

Enhance User Interface to Deaf E-Learning Based on User Centered Design

Fardan Zamakhsyari, Achmad Teguh Wibowo, Mohammad Khusnu Milad

Abstract—The cognitive learning approach through visual media is a characteristic of learning for deaf students because these students can receive learning more quickly. However, this method became an obstacle when this process was conducted online because of the effect of the Covid-19 pandemic. Based on the explanation, a need for media learning based on interactive media can help students in the studying process. This research focuses on developing learning media using User Center Design (UCD) method to a center for the development system. In this research, we develop a user interface (UI) for deaf students, especially in the Putra Asih inclusive school in Kediri, Indonesia. The evaluation of this research using ISO-9241 shows the effectiveness of using the application obtained 87,15%, the effectiveness of the user interface design obtained 80,05%, and user satisfaction obtained 71,18% where all parameters make sense and are accepted based on a response from the users.

Index Terms—Deaf Learning, User Interface, User Centered Design.

I. INTRODUCTION

Teaching and learning activities are essential processes in education, and there are two essential aspects (students and teachers). Learning media could increase efficiency and effectiveness in studying [1]. Interactive media use many variations used to send material, including books, cassettes, videos, photos, tape recorders, slides (picture frames), films, and computers [2].

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Learning media a developed by several processes, including observation, planning, and student requirement, which are used as an appropriate learning design [3]. The impact of learning media on the interaction process of students and teachers in the studying process is similar to tools for social interaction in education [4].

Students can be categorized as general and inclusive students. The focus of this research is on deaf students. This student has a deficiency in the auditory system, so that hard to study based on voice [5]. To the studying process, deaf students are suitable for learning based on visuals. So visual media is more easily for deaf students [6].

Nowadays, learning activities encounter obstacles since the Covid-19 pandemic required studying using the online method. This method significantly impacts deaf students because of the lack of interaction in the learning process [7]. So that is necessary to develop media learning that can positively affect teachers and deaf students in virtual interaction, so the use of the website can be a solution to the learning process [8].

Nowadays, deaf students can use electronic devices to support the learning process. Such as handphones, laptops, tablets, computers, et cetera [9]. So the website is suitable for learning for deaf students because it is easy to access for students and has a function to communication for learning because it can integrate technology with efficient pedagogic. Online learning became important two decades ago after the popularity of the world wide web [10].

The interface connects the user with a computer, so it is necessary to enhance effectiveness in this case [11]. This research uses User-Centered Design (UCD) to develop a user interface. The concept applied to the UCD method is a development and evaluation based on users [12]. So deaf students are the center for UI development. Implementing the UCD method can increase the efficiency and suitability of the system with the user. UCD has four primary processes: first, Understanding and Determining the Context of Use; second, defining User and Organizational Requirements; third, Generating Design Solutions; and four, Evaluating Designs against Requirements [13]. This research test the suitability of the product using ISO-9241 to test the learning media functionally based

on Usability testing. This testing encompasses the users' effectiveness, efficiency, and satisfaction because ISO-9241 focused on users and usability results needed as an evaluation stage [14].

II. MATERIALS

Research-Based on that conducted by Abdallah A. Alshawabkeh, M. Lynn Woolsey, and Faten F. Kharbat, in a study entitled Using online information technology for deaf students during COVID-19: A closer look from experience. This study aimed to determine perceptions about technology instruction and accommodation provided to deaf students in online distance learning during the COVID-19 pandemic. The results of this study are in the form of perceptions of deaf students toward the need for online learning [15].

Furthermore it, based on research conducted by Harry Budi Santoso, Panca O. Hadi Putra, and Febrian Fikar Farras Hendra, with the title Development & Evaluation of E-Learning Module Based on Visual and Global Preferences Using a User-Centered Design Approach. This study aims to provide an alternative interaction design for the e-Learning module by developing content based on user needs using the User-Centered Design methodology. The result consists of an alternative design and a proposed interface design [16].

Then the research was conducted by S.C. Nwaneri and H.C. Ugo, under the title Development of a Graphical User Interface Software for The Prediction of Chronic Kidney Disease. This study is designed to develop a user-friendly web-based graphical user interface (GUI) software for the prediction of Chronic Kidney Disease (CKD) using Artificial Neural networks (ANN). The GUI software is developed on a model basis using Django, the open-source python web development framework. The model achieves 95.83% accuracy, 100% precision, 100% specificity, and 89.80% sensitivity. GUI software is effectively used to predict CKD and can be of great benefit as a point of care application for early CKD prediction [17].

Further research was carried out by Galina Volkovitchkaia, Yuliya Tikhonova, and Olga Kolosova, with the title Educational Experience in the Mobile Learning Environment: Consumer Behavior Perspective. This study aims to identify aspects of consumer demand for educational services in the process of testing a conceptual model of mobile learning that is adapted to the modern business environment in the context of the digital transformation of socio-economic life. Until now, research has not touched a tangible thing that is measurable in terms of real income from certain activities, the results of implementing mobile learning. The contribution of this research to the field under study is to establish the pedagogical demands that can be met by mobile learning [18].

And the last research was written by Nik Azlina Nik Ahmad and Muhammad Hussaini with the research title A Usability Testing of a Higher Education Mobile Application Among Postgraduate and Undergraduate Students. This study presents an evaluation of the usability of higher education mobile applications at the University of Kuala Lumpur. The study was conducted

using a usability testing methodology based on the ISO 9241-11 standard to measure three usability factors: effectiveness, efficiency, and satisfaction. The results of the study indicate that the application is effective, efficient, and fulfills user needs. satisfaction with its use, with a satisfaction level of 82.15%. However, several issues were highlighted by the respondents during the usability test [19].

III. METHOD

This research uses mixed methods. The experimental sequential design begins with the collection of qualitative data furthermore proceeds with the collection of quantitative data. This data is used to explore the existing phenomena and collect quantitative data to find a correlation between the variables' relationship in the qualitative data [20].

2.1. User Centered Design

The following process is designing UI e-learning for the deaf using data from the previous process based on the UCD method. The last process is testing using usability testing. The UCD method has four standard steps as its implementation activity [13], an illustrated the UCD shown in Fig 1.

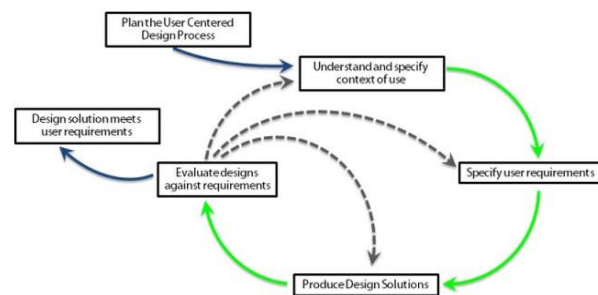


Figure 1. Stage of User Centered Design [13].

The first process of UCD is understanding and specifying context, knowing of need and usage environment, including the task to product usage. Second, specify the user and organizational requirements and the boundary [21]. Third, applied the aspect of human and computer interaction (visual design, interaction, and usage) into solution design using produce design solutions. The last evaluation of design implementation using user usage is based on the usability testing method [13].

2.2. Usability Testing ISO 9241-11

Usability Testing is a testing technique used in user-centered UI design to evaluate a product by testing the user's experience. Testing focuses on measuring the product's capacity to meet its intended purpose. The measurement of usability testing using point of view and ease of operation based on particular or several objects from the users. Users can provide input regarding the process of the system [22].

Usability testing on UI design in this research uses ISO 9241-11. In ISO 9241-11, there are three assessment variables. First is effectiveness which shows how well users use the system; second is efficiency which assesses the system's suitability with users. And

last is satisfaction which is an assessment from the user's point of view [23]. The usability measurement uses effectiveness, efficiency, and user satisfaction components. This component can be measured using a post-task questionnaire [24].

Effectiveness is related to the suitability of the system to the ability of users in working on the process, effectiveness can be calculated based on the number of all tasks that have been successfully carried out from all existing processes, with the value of effectiveness,

$$\frac{\text{number of task completed successfully}}{\text{total number of task}} \times 100\% \quad (1)$$

The number of Tasks Completed Successfully is the number of tasks that were successfully completed, and the total of tasks is the number of tasks [25]. Efficiency relates to the suitability of the system with the user's ability to perform tasks based on accuracy and processing time. Efficiency can be measured by the following equation.

$$\text{Time Based Efficiency} = \frac{\sum_{j=1}^R \sum_{i=1}^N \frac{n_{ij}}{t_{ij}}}{NR} \quad (2)$$

In calculating the efficiency of the system for users, several variables are needed, the total number of tasks performed (N), the variable (R) indicates the number of users tested, and the results of the task (i) performed by the user (j), if the task is successful then (nij) the value is 1 and if it fails to complete the task then (nij) is worth 0. and the time used by the user - j in completing the task - i (tij). If the task is not successfully completed, then the time is counted until the User stops working on the task [25].

The level of satisfaction of the user can be measured using the System Usability Scale (SUS) questionnaire which is a method used to measure the level of user satisfaction with an application [26]. This questionnaire consists of 10 different questions with a ratio between positive and negative questions of 5:5, odd statements match positive while even questions have negative values. In calculating the results of the questionnaire can use the following methods:

For each odd-numbered question, the respondent's score is reduced by 1. Meanwhile, for each even-numbered question, the respondent's score is used to subtract 5.

$$\text{Odd score} = \sum Px - 1 \quad (3)$$

$$\text{Even score} = 5 - \sum Px \quad (4)$$

for the adjusted value for odd-even questions, and P is equal to the value of the question. Then the results of each question are added up and divided by 2.5.

$$(\sum \text{odd score} + \sum \text{even score}) \times 2,5 \quad (5)$$

The final step is averaging the results of all respondents. Then all the scores are added up and divided by the number of respondents.

$$\bar{X} = \sum x / n \quad (6)$$

Where X is the average value. Later the final score of the SUS questionnaire will be in the range of 0-100. Based on the final score of the Adri SUS questionnaire, it will be known what the level of usability and acceptable design of the application system is being developed. The range of assessments can be of 3 kinds, as shown in the following table [26].

IV. RESULTS AND DISCUSSION

4.1 Understand and Specify Context of Use

To find out user needs, it is necessary to carry out a data collection process. At this stage, interviews with students and several educators are carried out. The results are obtained in the form of existing conditions and problems related to the teaching and learning process.

(a) SLB-B participants are students with low to medium levels of deafness. (b) In the offline learning process, the teacher delivers material using cognitive learning methods that emphasize visuals, either in the form of hand movements, facial expressions, or learning videos. (c) In the online learning process, teachers often use the WhatsApp application in the learning process, both in delivery and supervision. (d) The use of the WhatsApp application as a learning tool is considered less effective because the learning process needs to be more focused. (e) The teachers tried to use Virtual Meeting applications, However, some parents oppose the decision because of the application's complexity, which also makes it difficult for students. (f) Some students also prefer to avoid the learning method with the WhatsApp application because they tend to learn without visual interaction. (g) Some students need help understanding the material if the material is presented in the form of literature because of the student's reading ability level.

From the results of interviews that have been carried out, several problems appeared, namely the ineffectiveness of teaching and learning activities carried out online. Online learning media are not able to adopt offline learning models. This leads to a reduction of student interest in learning, and less material is conveyed to students. So online learning media that can help the student learning process is very much needed.

4.2 Specify the User and Organizational Requirement

After knowing the traits of the user, then another data collection is carried out to determine the user's requirements for the system. A questionnaire is prepared with Human Considerations in the Design of the Business System method as the research instrument. The value of the questionnaire consists of to which extent the user understands the system, the processes needed by the user, psychological and physical traits of the user. The questionnaire is intended to determine the conditions required by the user. Questionnaires will be filled in by deaf students manually answering a question sheet as they are the respondents who will interact

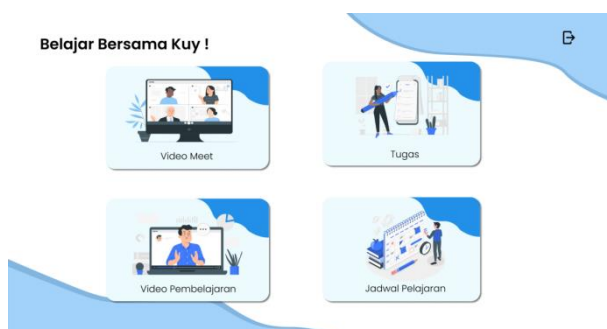


Fig. 4. Home Page

Figure 4 is a display design for the main page, there are six main features on the main page; lesson schedules, learning videos, assignments, assignments archives, questions and answers, and logout. These six features are the main menu of this learning application, which have different functions to help support the learning activities of deaf students.

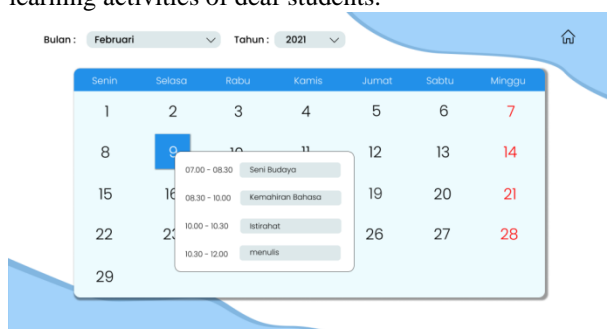


Fig. 5. Schedule Page

Figure 5 is schedule will be displayed when the mouse cursor is on the selected day. The schedule will be displayed according to hours and subjects. The schedule is made in a minimalist design with few words and using borders on fields in each subjects so that they are easily marked.



Fig. 6. Subject Page

Figure 6 is a display design for the learning video page. This page displays the subjects that are being studied. Then, at the side part of the page, there is a history list of materials that have just been accessed. The use of the last history list is intended to make it easier for students to remember or find material that has been accessed. In addition, the subject data is also illustrated with illustrations for easy understanding.

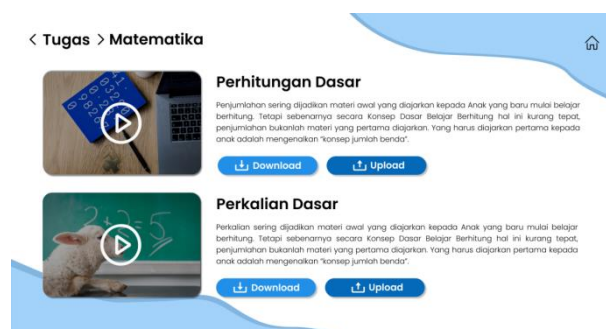


Fig. 7. Task Page

The design of the task list page is shown in Figure 7 this page displays a list of assignments for the subjects being taken and provides a brief explanation as an introduction to the assignments. In this menu, assignments can be downloaded via the button, and you can use the upload button for collecting the assignments. This is to make it easier to collect the assignments.



Fig. 8. Logout Page

The logout page design can be seen in Figure 8 on this page it displays the option to exit or not, with the use of green and red colors to distinguish between yes and no. The colors green and red were chosen because they tend to represent approval and rejection. In addition, being given a choice between yes and no is also intended to determine user consent, to determine whether they want to exit or not.

4.4 Testing Aspects of Effectiveness

the results of the percentage of success (completion rate) from the effectiveness test got a score a total of 87.15%. Based on the standard issued by ISO/IEC 9126-4 that the system can be declared effective if the percentage of success (completion rate) of respondents in completing their task scenario is 78% or more. So that this application at the level of effectiveness is still classified above the average standard.

4.5 Testing Aspects of Efficiency

The efficiency aspect is measured based on the duration of the total time of task execution by the respondent or user. Calculation and analysis of data on this aspect using the formula time-based efficiency. Based on testing using the time-based efficiency formula of 32 respondents and 27 task scenarios on the efficiency level, the result is 80.05%.

4.6 Testing Aspects of Satisfaction

After recapitulating the data from the SUS questionnaire above, then the calculations are carried out according to the formula for calculating the SUS questionnaire, namely, for each question with an odd number (1,3,5,7,9) the score given by the respondent is reduced by 1, and for each question with an odd number even number (2,4,6,8,10) the score given by the respondent is used to subtract 5. Next, the results of each question from each respondent are added up and then divided by 2.5 ($\sum \text{odd score} + \sum \text{even score}$) x 2.5. Then do the average results of all respondents. Add up all the scores then divide by the number of respondents. The calculation of the SUS questionnaire formula obtained the following results.

Based on the calculation results, the overall average total is 71.18. Furthermore, the results of the above calculations can be described in the form of a diagram of the total score scores of the SUS questionnaire conducted by 32 respondents, 16 respondents from junior high school students, and 16 respondents from high school students. The diagram image is as follows.

4.7 Result

After creating the user interface design, it is necessary to evaluate to determine the level of system usability, which in the evaluation process uses usability testing by measuring the level of effectiveness, efficiency, and user satisfaction. The results are described in the following table.

Table 2. Results Using Usability Testing

Usability Aspect	Formula	Result
Effectiveness	Completion Rate	87.15% (above average)
Efficiency	Time Based Efficiency	80.05%
Satisfaction	System Usability Scale (SUS)	71.18% (Acceptable)

Based on Table 2, it can be said that every aspect of usability testing using the ISO 9241 method has a value that meets the standard. In testing the effectiveness of the deaf learning application design, the percentage value is 87.15% and is in the above-average category. Furthermore, the efficiency aspect in the design of the deaf learning application has a percentage value of 80.05% and has met the standard. And finally, the satisfaction aspect in the design of the deaf learning application has a percentage value of 71.18 and is included in the Acceptable category. Overall, it has met the aspects of usability testing ISO 9241.

V. CONCLUSIONS

The results of the User Interface Design planning for deaf learning media are carried out using the user-centered design method by going through 4 stages. The stages are Understand and Specify Context of Use, Specify the User and Organizational Requirements, Produce Design Solutions, and Evaluate Designs against Requirements. After planning the User Interface Design using the user-centered design method, the design gets tested using the ISO 9241-11 usability testing method, which assesses the effectiveness, efficiency, and user satisfaction. From the results of this test, it was found that the application's effectiveness got a value above the average with a success percentage of 87.15%. The effectiveness of the user interface design also got a value above the average with a percentage of 80.05%. Moreover, finally, in terms of user satisfaction, the percentage value is 71.18%, which is included in the Acceptable category, which means getting a positive response from the user.

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