

**Flowmap in the proposed system.** In the proposed system, there is a flowmap that illustrates the interaction between three actors, namely the admin, student, and teacher, in the sign language learning process. The role of the admin is crucial in initiating and managing the system as a whole. The admin is responsible for initiating and ensuring the smooth operation of the system, including user settings, content management, and general maintenance. Meanwhile, the teacher plays a key role in providing relevant and valuable learning materials. The teacher is tasked with uploading and organizing videos, images, and other learning materials for students to access. On the other hand, the student has an active role in the learning process. They can access and interact with the learning materials provided by the teacher, whether it's through watching videos, viewing images, or participating in given exercises. Through the interaction between the admin, teacher, and student in this flowmap, the goal is to create an effective, interactive, and beneficial sign language learning experience for students. Please refer to Figure 5 below for visual representation.



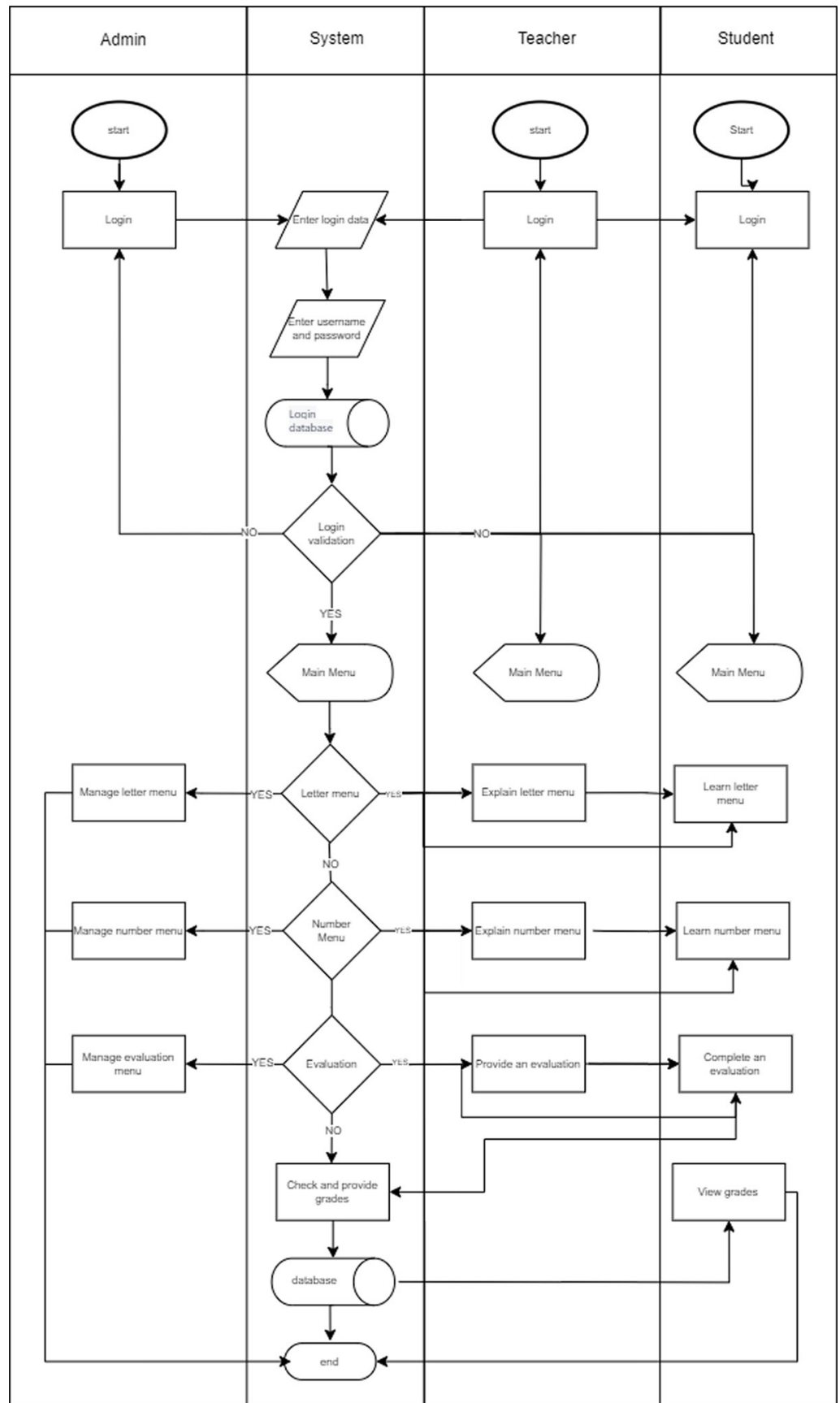


Fig. 5. Flowmap in the proposed system

### 4.3 Material collecting

In the material collection phase, there are several elements with different descriptions and formats. The first element is text, which contains information about the usage of the application, the application name, and the application version. This text is stored in a .txt (text file) format. The second element consists of various images, including alphabet letters from A to Z, numbers from 0 to 9, quizzes, information about Learning Objectives/Competencies (KI/KD), and application logos. These images are saved in both .mp4 (video file) and .gif (animated image file) formats. By gathering these elements in their respective formats, the sign language learning application aims to provide a comprehensive learning experience for its users. Please refer to Table 2 below for more details.

**Table 2.** Multimedia components

No	Element	Description	Format
1	Text	Information about the usage of the application, application name, and application version. Information about Learning Objectives/Competencies (KI/KD)	.txt
2	Image	Alphabet letters A to Z – Numbers 0 to 9 Quiz Information about Learning Objectives/Competencies (KI/KD) Application logo and Universitas Negeri Padang logo	.Gif .jpeg
3	Video	Video Alphabet A–Z Video Number 0–9	.Mp4

### 4.4 Assembly

Assembly stage is where all the objects and multimedia elements are created. The application development process is based on the design stage, typically utilizing authoring software. In this particular case, the Flutter framework is used for coding and programming the application. The application will showcase easily understandable symbols, images, and videos depicting sign language movements for the users. Here are some preview images of the application's interface.

**Main menu display.** The application's display includes seven user-friendly menu options for easy navigation and access to various features. These menu options are "Letter," which allows users to learn and practice sign language alphabet letters. The "Numbers" menu offers a range of number signs to enhance numerical skills. For interactive learning, the "Quiz" menu presents engaging quizzes to test the user's understanding of sign language. To track progress and performance, the "Score" menu displays the user's quiz results and learning journey. The "Competence Standards (KI/KD)" menu provides information about the learning objectives and competencies achievable through the application. Users can find app details, such as its name, version, and usage guidelines, in the "Application Information" menu. Lastly, the "How To Use" menu offers step-by-step instructions on effectively navigating and utilizing the app's features. Please refer to Figure 6 for more details.

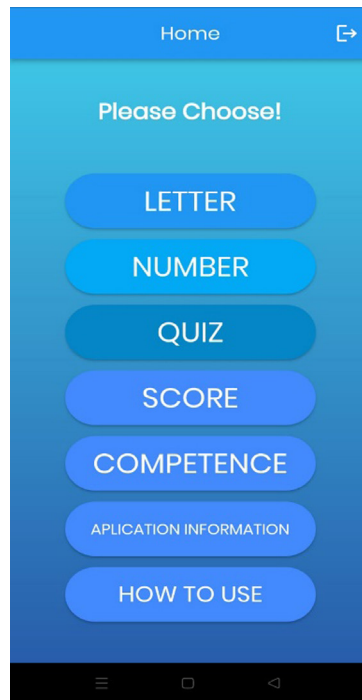


Fig. 6. Main menu display

**Letter menu list view.** In this view, a list of alphabets in sign language (SIBI) is displayed. The menu includes letters from A to Z, and each letter is presented in the form of a 2D animation. With these animations, users can clearly see the hand movements and shapes that represent each letter in sign language. This provides an interactive learning experience and helps users better understand and remember each letter in sign language. Please refer to Figure 7 below for visual reference.

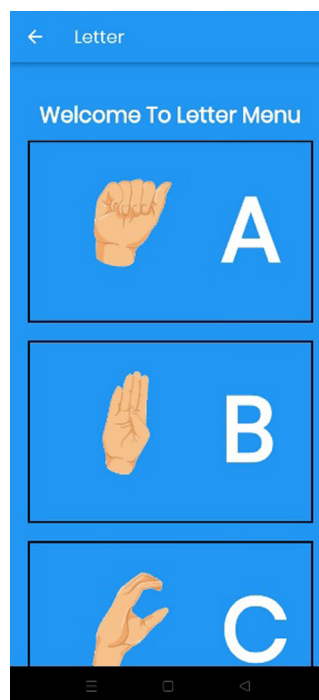


Fig. 7. Letter page

**Output list view.** In this view, there is a list of videos showcasing sign language movements in SIBI (Sign Language of the Deaf). The menu presents a collection of videos that demonstrate the proper hand gestures and movements used in sign language. Each video provides visual guidance on how to perform various signs and communicate effectively using sign language. This interactive feature allows users to observe and practice sign language movements, enhancing their understanding and proficiency in SIBI. By watching and learning from these videos, users can develop their sign language skills and engage in meaningful communication with the deaf community. Please refer to Figure 8 below for visual reference.



**Fig. 8.** Output view

**Menu quiz view.** In this display, there are five questions presented. Each question is accompanied by four answer choices for the user to select from. If the user answers correctly, they will receive a score of 10 points. This score reflects the user's success in answering the question accurately. With five questions and a maximum score of 10 points for each correct answer, users can evaluate their understanding and assess their knowledge on the topic being assessed. This provides an opportunity for users to test themselves and enhance their understanding through an interactive learning process. Please refer to Figure 9 below for visual reference.

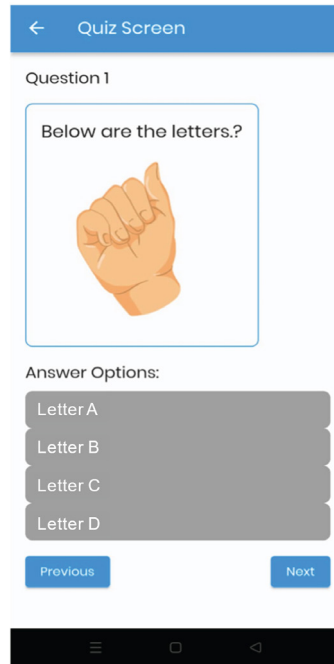


Fig. 9. Menu quiz view

**Menu score view.** The Scores menu displays the results of the answers given in the Quiz menu. It shows the scores achieved based on the answers provided during the quiz. By accessing the Scores menu, users can see how well they have answered the quiz questions and gain an overview of their performance. This allows users to track their progress and evaluate their understanding of the topic being tested. With the Scores menu, users can measure their achievements and motivate themselves to continually improve their understanding through active participation in quizzes. Please refer to Figure 10 below for visual reference.

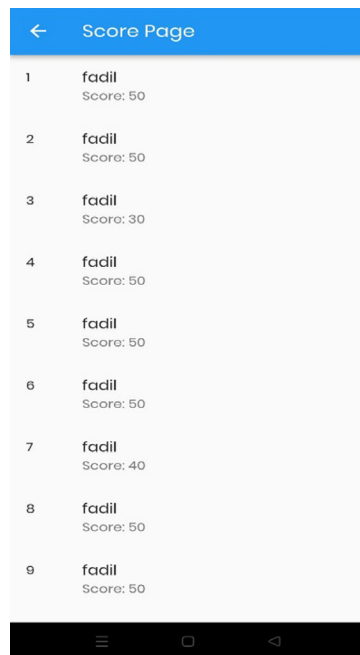


Fig. 10. Score page

## 4.5 Testing

The testing conducted for the Sign Language Learning Application for the Deaf with the BISINDO Method involves performing alpha testing and beta testing.

**Alpha test.** This Sign Language Learning application has undergone a series of Alpha tests to ensure its quality. These tests were conducted to identify and address any potential issues and gather feedback from early users. The results of these tests have been valuable in improving the performance and user experience of the application. The development team has conducted a thorough evaluation of the alpha test results and taken necessary steps for improvements. As a result, the application has seen significant enhancements in terms of functionality, stability, and overall quality. Through this comprehensive alpha testing process, the Sign Language Learning application is now ready to move forward to the next stage of development and deliver a high-quality learning experience for users. Please refer to Table 3 below for further information.

**Table 3.** Alpha testing result

Figure	Test item	Expected result	Description
Login	Login with username and password (correct input)	Successfully access the home page	Accepted
	Login with username and password (incorrect email input)	Popup alert appears: "Please enter valid Email and Password."	Accepted
	Click on the "Don't have an account? Register now" button	Redirected to the account registration page	Accepted
Registration Page	Register by entering "Email, password, and name".	Popup alert appears: "Registration successful! Your account has been created. You will now be redirected to the login menu."	Accepted
	Register with incomplete email input	Popup alert appears: "Registration Failed. The email address is badly formatted."	Accepted
	Register with a password less than 5 characters	Popup alert appears: "Registration Failed. The password should be at least 6 characters."	Accepted
	Enter an email that has already been registered	Popup alert appears: "Registration Failed. The email address is already in use by another account."	Accepted
Home Page	Displaying the home page	The home page displays buttons for alphabet, numbers, quiz, and scores.	Accepted
Alphabet Page	Displaying 2D sign language alphabets	The Alphabet page displays alphabets A-Z along with videos demonstrating sign language.	Accepted
Numbers Page	Displaying 2D sign language numbers	The Numbers page displays numbers 0-9 along with videos demonstrating sign language.	Accepted
Quiz Page	Displaying the Quiz page	The Quiz page displays objective questions, with each correct answer worth 10 points.	Accepted
Competency Standards (KI/KD) Page	Displaying the Competency Standards (KI/KD) Page	Displaying The Competency Standards (KI/KD) Page	Accepted
Application Information Page	Displaying application-related information	Displaying the application information page	Accepted
How to use	Displaying the application usage instructions	Displaying the application usage page	Accepted

**Beta test.** Beta testing is a phase of testing conducted with end users who provide feedback and evaluation of the application. Beta testing has been carried out involving teachers from SLB N 2 Padang and several application users, including both the general public and the deaf community. The purpose of beta testing is to gather valuable inputs and suggestions for the further development of this application. Some common feedback from users includes:

1. The need for improvements in the visual and auditory aspects of the developed application.
2. The necessity of adding numbers up to hundreds or thousands

#### 4.6 Distribution

After the program is completed and goes through the testing phase, the next step is to publish the program. Prior to that, the application is converted into the \*.apk format so that it can be installed on Android devices.

### 5 CONCLUSION

Based on the conducted research, several important conclusions can be drawn. First, the sign language application developed for assisting individuals with hearing impairment in communication has been successfully designed and built. The application specifically targets SLB Negeri 2 Padang.

Furthermore, the application's menu functions were thoroughly tested. The results of the testing phase demonstrated that each menu operates smoothly and according to the provided instructions. Users can easily access and utilize the available features within the application. This serves as evidence that the application effectively meets the communication needs of individuals with hearing impairment.

The research findings also indicate that the application significantly contributes to facilitating communication among individuals with hearing impairment. It enables them to comprehend and convey messages through sign language more fluently and effectively. Consequently, the quality of their communication is enhanced, and their participation opportunities in various social and educational activities are expanded.

In conclusion, the sign language application has been successfully designed, developed, and thoroughly tested. It provides tangible benefits to individuals with hearing impairment, empowering them to strengthen their communication skills. It is hoped that the application will continue to be used and further developed to offer broader benefits to the community of individuals with hearing impairment.

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