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Research Article

Design of Usability and Accessibility Evaluation for a Multimedia-Based Animal Life Cycle Learning Application for Deaf Students

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Abstract. Previous research on a multimedia-based animal life cycle learning application for deaf students has produced a system design, interface storyboards, instructional materials, an evaluation, and sign language videos; however, it has not yet reached the stage of evaluating the quality of use. This situation highlights the need for further research with stronger scientific rigor, specifically testing the usability and accessibility of the designed application. This article aims to develop a more formal, submission-ready, and conceptually robust follow-up manuscript by placing evaluation as the primary focus of the research. The proposed approach employs an evaluative mixed-methods design combining usage observation, task scenario completion, brief interviews, and the System Usability Scale (SUS) questionnaire. The evaluation framework is structured by integrating usability concepts from ISO 9241-11, accessibility principles from WCAG 2.1, and findings from studies on digital learning media for Deaf and Hard of Hearing students. The main outcomes of this article are: (1) a reformulation of the title to make it more journal-ready, (2) strengthening of the literature review and citations, (3) formulation of operational evaluation indicators, (4) design of task scenarios for application testing, and (5) clarification of the contribution of this follow-up paper compared to the source paper. This manuscript does not yet present empirical field data; therefore, its status is that of a research article draft ready to be supplemented with test results in the next phase. Thus, this article can serve as a methodological bridge from design research to evaluative research that is more suitable for submission to a journal.

Keywords: Accessibility; Application Evaluation; Deaf People; Educational Multimedia; Sign Language Videos; SUS; Usability; WCAG.

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1. Introduction

The source paper titled "Design of a Multimedia-Based Learning Aid on the Animal Life Cycle for Deaf Students in Special Education School Section B" contributes to the needs analysis and design stages of a learning application for deaf students, specifically through use cases, activity diagrams, storyboards, and sign language video designs [1]. This focus is relevant as an initial foundation because deaf students rely heavily on visual channels when receiving learning materials.

However, a design paper alone is not sufficient to demonstrate that an application is truly user-friendly and accessible. In the context of human-computer interaction, usability is defined as the extent to which a system can be used by a specific user to achieve specific goals effectively, efficiently, and satisfactorily within a specific context of use [2].

From an accessibility perspective, WCAG 2.1 emphasizes that digital interfaces must adhere to the principles of perceivable, operable, understandable, and robust to be more widely accessible to users with diverse needs [3].

These two principles are essential for learning applications designed for students who are deaf or hard of hearing. The presence of images, animations, or sign language videos does not automatically guarantee a high-quality user experience. Research on e-learning and multimedia for Deaf and Hard of Hearing (DHH) users indicates that visual features, captions, sign language, navigation consistency, and appropriate content representation significantly influence comprehension and learning comfort [4]–[9]. Other studies also show that the online learning experience of DHH students is often disrupted by communication issues, content structure, and a lack of adequate non-audio accessibility support [10]–[13].

Furthermore, the usability literature emphasizes that evaluation should not rely solely on general impressions of the application. Testing must be supported by clear tasks, observations of user success, and reliable instruments such as the System Usability Scale (SUS) [14]–[16]. In the context of specialized learning media, previous findings suggest that evaluations should not only assess appearance but also examine whether visual elements and sign language genuinely support learning, rather than merely serving as supplements [5], [6], [8], [9].

Given this gap, the most logical and valuable follow-up to the original paper is an evaluative research article. The focus is no longer on how the application was designed, but rather on how it was tested in terms of usability and accessibility. With this approach, the research process becomes more comprehensive: from identifying needs, to application design, to evaluating usability.

The contributions of this article are as follows. First, reformulating the title and focus of the article to make it more formal and journal-ready. Second, strengthening the theoretical foundation with more relevant and robust citations. Third, developing an operational evaluation framework that can be directly applied in field research. Fourth, preparing a manuscript structure that is more ready for submission, although the empirical results section still needs to be filled in after the actual testing is conducted. The structure of this article includes an introduction, literature review, proposed methods, results and discussion in the form of an evaluation design, a comparison of contributions with the source paper, and conclusions.

2. Introduction or Related Work or Literature Review

Educational Multimedia for Deaf Students

Learning media for deaf students requires an emphasis on visual elements, a clear information structure, and content representation that does not rely on audio. The source paper has utilized a combination of text, images, animations, and sign language videos for material on the life cycle of animals [1]. This approach aligns with various studies that position multimedia as a crucial medium for supporting the understanding of students with hearing impairments, particularly when the material is process-oriented or requires step-by-step visualization [4], [5], [7], [8].

Related research also indicates that effective multimedia for students with hearing impairments does not merely add visual elements but organizes content in a bilingual or multimodal manner, for example, through a combination of written language, sign language, video, and illustrations that reinforce one another [6], [9], [17]. Therefore, the quality of media cannot be assessed solely based on available features but rather on the alignment of those features with the learning styles of the target users.

Usability and Accessibility as Evaluation Focuses

Usability is a critical component because learning applications must be learnable and usable with minimal barriers. ISO 9241-11 emphasizes three key components: effectiveness, efficiency, and satisfaction [2]. In evaluation practice, this framework is often combined with task-based testing and the SUS because the SUS is relatively concise, stable, and has been widely used across various digital systems [14]–[16]. From an accessibility perspective, WCAG 2.1 provides a strong reference for assessing whether digital content can be perceived, operated, understood, and remains reliable under various usage conditions [3].

For learning applications for deaf students, the implications include clarity of text and icons, support for captions or sign language, consistent navigation, not relying solely on audio, and clear instructions for evaluation and game features [3], [5], [10], [11].

Position of the Follow-Up Study

While the initial research was in the design and development phase, this follow-up study is in the evaluation phase. This positioning is crucial because several studies on learning platforms for students with hearing impairments have only yielded significant contributions after demonstrating usability evaluation results and feedback from the target users [7], [11], [12].

Thus, this article does not break continuity with the initial research but rather clarifies the next steps, which are methodologically stronger. The object remains the same—a multimedia-based animal life cycle learning application—while the novelty lies in the evaluation framework and the measurement of usage quality.

3. Proposed Method

This article is structured as an evaluative research manuscript ready for implementation during the testing phase. The proposed research design is a descriptive-evaluative mixed-methods approach. Quantitative data are used to describe task success, completion time, and usability perception scores, while qualitative data are used to capture barriers, confusion, and improvement suggestions from users.

The research object is a multimedia-based animal life cycle learning application as designed in a previous study [1]. The most relevant research subjects are deaf students as the primary users and teachers as accompanying informants. During the implementation phase, the number of participants can be adjusted based on school availability and the feasibility of field studies; however, the minimum design should still allow for direct task observation.

Data Collection Techniques

Table 1. Presents The Proposed Data Collection Technique Design.

Technique	Data Source	Focus	Output
Observation of usage	Students	Navigation, confusion, assistance needed, and response to visual displays	Usage behavior notes
Task scenarios	Students	Success in completing core tasks in the course materials menu, evaluation , and sign language videos	Task success rate and time
SUS Questionnaire	Students/teachers	General usability perception	SUS score
Short interview	Students/teachers	Usage experience, obstacles, and suggestions for improvement	Qualitative findings

Evaluation Indicators

The evaluation indicators were developed based on a combination of usability and accessibility concepts, as well as application characteristics from the source paper. Table 2 shows the proposed operational indicators

Table 2. Shows The Proposed Operational Indicators.

Aspect	Indicator	Observed Evidence	Data Type
Visual clarity	Text size, icons, colors, and layout are easily recognizable	Users can identify buttons/menus without much assistance	Observations and scores
Navigation	The flow of movement between pages is consistent and easy to understand	Users can go back, navigate menus, and resume activities correctly	Observations
Non-audio access	Core information is not dependent on sound	Content can be understood through text, images, animations, or sign language videos	Observations and interviews
Comprehension of the material	Metadata and evaluation instructions are understandable	Users are able to explain the content or complete the requested tasks	Observation and interviews
Ease of evaluation	Practice questions, quizzes, and games can be operated without excessive confusion	Users are able to start, answer, and complete assessment features	Observation and time
User satisfaction	Users find the app helpful and easy to use	Perception scores on the SUS and user comments	SUS and interviews

Data analysis

Quantitative data were analyzed descriptively. The task success rate can be calculated using Equation (1).

Task success rate (%) = (number of successful tasks / total number of tasks) × 100% (1)

SUS scores were calculated following standard procedures, namely converting odd and even item scores, summing all scores, and then multiplying the result by 2.5 to obtain a range of 0–100 [14]–[16]. Meanwhile, qualitative data from observations and interviews were analyzed through thematic grouping, such as navigation issues, clarity of terms, text readability, or the function of sign language videos.

4. Results and Discussion

Evaluation Objects

Based on previous research, the evaluation objects can be categorized into five groups: (1) the introduction page and core competencies; (2) the metamorphosis content page; (3) the assessment page consisting of practice questions and quizzes; (4) the puzzle game page; and (5) sign language videos [1]. This categorization is important because each group represents a different type of interaction.

The introductory page is primarily related to the user's initial orientation. Content pages assess the extent to which visual content and explanatory structure support understanding. Evaluation and game pages are more sensitive to interaction load, as users not only read the material but must also make decisions, select answers, and understand instructions. Meanwhile, sign language videos serve as a critical accessibility component for deaf users [1], [3], [7].

Task Scenario Design

Table 3. Shows an Example of A Task Scenario That Can be Used During Testing.

No.	Task Scenario	Evaluation Objective	Key Indicators
1	Open the introductory menu and basic competencies	Assess the user's initial orientation	Visual clarity; navigation
2	Opening the material on complete and incomplete metamorphosis	Assessing understanding of the material structure	Navigation; comprehensibility of the material
3	Accessing sign language videos for one of the topics	Assessing non-audio accessibility support	Non-audio access; comprehensibility
4	Completing practice exercises	Evaluating the ease of use of evaluation features	Ease of evaluation; navigation
5	Starting and completing puzzle/quiz games	Evaluating interactions with active features	Ease of evaluation; satisfaction

Discussion of Results

If, during the testing phase, students are able to complete most tasks without significant assistance, this can be interpreted as an indication of good effectiveness and ease of use [2]. If the SUS score also falls into the adequate or high category, the argument regarding usability becomes stronger [14]–[16].

However, the discussion should not stop at the scores. For example, even a fairly high score still needs to be interpreted alongside observational data. It is possible that users successfully completed the tasks but had to go through repeated confusion or required teacher assistance. In the context of an application for deaf students, such findings remain important because they indicate the presence of access barriers that must be addressed [7], [10], [11].

Regarding accessibility, the main discussion focuses on whether sign language videos, text, and animations truly function as complementary learning supports. If students find it easier to understand the material after using sign language videos and visual representations, then these features serve a substantive purpose. Conversely, if videos or text are available but rarely used or difficult to understand, then the app's design needs to be reevaluated [3], [5], [8], [9].

Potential Improvement Recommendations

Based on the design characteristics from previous studies, potential recommendations include simplifying icons, adding step-by-step instructions on the evaluation page, ensuring consistency of terminology across all menus, improving text readability, and enhancing the integration of sign language videos to make them more accessible [1], [3]. Thus, follow-up research does not merely stop at evaluation but generates an evidence-based foundation for improvement. This added value is what makes an evaluative article stronger than a mere design article. Table 4 illustrates the contribution of the follow-up research compared to the previous study.

Table 4. Shows the Contribution of the Follow-Up Study Compared to the Previous Study.

Aspect	Source Paper	Proposed Follow-up Paper
Focus	Needs analysis and application design	Evaluation of application usability and accessibility
Key Deliverables	Use cases, activity diagrams, storyboards, material designs	Evaluation instruments, test results, usability scores, identified barriers, and recommendations for improvement
Methodological approach	Design/development	Evaluation
Type of contribution	Shows how the application is designed	Demonstrates how well the application is used and accessed
Strengths of the article	Clarity of system design	Strength of evidence of real-world use by the target users

5. Conclusions

This study confirms that the development of educational applications for deaf students should not stop at the design stage, but must be followed by usability and accessibility evaluations so that the quality of the applications can be systematically assessed. The designed multimedia application has the potential to support learning through text, images, animations, interactive assessments, and sign language videos; however, the effectiveness of its use still needs to be proven through testing with real users. Thus, this paper contributes to guiding research from the design stage toward evaluating the quality of more inclusive digital learning applications.

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