User Interface Modelling for SIBI (Sistem Isyarat Bahasa Indonesia/Indonesian Sign Language System) learning applications using the User-Centered Design Method

Desanty Ridzky¹, Veronikha Effendy² and Danang Junaedi³
School of Computing, Telkom University, Bandung, Indonesia

E-mail: ¹desantyridzky@students.telkomuniversity.ac.id, ²veffendy@telkomuniversity.ac.id, ³danangjunaedi@telkomuniversity.ac.id

Abstract. Sign Language is a type of language used to help deaf children to communicate. The Indonesian government has created their standardization system for sign language called SIBI (Sistem Isyarat Bahasa Indonesia). Deaf children have characteristics such as lack of memory ability. Therefore they need media for repetition in learning. The actual mobile-based learning could support recurrence in the subject is already available, but not all the designs on mobile technology are suitable for children's needs, proven by testing the existing application using USE Questionnaire which obtained a usability average of 58%, which mean that the app could not provide convenience and satisfaction for users. Therefore, to create a user interface that suits the needs of the user, the User-Centered Design (UCD) method is used. The usability testing conducted for the prototype application and the result is 90% with an excellent category. If the result of the usability is an excellent value, then the app could be used very easy and satisfied for user.

Keywords: Deaf child, user interface, user-centered design, USE Questionnaire

1. Introduction

According to the Department of Demographics and Civil Recording, in 2016 the city of Bandung had 1835 people with disabilities with 309 deaf people [1]. Based on the population of deaf people in Bandung the inability of the deaf has an impact on the development of children communication which causes a lack of information that can be accepted by them [2]. Sign language is one way for deaf children to communicate with each other and regular people. According to the Ministry of Education and Culture Regulation No. 0161/U/1994, SIBI (Indonesian Language Sign System) is the standard sign system for the deaf by the appropriate curriculum and is the uniform system for sign language [3]. In the alphabet of SIBI dictionary, the importance of knowing the SIBI sign alphabet is a fundamental element for the deaf because the combination of the alphabet of SIBI can form vocabulary [4].

The Bandung Educational Office noted that the number of Disability Schools (SLB) in Bandung was 45 schools, with six schools for the deaf [5]. By using the accidental sampling technique [6], out of the six schools for the deaf, samples were taken from one SLB-B because there were problems related to the use of SIBI sign language learning. Based on observations, learning in school was not sufficient for deaf children because of the limited time spent in school. Deaf children in first grade at the school have a lack of memory. There are already using media to repeat the material, but the design of existing media using mobile applications tends aimed at ordinary people. The media does not pay attention to the
individual needs of deaf people [7] such as the need of videos, animations and running text because these aspects are essential for deaf people [8], proven through the usability testing of the USE Questionnaire. The USE Questionnaire was used because it has an even choice of questions between measuring usability values and user experience [9] so that it can increase usability values [10]. Based on the results the application sample obtained a 48% for usefulness, 56% for ease of use, and 58% for satisfaction which indicates that the application has not provided convenience and pleasure for children. The User-Centered Design (UCD) method can be used in research because it can produce a design that suits the needs of the user and has the benefit of increasing the usability value [11] for deaf children in first grade at SLB-B.

It found that the sample application still has a low usability value on usefulness, ease of use, and satisfaction with an overall average score of 58% which causes difficulty for the users who use the application to learn sign language. The research question made is how user interface model introduction the SIBI alphabet can meet the needs of users by using the User-Centered Design (UCD) method with usability measurements using the USE Questionnaire. The limitation in this study is that the target users are deaf children in first grade at the SLB who are learning sign language and this study will produce a prototype application of SIBI alphabet recognition.

This study aimed to produce a model of the alphabet of SIBI user interface that suits the needs of deaf children in first grade using the User-Centered Design (UCD) method and conducting usability testing of the alphabet of SIBI recognition application using the USE Questionnaire.

2. Literature Study

2.1. Quota sampling
Quota sampling is the determination of samples based on specific characteristics. This technique is done by determining the number of samples needed based on the considerations of the researcher [12]. The characteristics of children in this study were 1st-grade elementary school children who had a hearing impairment, specifically deafness, but did not have other limitations. In first grade at SLB-B SD Sukapura, there was a total of seven children. Based on the quota sampling, the children who fulfilled the characteristics of the research and the number of samples needed were six children.

2.2. User-Centered Design
The User-Centered Design (UCD) method is a design method that involves users, namely deaf children in 1st grade at SLB-Elementary School, in the design process starting from the initial stages of analysis up to testing. This method is used because it focuses on finding the user needs to achieve application development goals and to consider the tasks that can be performed [12]. According to Travis [13], this method can also maintain good usability values. In general, the stages are carried out in the user-centered design method. The UCD process has four steps for design, namely: 1) Specify the context of use that generates information on user characteristics and user habits based on observations and interviews. 2) Specify user requirements that create user persona, user requirements, mental models, scenarios, and task analysis. 3) Produce design solutions which include conceptual modeling, wireframe, mockup, and prototype. 4) Evaluate design using the USE Questionnaire method. These four stages will continue iteratively until they reach the predetermined usability value [14]. The usability value determined by the researcher is based on the "outstanding" category which is between 88%-100%.

2.3. USE Questionnaire
Usability Testing is an evaluation carried out on a product that will be used by people [15]. According to ISO 9241-11, usability is how well a product can be used by others effectively, efficiently and satisfactorily [16]. This method was used in the previous study [17]. USE Questionnaire has the factors that become the focus of the UCD method, which was usefulness, ease of use and ease of learning [11] which according to Arnold Lund [10] the factors of ease of use and usefulness can encourage the satisfaction factors. In usability testing, a questionnaire is used on a Likert scale to measure a person's
attitude and perception by determining the positive or negative response of a statement. Table 1 shown the Likert scale used for usability evaluation has three weighting criteria as follows [17]:

| Scoring Criteria | Value |
|------------------|-------|
| Agree            | 3     |
| Neutral          | 2     |
| Disagree         | 1     |

Table 1. Questionnaire Weighing Criteria[17].

The questionnaire used as a test tool that can provide precise and accurate measurement results based on validity tests. A questionnaire is valid when it meets the correlation greater than the r-table values, with X as an item score, Y as the total score, and n as the number of subjects. Equation 1 is used to calculate validity ($r_{xy}$) [18]:

$$r_{xy} = \frac{n \sum XY - [(\sum X)(\sum Y)]}{\sqrt{n \sum X^2 - (\sum X)^2][n \sum Y^2 - (\sum Y)^2]}$$

A consistent reliable instrument can be used several times to test the same data. The reliability test uses Alpha Cronbach, while equation 2 calculates reliability:

$$r_{11} = \frac{n}{n - 1}$$

The "n" variable is the number of items that are tested, $\sum \sigma_i^2$ is the sum of the variance scores on each item, $\sigma_t^2$ is the total variance, and if the reliability is low, then there will be an unreliable item based on the classification of the reliability coefficient [18].

2.4. Measuring scale

Measuring the usability value percentage can be determined based on the category level. Calculation of the range (interval) to get the category level with the range is the result of the reduction of the largest percentage and the smallest percentage, and K the number of measurement categories [19]. Equation 3 calculates the range value [19]:

$$\text{Interval} = \frac{\text{range}}{K}$$

Based on equation 3, the interval and category can be used as scoring indicators that categorize the usability value that was obtained can be seen in Table 2

| Interval (%) | Category | Note |
|--------------|----------|------|
| 88%-100%     | Very Good| The application is handy, effortless to use, very easy to learn and very satisfying |
| 74%-87%      | Good     | The application is useful, easy to use, easy to learn and satisfying |
| 61%-73%      | Fair     | The application is sufficient, sufficient enough to use, sufficient enough to learn, sufficient enough to learn |
| 47%-60%      | Bad      | The application is not useful, not easy to use, not easy to learn, and not satisfying |
| 33%-46%      | Very Bad | The application is very useless, not very easy to use, not very easy to learn and not very satisfying |
3. Model flow

3.1. Specify context of use

At this stage, produced the data concerning the user. According to the Expert Judgment, an educational psychologist, to identify the characteristics of users, the information can be obtained based on the results of interviews with teachers and parents and those who know the child as a whole. This information produced the characteristics of deaf children in 1st grade at SLB Sukapura Elementary School who lacked memory skills, found it difficult to understand something abstract, preferred using visual means, caught material more easily if shown a direct example, were happy to be rewarded for what they had done, and the children who welcomed challenges. Other information obtained was related to user habits, namely children who used smartphones to play games and watch videos, and other children who learned using pictures.

This stage also produced information on the child's needs based on observations and interviews that apply to learn as it's done in class with learning SIBI alphabet, especially children that can recognize SIBI alphabet from A-Z, knowing the pronunciation of alphabet from A-Z and knowing how to write alphabet from A-Z. These children need repetition related to the material to understand how to use the application and their motivation for playing increases. Children can play while learning sign language and children need these types of challenges.

3.2. Specify user requirement

This stage produces a user persona that is distinguished based on the child's ability to use a smartphone and the child's knowledge of the SIBI alphabet which became three persona groups, high, medium and low. High persona characteristic is relied more on visual means, easily bored in doing activities that are not interesting. Medium persona difficulty understanding something that is abstract and Low persona caught material more easily if shown a direct example and practice it. Both medium and low persona have problems if there is no tutorial. Each user persona between 6-10 years old have low memory skills, were happy to be rewarded for what they had done, and the children who welcomed challenges. User requirements that have been described in the previous stage can be determined by the following: 1) SIBI alphabet recognition material, 2) Alphabet pronunciation material, 3) Alphabet writing material, 4) Repetition of content, 5) Instructions on how to play, 6) Distribution of awards, 7) Provide games related to sign language, 8) Consist of different levels of difficulty in the game.

In addition to determining user requirements, this stage also produces mental models based on persona's characteristics, specifications, and observations of user interactions when learning in class and using similar applications. The mental model that is produced starts with the interaction of the child choosing the game menu and choosing to look for a picture card or guessing certain pictures. Each child will be given a tutorial on how to play first. In the picture card search game, children are required to find a hidden card. After each card is detected, the material will be shown (picture of sign language, the pronunciation of alphabet, and how to write them) and repetition of the material. Children receive rewards if all the cards have been found. When the child plays the second game, the child looks at the picture and chooses the correct answer and will see help if the answer is incorrect. In the guessing game, rewards and repeat of the same level are given when the level has been completed. Finishing one level will open another level that was still locked. Children can exit the application by selecting the exit menu.

After identifying the mental model, a task analysis is performed using a hierarchical task analysis (HTA). Tasks are done in the form of seeing tutorials, looking at instructions, finding picture cards, seeing SIBI alphabet, seeing how to pronounce alphabet, practicing writing alphabet, and receiving rewards to reach the goal of identifying SIBI alphabet. During guessing alphabet, the task is guessing alphabet, looking at pictures, choosing an answer, seeing help, receiving a reward, and choosing the next level. The task done incorporates the primary purpose of the application, which is to learn SIBI alphabet.

3.3. Produce a design solution
At this stage, a conceptual model is made based on the previous step. Based on the conceptual model that was created, it produced the wireframe that was used to design mockups and prototypes. The prototypes built by design principle that can reduce short-term memory load based on observation each persona characteristic. In the prototype there were the following features: 1) Pictures and pronunciation of alphabet, 2) Alphabet tracing, 3) Rewards, 4) Finding and guessing alphabet, 5) Various Levels, 6) Alphabet repetition, and 7) Tutorial. An example of user interfaces found in the “Belajar Huruf SIBI” prototype which can be seen in Figure 1. Based on the characteristics, habits, requirements, and user needs that have been obtained in the previous stages, these elements produced features that were built in the prototypes. Children with difficulty in understanding something that is abstract and has good visual abilities. They need material and requirements for the existence of SIBI alphabet recognition material, alphabet pronunciation material and instructions on how to play led to the creation of features in the form of sign language and pronunciation videos that can be seen in Figure 1a and game tutorials. Children have an easier time catching material when directed shown an example which led to alphabet writing material and alphabet tracing features which can be seen in Figure 1b. Also, children that have a lack of memory ability create the need for repetition of the material which is shown in Figures 1a and 1b. Children are happy when they are rewarded for what they have done, and that creates a need for an award that can increase motivation and the requirements for the reward features are shown in Figure 1c. The habit of children using smartphones to play and learn shows the need for children to play while learning sign language which resulted in the requirement to provide games related to sign language. Card games and alphabet guessing features can be seen in Figure 1d. Children welcome challenges and that produced requirements for different levels of difficulty in the game, and these leveling features can be seen in Figures 1e, 1f, and 1g. The design of the image, icon shape, and icon color are made consistent in every screen.
4. Design evaluation
At this stage, an application evaluation was made using the USE Questionnaire method. The test was carried out on six first graders at SLB-B Sukapura elementary school. Before conducting the test, a questionnaire was made and tested for validity and reliability. According to the Expert Judgment, an educational psychologist, the questionnaire can be filled by the teacher to assess which reflects the user interface with the child as the user in the application test.

The test in the first and second iteration obtained usability values seen in Figure 2.

Based on Figure 2 Graph Results the results of the first iteration usability test showed that there are factors that still have an average usability value of all persona groups which fell below the interval 88% -100% which were the ease of use (75%), ease of learning (85%) and satisfaction (83%). Based on the results that have been made during the application test, there were deficiencies obtained from the first iteration of the usability test, which was:

1. Medium and low difficulty persona users were not proficient in using applications because during the card search the app could not display the differences between objects and images. This deficiency affects the ease of use and ease of learning factors that have statements related to the difficulty and skill of using the application.
2. High, medium and low difficulty persona users did not know the mistakes that they made because, in the card search game, the application does not provide an error warning and the child cannot resolve the error efficiently. These deficiencies affect the ease of use and satisfaction related to mistakes made and how the application is expected to work by the user.
3. High, medium and low difficulty persona users do not know the alphabet writing technique correctly because the application does not provide a direction to writing the alphabet in the tracing alphabet feature which created a need for teacher assistance. This deficiency affects the ease of use factor related to the application usage instructions.

4. High, medium and low difficulty persona users need help to return to the previous screen because the pop-up view on the image fills the whole screen which the application difficult to operate by the user. This deficiency affects the ease of use factor related to the ease of performing the application.

5. High, medium and low persona users feel frustrated when playing the app because of the limitations of tracing alphabet in tight spaces. This deficiency affects the ease of use and satisfaction factors which makes the application not work by what the child expects.

Based on observations made on the first iteration usability test, improvements were made to overcome the shortcomings of the UI:

1. Adding blinking animation effects to objects in the find image card game that captures the child’s attention.

2. Add incorrect warnings with cross symbols to indicate errors based on the design principle that application must have error handling.

3. Instructions were added to the tracing feature so that children can know the direction of tracing the alphabet.

4. The pop-up display size was improved on the guessing images so that children can quickly return to the previous screen.

5. The of tracing alphabet space limit was widened

After enhancing the user interface, a second iteration usability test was performed, and it increased all value factors in each persona which can be seen in Figure 3.

![Figure 3](image)

**Figure 3.** The average increase in the results of the first iteration and second iteration.

Based on Figure 3, the second iteration usability test produced an average usability value of all persona groups, including an increase in usefulness, ease of use, ease of learning and satisfaction. These increases are influenced by improvements made by incorporating a blinking animation on the object image to capture the attention of the child so that the child can know the difference in objects that can be selected. The increase in the ease of use and satisfaction factor is influenced by the improvement to provide error warnings that the child can find out the mistakes that have been made. Also, the increase is also affected by the widening of the alphabet tracing space that made them trace more easily. There was also an increase in other ease of use factors that were influenced by the addition of pattern instructions to write alphabet so that the children could know how to write alphabet correctly and there was an improvement in the size of the pop-up evaluation that made it easier for children to return to the previous screen.
Based on Figure 4 the results of the usability testing sample application on usefulness factors have a low usability value because the app does not meet user needs such as the absence of clear sign language images, video, and animation. The usability value ease of use factor is still low because the application did not provide instructions on how to use the app and the ease of learning element received sufficient usability values because the appearance of the app is still challenging to master. This is due to the use of dominant text while deaf children cannot read yet which influences the children's skills in using the application. The usefulness and ease of use factors can affect the usability value for satisfaction. Lack of these factors will affect the child's interest in the app which causes the usability value for the achievement to be low.

Comparison of usability samples of the application sample, the first iteration usability test and the second iteration usability test can be seen in Figure 5.

A significant correlation can be seen from the results of the application sample test with an overall average of usability samples of 58%. The usability value is still included in the weak category which means that the application has not been able to provide convenience and satisfaction for the user. This is caused by deficiencies in the application usage instructions, which has not met the needs of users, and there is the use of dominant text which makes the children not interested in using the application. Unlike the "Belajar Huruf SIBI" application that already has features that meet the needs of deaf children such as clear images, videos, and animations that can influence the usefulness factor. Tutorial features affect the ease of use factor and use of images that are familiar to children as a substitute for text that influence the ease of learning factor. These features impact the child's interest in the application and can increase the usability value in for the satisfaction factor. Improvement of the usability value in the first iteration and the second iteration of "Belajar Huruf SIBI" was obtained from the improvement in the user interface which consisted of the blinking animation, error warnings, widening of the alphabet tracing space, addition of pattern instructions, and improving pop up display that increases the value of each factor. Based on the results of the usability test of the application "Belajar Huruf SIBI" the second iteration showed that the application has a far better usability value compared to the sample application.
5. Conclusion

Based on the use of the user-centered design method, the introduction of SIBI alphabet user interface modeling met the needs of deaf children consisting of the presentation of sign language-related material using hand gestures in a card search game and guessing images based on the child's need to learn while playing the game. Other requirements are for the application include video pronunciation and alphabet tracing so children can know how to pronounce and write the alphabet. Besides, there is a tutorial on how to use the application through an animated video to help children understand more about how to use it. Different levels and rewards in the shape of stars on the game are used to motivate deaf children to learn. After performing two iterations, there was an increase in the first iteration usability value in the good category and the second usability iteration which resulted in an excellent class. This shows that the application "Belajar Huruf SIBI" has a user interface that suits the needs of deaf children.

Further research is needed to find out the increase in the children's knowledge about SIBI alphabet after using the application.

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