User Interface Modelling of Sundanese Culture Introduction for Deaf Youth using User-Centered Design Method

Andini Hanifah Ulya¹, Veronikha Effendy² and Danang Junaedi³
School of Computing – Telkom University, Bandung, Indonesia

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

Abstract. Culture is a heritage that needs to be preserved and passed on to future generations. Cultural preservation has to be held for everyone without exception even for a person with disability, such as the deaf. Now education can not only be done using traditional way such as books, but it can be done using an application on a smartphone. The use of smartphone could make the process of education to be more efficient and effective. However not every user interfaces (UI) could meet the needs and limitations for the deaf. As with the sample of the existing application that already tested with USE Questionnaire, it still has low usability value. Therefore to design a user interface that meets the users' need, we implemented the user-centered design (UCD) to this research. The prototype was measured its usability by using USE Questionnaire method. The usability testing result showed that the value is 82.75%. This score shows that the design of the user interface already has a usability value with an excellent category, and it also could be said that the user interface has met the user's needs.

Keywords: deaf children, user interface, sundanese culture, user-centered design, USE Questionnaire

1. Introduction
Based on the data from Dinas Pendidikan Kota Bandung, there are 45 Sekolah Luar Biasa (SLB) in Bandung, six of them are SLB-B [1]. With several SLB-B in Bandung, this indicates that the government has paid attention for the right to education for the deaf. Education for deaf can be provided using technology, such as smartphones [2]. Mobile applications used to help the learning process in school, because the subjects could be delivered more efficiently, also it can increase learning motivation of deaf people [3].

Indonesia is a country with a various culture. Therefore preservation action is needed [4]. Cultural education can be implemented as a way to preserve the literature[5]. According to Head of Dinas Pariwisata dan Kebudayaan Kota Bandung, cultural knowledge is essential and it needs to be protected by the next generation since Kindergarten until High School, no exception for persons with disabilities. Based on the sample observation results from SLB-B in Bandung cultural education that was delivered is Sundanese culture, which had been adjusted with the local content from every school.

In general, not every application can be used by the disabled, because applications use a lot of universal designs that do not pay attention to the problems of the disabled, such as the usage of video, animation, and simple text that are important factors in mobile application for deaf people [6] [7]. According to the observation results, there are several problems in application sample used by SLB-B students, such as the usability problem. Thus usability testing can be conducted using USE Questionnaire.
method. This method used because it has interrelated factors that can increase the usability values [8]. The application has a low usability value that is equal to 41.80%, which means the app still has a low usability value, difficult to use and learn, and has a low level of user satisfaction. To design a suitable application, the user interface (UI) should meet the limitations and needs of the user [9]. To be able to create a user interface model that suits the needs of the user, the user-centered design (UCD) method can be applied to this study because it can produce UI that is suitable for user needs and can provide high usability values [10].

Based on the explanation of the background, generally, UI application still use universal design which does not pay attention to the needs of people with disabilities, so that people with disabilities, such as deaf people are still having difficulties in using applications to learn. Therefore, this research will focus on how to create a user interface model regarding the introduction of Sundanese Culture that can meet the needs of deaf children by using the User-Centered Design method with usability measurements utilizing the USE Questionnaire. The limitation of this research is that the user is a deaf child in one of the SLB-B in the city of Bandung who does not have mental constraints, aged 13-17 years, and has reading skills at an advanced stage.

This research aims to produce user interface (UI) model of Sundanese Culture introduction that is suitable with the needs of deaf children using the User-Centered Design, as well as conducting usability testing using USE Questionnaire method.

2. Literature study

2.1. Characteristics of deaf children
There are several characteristics of deaf children such as the ability to understand the text (literacy skill), visual attention, focus, social skills, and memory [11].

1. Text understanding ability (literacy skill). Reading has become a significant factor in education for people with hearing impairment. Limitations in understanding words can affect the other abilities. In the process of reading it needs to be considered in the delivery process, using words that have been corrected, such as avoiding abstract and unfamiliar words for people with hearing impairment. This can be seen in students, that they have deficiencies regarding the understanding text. Children are still having difficulties with unfamiliar and abstract vocabulary, besides that children also find it difficult to read long passages.

2. Visual attention. Visual attention is the ability to be able to focus on objects related to the goals to be achieved by ignoring other distractions. For deaf people, to be able to focus on one thing is quite tricky because deaf people are easily distracted. Deaf people are more easily distracted from the surrounding environment than things that are right in front of them.

3. Focus attention and social interaction. Deaf people generally have problems in concentration, so it is difficult to focus on something. In building an application, to get attention from deaf people can use feedback in the form of vibration or movement. This can be seen when the child uses the app. Children are indeed challenging to focus on things and less sensitive to things around, so that movement feedback can be used to get children's attention.

4. Memory. Most deaf people tend to has low memory skill, it can affect to reading ability due to the inability to remember vocabulary well. This found from the designed user persona, that is the child has a low memory so that the child needs repetition to be able to recall things that have been learned.

2.2. User-centered design
The UCD method (user-centered design) is used in this study because it can provide a user interface that suits with the needs of users so that the UCD method implemented because the development process focuses on user needs [12]. The UCD method has four stages [13]: 1) Specify the context of use, at this stage the characteristics, environment, and habits of the user are generated. This is obtained from the interview and observation process. 2) Specify user requirement, which will create user persona and user
requirements that can be used as a reference in the next stage. 3) Designing design solutions, including creating scenarios, mockups, and prototypes. 4) Design evaluation that has been designed, the evaluation process in this research using USE Questionnaire method. This method is used because the factors are a focus on UCD method, such as usefulness, ease of use, and ease of learning [14], besides USE Questionnaire also has fair questionnaire distribution between usability values and user experience [14].

2.3. Questionnaire
USE Questionnaire is a usability testing method that used in UCD method to evaluate products that will be used by users [15]. Based on ISO 9241-11, usability is how well a product can be used by users effectively, efficiently and satisfactorily [14]. The USE Questionnaire consists of three interrelated and mutually enhancing factors; these factors are usefulness, satisfaction, and ease of use [8]. The ease of use factor is an essential factor in designing an application for people with disabilities [16].

2.4. Guttman scale
In usability testing phase, Guttman Scale questionnaire was used, it was based on the opinion of the expert judgment which said that the "yes" and "no" scales were suitable for deaf children in middle school. On Guttman Scale, the answer "yes" is given a score of 1, while "no" is given a score of 0 [17]. In addition to conducting usability testing, the questionnaire must be tested for validity and reliability first. Below is the validity test formula which can be seen in equation 1 [18]:

$$ Kr = 1 - \left( \frac{e}{n} \right) $$

(1)

with e is the number of errors while n is the number of questions multiplied by the number of respondents.

Reliability testing in the Guttman Scale using Kuder-Richardson KR21, because this formula is intended for questionnaires that have "yes" and "no" variables [19]. The formula KR21 can be seen in equation 2 [19]:

$$ KR21 = \left( \frac{K}{(K - 1)} \right) \left( 1 - U \left( \frac{K - U}{K * V} \right) \right) $$

(2)

From equation 2, it is known that K is the number of items, U is the average score of the question, and V is the number of variance questions.

2.5. Measuring scale
At this stage, the data will be processed from the results of the questionnaire. Previously the questionnaire data must first be tested for validity and reliability. After passing the validity and reliability testing, the questionnaire can be given to the user who then results will be adjusted to the range of values. To find a range of values, there are several stages, consist of [17]

1. Determine the range with the largest value minus the smallest value. In this study, because it uses the Guttman Scale, the largest value is 1, and the smallest value is 0. Then the value ranges = 1 - 0 = 1.
2. Equation 3 used to determine the interval value

$$ Interval = \frac{highest \ value - lowest \ value}{number \ of \ classes} $$

(3)

From equation three the highest value on the Guttman Scale is 1, while the lowest value on the Guttman Scale is 0. The number of classes is the number of classes in the interval class that is 5.
3. Determine the number of classes to be made (K), can be seen in equation 4.
\[ K = 1 + 3.3 \log N \]  

(4)

Based on equation 4, K is the number of classes that will be created, and N is the amount of data available. After knowing the value of the number of classes that will be used along with their interval values, usability values, and their categories can be described in Table 1.

| No | Interval | Category | Description |
|----|----------|----------|-------------|
| 1. | 81-100%  | Very good| The applications have excellent usability values, very easy to used and learned, and have an excellent level of user satisfaction. |
| 2. | 61-80%   | Good     | The app has good usability values, easy to used and acquired, and have a good level of user satisfaction. |
| 3. | 41-60%   | Fair     | The applications have fair usability values, quite easy to used and learned, and have an excellent level of user satisfaction. |
| 4. | 21-40%   | Bad      | The app have poor usability, difficult to used and learned, and have a low level of user satisfaction. |
| 5. | 0-20%    | Very bad | The applications have inferior usability values, very difficult to used and determined, and have a shallow level of user satisfaction. |

3. Scheme of modeling

3.1. Specify context of the user
To specify the context of use, the interview and observation process is conducted to know the environment and what tasks the user is doing. The interview is conducted with homeroom teacher by giving questions about user's habits, environment, and characteristics of the user. Whereas for the observation process is done when the children are learning Sundanese Culture and using an existing application. Some prominent user characteristics include having low literacy comprehension ability due to the lack of vocabulary, having low memory, feeling motivated when they are given appreciation for what has been done, and liking challenges.

From the results of observations and interviews, several prominent user needs were obtained, such as requiring simple explanation, requiring direct activities when learning Sundanese Culture so that they would not get bored quickly, needed motivation when working on questions, and challenges required.

3.2. Specify user requirement
From the results of the user persona that has been made, it can be concluded that the user is divided into a persona, high user persona, and low user persona. This is based on the user's ability to use a smartphone. From the persona that has been made, it can be seen several characteristics, such as having a low text comprehension ability, liking challenges, feeling motivated when they get awards and praise, and having a high competitive spirit.

Based on the user person and user needs that have been made, some user requirements can be determined as follows:

1. How to deliver cultural material that suitable with user's ability
2. Provide the content of Sundanese Culture
3. Provide game about Sundanese Culture
4. Awarding and ranking
5. The differences in level's difficulty

In addition to generating user requirements, this stage also produces mental models based on the observation process and user interaction when playing pictures guessing in the classroom and when the
A child is using an existing application. The interaction starts from selecting a menu, to be able to see the play instructions, the user selects the instructions menu, while if you want to play, you can choose the play menu. The user selects their name in the player list or inputs a new name. When the user wants to play, a user chooses an open level, then weighs and answers the question given. The award provided for each correct answer. Otherwise, they are given the hints and the opportunity to answer the question again. The next level will be opened if the user has successfully responded to all the questions correctly at the level they worked. The user can stop playing by selecting the exit menu. From the mental model, it can be seen the flow and tasks that are done by the user when they are guessing images so that task analysis can be done using hierarchical task analysis (HTA).

3.3. Designing a solution
At this stage, the task generated in the previous step will be detailed, so that the design of the wireframe can be done which will be used as a reference for making mockup and prototypes. In the prototype there are several features obtained from the user requirements, 1) Material view feature with simple text and fonts that are quite clear, 2) Image guessing, 3) Rewards features, 4) Scoreboard features, 5) Levelling. Examples of prototype user interface “Tebak Budaya Sunda” applications can be seen in Figure 1.

![Prototype](image)

Figure 1. Prototype.

Based on the prototype in Figure 1, there are three types of questions which divided into three levels where the first two levels (a and b) are multiple choice questions, while level three (c) is a filling question. This was adapted from the items that commonly used in school; multiple choice questions are...
used in the first two levels because they have a lower level of difficulty. The purpose of using a filling question in level 3 is to improve children's vocabulary and literacy skills.

4. Evaluation
This stage user interface is evaluated using the USE Questionnaire method. Before the test was conducted, the questionnaire that has validated and tested for its reliability was carried out. Children are given the opportunity to interact with the prototype that has been made for five minutes. Then they are given several tasks, such as they must input the name before starting to play, then work on at least 5-6 questions, and asked to try out the existing help features and see the score they have obtained. After all the tasks have completed, the children have to fill out the questionnaire regarding the usability test of the application.

The value of the test results carried out two iterations; the test results will be displayed in a graphical form which can be seen in Figure 2.

![Usability testing first and second iteration graphic.](image-url)

Figure 2. Usability testing first and second iteration graphic.

From the results of the first iteration usability evaluation graph in Figure 2, we can know the average usability percentage value of high user persona is 74.25%, it means the application has good usability value, while the low user persona has an average value of 57.5% and the value usability is enough. For the average results, the first usability iteration value of the entire user persona is 65.87%, which means that usability is enough. This refers to the interval class value that has been obtained in the data processing process.

Based on Figure 2 factors ease of use, ease of learning, and satisfaction at the low user persona still has a lower value compared to other factors. From the results of observations of tests that have been carried out, there are several disadvantages such as:

a. The children cannot see all the names listed on the score screen. This can affect the ease of use and satisfaction factors that have questions about the ability of the application to be able to meet the wishes of users.

b. There is no return button on the name input screen, so the children must enter the next screen to return to the main menu. It affects the factors of ease of use, satisfaction, and ease of learning for users who still have difficulties when using the application, and the app still does not match the user's wants.
c. When the children answer the question incorrectly, the children do not realize that there is a help button because it is less flashy and the size is quite small. This affects the ease of use factor that the application still cannot be used without clear instructions so that the child is not aware that there is a help button.

d. Children are still confused when choosing a name because there are no highlights that indicate which name the child has selected. This affects the ease of use and satisfaction factors, which means that the application is still not by the wishes of the user.

Based on these shortcomings, the correct improvements can be analyzed. Here are the following is a list of improvements made:

a. Fix the score viewing feature so that the application can display all registered usernames.
b. Give the back button so the child can return to the main menu when the child wants to recover from the name input screen.
c. Give animation effects and enlarge the help button so the child can realize there is a help button when the child answers the question incorrectly.
d. Give a highlight to the name that is being chosen by the child, so that the child is not confused when choosing a name.

After evaluating the usability of the second iteration, the results shown in Figure 2, the average usability percentage value of the high user persona is 88%, which means that the usability value is excellent, while the percentage value from the low user person is 77.5%, which says it's good. For the results of the average percentage of usability value of the overall user, person is equal to 82.75%, which means that the usability value is excellent.

From the results of the second usability iteration evaluation, the usability value of low persona is still in the good category of factors of learning and satisfaction. This is because the child still feels confused when using the application. This affects the element of learning and satisfaction because there are still features in the app that seems ambiguous, such as the use of the button ok and the button select a name that seems unclear to the child.

![Figure 3. Usability Evaluation of Existing Application Sample Graphic.](image)

It can be seen from Figure 2 and Figure 3 that the usability factors of existing sample applications still have some disadvantages, such as usefulness, ease of use, and satisfaction factors. In usefulness factor, the app still has less usefulness value due to the delivery of material that is not by the limitations of the child, such as the use of text with small and long sizes, so that the process of cultural learning using applications becomes less optimal. Whereas the ease of use, satisfaction, and ease of learning
Factors of the app are still confusing and difficult to ascertain due to lack of navigation, and the application still has errors so that the app still cannot be used optimally.

![Figure 4. Comparison of usability test result.](image)

Based on Figure 4, there is an increase in usability value in the first iteration usability testing and the second iteration usability testing from 65.78% to 82.75% in the good category to be very good. This is obtained from the process of repairing the features found at the time of the first iteration usability test that affects several usability factors such as ease of use, ease of learn, and satisfaction. As in the improvement of choosing a name, after highlighted chosen name, then children might be able to know what is the name chosen, this affects the factor of ease of use and satisfaction. Furthermore, there is an improvement for the help button with the use of animation effect, so that the children know if there is the help button if the children answer incorrectly. That improvement affects the factor of ease of use. The use of the back button on name screen input make it easier for the children to return to the previous screen, this affects the factor of ease of use, ease of learn, and satisfaction.

From Figure 4, it can be seen that the results of the first and second iteration usability testing on Tebak Budaya Sunda Application have produced usability values that are better than the usability values of samples in existing applications. Tebak Budaya Sunda Application has a usability value that is good at factors such as usefulness, ease of use, ease of learning, and satisfaction. So that the application already has good usability values, it is easy to use and learn and has a good level of user satisfaction.

5. Conclusion
After implementing the UCD method, the user interface model of Sundanese Culture Introduction is obtained which has the features needed by deaf children. This feature consists of giving Sundanese Culture material with simple text and large font size, which is provided when the child can guess the picture. A picture guessing game is presenting to prevent the children easily get bored when learning the Sundanese culture. In this application, there are also pictures or videos on each screen of Sundanese Culture material. The level features provide different levels of difficulty because children are happy with challenges, reward features in the form of points that can motivate children when answering questions, use of navigation that makes it easy for children to use the application, and the use of animation that can attract children's attention. After two iterations on the UCD method, there was an increase in the usability value of the proper category to be very good. This shows that the user interface of the “Tebak Budaya Sunda” application has met the needs of deaf children. Further research is needed after using the “Tebak Budaya Sunda” application to find out the level of children's understanding of Sundanese Culture.

References

[1] D. P. K. Bandung 2017 Data Jumlah Siswa Sekolah Luar Biasa (SLB) Dinas Pendidikan Kota Bandung Tahun Pelajaran 2014-2015
[2] N. L. H. A. H. Shelena Soosay Nathan 2016 *AIP Conf. Proc. Studies on Deaf Mobile Application*

[3] H. O. a. A. K. Cem Çuhadar 2009 *Int. Journal of Education and Information Technologies* m-Learning for Hearing Impaired Learners: Dimensions of Evaluation, vol. 3, no. 3.

[4] R. Linton 2017 *Stalinism: Essay in Historical Interpretation* (New York: Routledge)

[5] M. D. N. d. M. K. Pariwisata 2009 Peraturan Bersama Menteri Dalam Negeri dan Menteri Kebudayaan dan Pariwisata tentang Pedoman Pelestarian Kebudayaan Nomor 42 Tahun 2009

[6] S. D. B. C. N. P. Z. J. Abascal 2015 Rethinking Universal Accessibility: A Broader Approach Considering The Digital App Universal Acces in The Information Society pp 1-4

[7] A. H. N. L. H. Shelena Soosay Nathan 2016 *Proc. of The International Conference on Applied Science and Technology* Deaf Mobile Application Requirements

[8] A. Lund 2001 Measuring Usability with the USE Questionnaire

[9] C. P. B. Shneiderman 2007 *Designing The User Interface: Strategies for Effective Human-Computer Interaction* (Addison-Wesley)

[10] A. S. K. H. Kh. Rekha Devi 2012 *Int. Journal of Scientific and Research Publications* A working Framework for the User-Centered Design Approach and a Survey of the available Methods vol 2 no 4

[11] R. G. A. M. P. V. Tania Di Mascio 2013 *Int. Journal of Technology Enhanced Learning, Designing Games for Deaf Children: First Guidelines* vol 5

[12] K. E. L. W. J. C. B. Julie Fisher 2013 24th Australian Conference on Information System (Melbourne) Taking a User Centred Design Approach for Designing a System to Teach Sign Language

[13] I. O. f. Standardization 2010 *Ergonomics of human-system interaction: ISO 9241-210 Human-Centred Design for Interactive Systems*

[14] N. S. Tet Kun Chung 2015 *International Journal of Computer and Engineering* Utilitarian or Experimental An Analysis of Usability Questionnaires 7

[15] I. O. f. Standardization 2011 *Systems and Software Engineering* Systems and software Quality Requirements and Evaluation (SQuaRE)

[16] A. H. N. L. H. Shelena Soosay Nathan 2016 *Journal of Telecommunication Electronics and Computer Engineering* Studies on Deaf Mobile Application: Need for Functionalities and Requirements 8

[17] Sugiyono 2017 *Metode Penelitian Kuantitatif, Kualitatif* (Bandung) Alfabeta CV vol 25

[18] S. E. Masri Singarimbun 2008 *Metode Penelitian Survei* (Jakarta) LP3ES Indonesia Anggota IKAPI vol 19

[19] IBM 2016 *Kuder-Richardson Reliability Coefficients KR20 and KR21*