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Analysis of TongueFit's Usability Issues Using User Experience Method

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Abstract

Introduction: TongueFit designed to address the challenges of managing oral dysphagia in children. Integrating technology into rehabilitation has shown promise in enhancing therapeutic outcomes. Usability testing involving end-users is essential to ensure effectiveness and satisfaction. This research aims to evaluate usability issues of the prototype orofacial manometer, Tonguefit using user experience method. Methods: The assessment used a questionnaire modified from Baharum et al that was translated into Bahasa. To ensure face validity, the questionnaire was given to 3 users, who were required to evaluate the items with respect to ambiguity and understandability. Fleiss Kappa Index was used to determine the face validity. For user experience, 20 users who met the inclusion criteria were required. They were asked to assess the usability issue using the questionnaire. Data was transposed and analyzed using User Experience Questionnaire methodology. Result: All reviewers of the instrument have had equal agreement and the questionnaire is clear and suitable to collect data (FKI 0.792). Based on the results of the user experience, the 2 variables obtained positive evaluation values, namely the Perceived Usefulness (mean 1.35) and Continuance Intention (mean 0.83). The highest evaluation value was on the Perceived Usefulness variable, while the lowest value was on the Interface Quality (mean 0.09). However, there is still potential for improvement to meet the desired standards of excellence. User feedback and suggestions have been instrumental in identifying areas for improvement. Conclusion: Tonguefit demonstrates strong perceived usefulness and continuance intention, while other areas require development to improve overall user satisfaction.

Keywords: orofacial manometer, usability, user experience,

INTRODUCTION

Dysphagia, or difficulty swallowing, is a condition characterized by challenges in moving food or fluids from the mouth, pharynx, or esophagus to the stomach. Oral dysphagia, specifically caused by tongue function disorders, is commonly associated with sensory, musculoskeletal, neuromuscular, and nutritional or metabolic issues. Studies in Cipto Mangunkusumo Hospital utilizing videofluoroscopic swallowing studies (VFSS) have reported that swallowing disorders occur in the oral phase (22%), pharyngeal phase (9.8%), and oropharyngeal phase (63.4%), with cerebral palsy being the most common underlying condition (59.2%).1,2

Weakness in tongue muscles often manifests as difficulties in bolus control, mastication, bolus transport, and the presence of oral residue.2,3 Tongue strength serves as a critical objective measure for tongue function, essential not only for diagnosing dysphagia but also for setting therapeutic goals and evaluating treatment outcomes.4 Unfortunately, Indonesia lacks accessible tools to measure tongue strength and endurance or to provide tongue exercise therapy. Available devices, such as the Tongueometer and the Iowa Oral Performance Instrument (IOPI), are costly, difficult to access, and not user-friendly for children. 5,6

To address these challenges and meet the demand for managing oral dysphagia in children, there is a need for a prototype orofacial manometer (PMO) that is easy to use and understand for children, affordable, and accessible in Indonesia.

The development of such tools and approaches holds significant potential for revolutionizing the treatment of dysphagia, particularly for pediatric patients, by combining effective diagnostics, rehabilitation, and motivation through interactive methods. The integration of technology into rehabilitation has garnered considerable interest due to its potential to improve therapeutic outcomes.7-9 To ensure effective adoption, the design and development process must be iterative and involve collaboration across multiple disciplines.10 At a minimum, this process should include the participation of individuals who will ultimately use or advocate for the device. A crucial aspect of this approach is usability testing by end-users, which assesses how easily the prototype can be used to achieve specific goals with effectiveness, efficiency, and satisfaction in a particular context.11,12 Feedback from these users, who often have different perspectives and behaviors compared to technical experts, can highlight necessary design adjustments and provide insights for successfully adapting and implementing the prototype in real-world settings beyond the development phase.13,14 The aim of this research is to evaluate user experience toward prototype orofacial manometer, Tonguefit.

RESEARCH METHOD

The design of TongueFit began with identifying the advantages and disadvantages of existing measuring instruments and identifying the specifications of the required instrument. The initial specifications set for the instrument were the need for a power button, battery indicator, and rechargeable battery embedded in the instrument, portable instrument size, and lightweight. The instruments included a manometer device along

with two variations of bulb sizes.

The tool is made of plastic that has SNI certification. Based on the initial specifications set for air-filled bulbs, there are two variations in size on the bulb, then the size of two variations in size for children aged over 6 years old (3 cm x 1.5 cm) and children under 6 years old (2 cm x 1.8 cm), made of food grade thermoplastic so it is safe to put in the mouth, and has a serrated pattern that functions as an anti-slip. The connecting tube was 50 cm long so that the instrument could be placed during the training process and was equipped with five colored lines as length markers.

Mockup Design is a visual representation or physical form of a product before the actual implementation stage. The creation of this mockup aims to identify potential improvements or changes from the beginning of the process before entering the further production stage. In the design of the orofacial manometer tool mockup, the tool design is printed using 3D printing. This needs to be done to ensure that all tool specifications are in accordance and to review whether the tool requires design optimization. The application mockup is created using figma. The application mockup includes details of the layout structure, graphic elements, navigation, and all the features in the application so that the final appearance of the application can be clearly depicted.

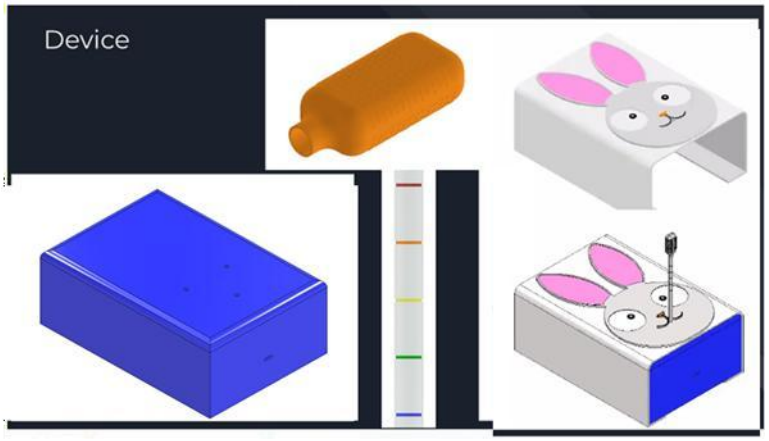

Figure 1. Design Plan of TongueFit

The tool mockups that have been created are then tested on a group of individuals representing potential users to ensure the quality and comfort of using the final product. Although the mockup is not functional, initial testing of the model is needed to explore user responses to its physical design. This preliminary testing process involves aspects of usability, ergonomics, and potential design improvements.

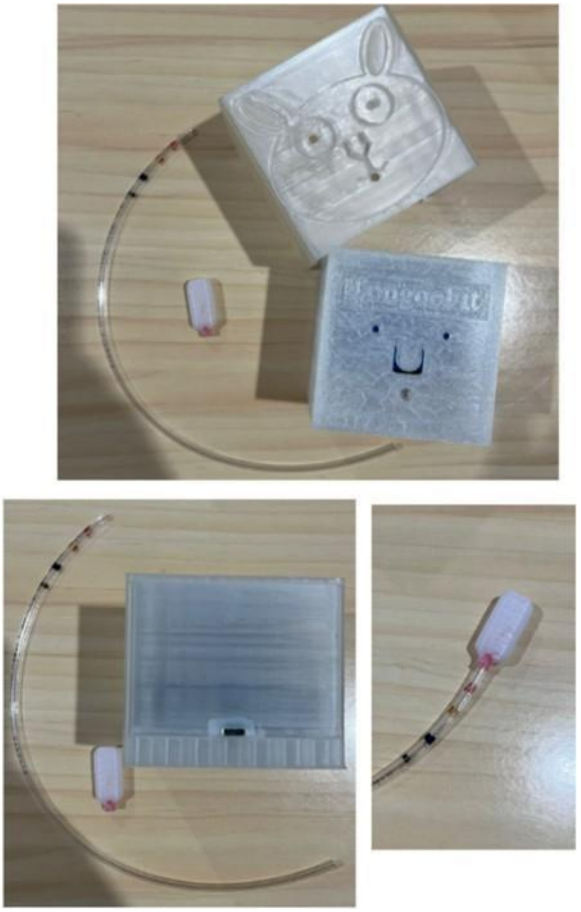

Figure 2. Mockup of TongueFit

The assessment in this trial used a special questionnaire modified from Baharum et al.. This questionnaire can be used to measure usability of an instrument. There were 24 items to measure consumer perceptions to design with seven constructs, namely Perceived Usefulness, Perceived Ease of Use, Expectation, Confirmation, Satisfaction, Continuance Intention, and Interface Quality. These items are scored based on a 5-point Likert scale ranging from -2 (completely disagree/negative evaluation) to + 2 (completely agree/positive evaluation). Baharum et al. provides an essential guideline for enhanced usability in interface design.15,16 The questionnaire was translated to bahasa using a forward-backward method. At first, one of the researchers translated the questionnaire into Bahasa. Then, the other researcher translated it into English. Finally, both researchers compared the two versions and presented the Bahasa version. This study was approved by the University of Indonesia Ethics Committee (KET611/UN2.F1/ETIK/PPM.00.02/2024) and written informed consent was obtained from all participants prior to data retrieval.

Face Validity

Face validity, using convenience sampling, the questionnaire was given to 3 users. The criteria for inclusion were as follows: medical doctors, familiar with the concept

under investigation and instrumentation. and willing to participate in the study. Then the participants were required to evaluate the items with respect to problems, ambiguity, relativity, proper terms and grammar, and understandability. The feedback received from the panel of experts used is agree (Yes) and disagree (No). Agree value means that the item is organized empirically and according to the classification of thematic categories In addition, the expert panel was also asked to provide comments and suggestions to improve the instrument.

The measurement data obtained were recorded and processed using Microsoft Excel (Microsoft Office 2019 version). Data analysis was conducted using SPSS software version 27. Responses will be analyzed using the Fleiss Kappa Index to determine the face validity of the study instrument. The items are indicators of evaluation done by three evaluators by determining the agreement of similarity of sets of data categories. A Kappa value equal to +1 indicates complete agreement between the two raters, while –1 indicates complete disagreement.

User experience

User experience was assessed by potential users who are expected to use TongueFit in clinical applications. These users were medical doctors with expertise in rehabilitation medicine and familiarity with instrumentation processes. Convenience sampling was employed to select participants, with exclusion criteria including failure to return the questionnaire or incomplete responses. A total of 20 users participated, providing feedback that was collected, analyzed, and utilized to generate improvement recommendations.

The data analysis was conducted using Microsoft Excel (Microsoft Office 2019 version) in alignment with the User Experience Questionnaire (UEQ) methodology.17,18 Responses were transformed into input values to calculate user experience scores, identifying positive and negative responses for each item. The processed data produced mean values for each variable, which were analyzed to evaluate TongueFit's user experience

Scoring was based on a scale of -2 to +2, where -2 represented the most negative response, 0 represented neutrality, and +2 represented the most positive response. The evaluation results were classified into three categories: positive, neutral, and negative. The analysis included the calculation of mean across 24 questionnaire items.A mean score >0.8 indicated a positive evaluation, scores between -0.8 and 0.8 were classified as neutral, and scores <-0.8 reflected a negative evaluation.17-18 These results informed targeted recommendations for refining TongueFit’s features, ensuring its quality and effectiveness align with clinical needs, and enhancing user satisfaction.

RESULTS AND DISCUSSION

Face validity

Validity values were analyzed through seven evaluation criteria and 24 statements that were given to 3 users. Validity values have been calculated by using Fleiss Kappa calculation. Table 1 shows that both expert reviewers of the instrument have had equal

agreement on 22 statements and have a difference of opinion on 2 others statements. The Kappa Coefficient value shows a value of 0.785 where it is at a good level of validity and suitable to be used to collect research data. This means there is significant agreement between expert reviewers of the first and second instruments ($p = 0.001 < \text{alpha} = 0.05$). Kappa values of 0.60 to 0.79 are generally considered satisfactory. All comments and suggestions from experts were taken and the researcher made corrections and improvements to the instrument.

Table 1. The experts agreement on face validity

Code	Rater 1	Rater 2	Rater 3
Perceived Usefulness			
PU1	✓	✓	✓
Perceived Ease of Use			
PE1	✓	✓	✓
PE2	✓	✓	✓
PE3	✓	✓	✓
PE4	✓	✓	✓
PE5	✓	✓	✓
PE6	✓	✓	✓
PE7	✓	✓	✓
PE8	✓	✓	✓
PE9	✓	✓	✓
Expectation			
E1	✓	✓	✓
E2	✓	✓	✓
E3	✓	✓	✓
Confirmation			
C1	✓	✓	✓
C2	✗	✗	✗
Satisfaction			
S1	✓	✓	✓
S2	✓	✓	✓
S3	✓	✓	✓
Continuance Intention			
C1	✗	✓	✗
C2	✓	✓	✓
Interface Quality			
IQ1	✓	✓	✓

IQ2	✓	✓	✓
IQ3	✓	✓	✓
IQ4	✓	✓	✓
Total of Agreement	22/24	23/24	22/24
Percentage of Agreement	91.67%	95.83%	91.67%
Average Percentage of Agreement	93.05%		

Usability testing

The questionnaire results provide valuable insights into the evaluation of Tonguefit across various research variables.

Table 2. Evaluation results of User experience

Code	Mean	Evaluation assessment
Perceived Usefulness	**1.35**	**Positive**
PU1	1.35	Positive
Perceived Ease of Us	**0.58**	**Neutral**
PE1	0.85	Positive
PE2	0.60	Neutral
PE3	0.25	Neutral
PE4	0.75	Neutral
PE5	0.80	Positive
PE6	0.40	Neutral
PE7	0.80	Positive
PE8	0.25	Neutral
PE9	0.55	Neutral
Expectation	**0.13**	**Neutral**
E1	-0.05	Neutral
E2	0.30	Neutral
E3	0.15	Neutral
Confirmation	**0.30**	Neutral
C1	0.25	Neutral
C2	0.35	Neutral
Satisfaction	**0.20**	Neutral
S1	0.10	Neutral
S2	-0.35	Neutral
S3	0.85	Positive
Continuance Intention	**0.83**	**Positive**
C1	0.85	Positive
C2	0.80	Positive
Interface Quality	**0.09**	**Neutral**
IQ1	-0.55	Neutral
IQ2	-0.25	Neutral
IQ3	0.65	Neutral
IQ4	0.50	Neutral

Perceived Usefulness, which measures users' perceptions of the expected benefits of using Tonguefit, received a positive evaluation with a mean value of 1.35. Users found Tonguefit helpful and efficient for assessing and treating dysphagia. However, Perceived Ease of Use, reflecting users' perceptions of the tool's ease and convenience, received a neutral evaluation with a mean value of 0.58. While users generally found Tonguefit easy to use, they noted that the power button and tubes require improvement.

The Expectation variable, which evaluates users' expectations for the tool, also received a neutral evaluation with a mean value of 0.13. Many users expressed uncertainty about whether the tool's display met their expectations. Similarly, Confirmation, which assesses the alignment between users' expectations and Tonguefit's actual performance, received a neutral evaluation, with a mean value of 0.30 indicating users expressed ambiguity about whether Tonguefit's display meets their needs.

The Satisfaction variable, capturing users' feelings about their prior experience with Tonguefit, received a neutral evaluation as well with a mean value of 0.05. While users were satisfied with the tool's benefits, they were dissatisfied with its interface design. In contrast, Continuance Intention, reflecting users' intent to continue using Tonguefit, received a positive evaluation with a mean value of 0.825. Users expressed a strong desire to continue using the tool and recommended it to others. Lastly, Interface Quality, which measures users' perceptions of the design and attractiveness of Tonguefit's interface, received a neutral evaluation with a mean value of 0.09, signaling a need for significant improvements in the interface design.

Discussion

TongueFit is a new portable orofacial manometer. This tool was specifically designed and developed for children to measure tongue strength and endurance. The device consists of a manometer device along with two variations of bulb sizes that measures the pressure and duration exerted on the air-filled bulb and transmits the information via bluetooth to an android phone, where the application is installed. This study aimed to evaluate the user experience of TongueFit as an instrument in potential users.

For face validity, the Fleiss Kappa Index delineates chance agreement where all reviewers of the instrument have had equal agreement with the Kappa Coefficient value 0.792. It shows a good level of validity and is suitable to collect data. Although, face validity is often said to be very casual and soft as an active measure of validity, it remains useful for ensuring the clarity and relevance of questionnaire items.

The results of the face validity assessment confirmed that the questionnaire items were understandable. Based on expert feedback and suggestions, the researcher revised and refined the items to enhance its quality. The revised questionnaire was subsequently utilized to measure user acceptance of TongueFit. At this stage, all participants agreed that the questionnaire items were simple, clear, and aligned with the study's objectives.

Based on the results, two variables perceived usefulness and continuance intention received positive evaluation while other variables such as perceived ease of use,

expectation, satisfaction, confirmation, and interface quality received neutral evaluations. Among these, the highest evaluation score was for Perceived Usefulness at 1.35, while the lowest was for Interface Quality at 0.09. This indicates that TongueFit is perceived as helpful, and users expressed a willingness to continue using it in the future. However, the findings also highlight the need for design enhancements to improve user satisfaction and optimize the tool's overall usability.

There were several item questionnaires that received positive evaluations including PU1, PE1, PE5, PE7, S3, C1, C2. These findings indicate that the tool offers significant benefits, facilitates ease of use, and is highly portable. Users expressed satisfaction with its functionality, noting that the air-filled bulb is comfortable to use. The bulb's soft design allows the tongue muscles and tissues to envelop it without discomfort, and its serrated pattern serves as an anti-slip feature, enhancing usability. The tool is made of lightweight plastic, features a compact design, and is equipped with a rechargeable battery, making it both portable and convenient to carry.

Moreover, there was no item questionnaire that received negative evaluations. All remaining items received neutral evaluations. However some items scored below zero including E1, S1, S2, IQ1, IQ2. It indicates that the tool's appearance did not meet expectation, not pleasant to use, not satisfied, not attractive. These negative scores align with user comments and suggestions, indicating areas for improvement. The tool's appearance is a critical factor influencing multiple aspects of user experience, including perceived ease of use, expectation, confirmation, satisfaction, and interface quality. Therefore, to enhance these aspects, improvements in the tool's appearance are necessary. This research is aimed at evaluating the user experience of the TongueFit based on 7 aspects and to produce recommendations for the TongueFit mockup instrument which can be used as a reference for developing TongueFit. This research offers recommendations derived from the analysis of questionnaire data, providing a foundation for enhancing the quality of TongueFit in future iterations. To enhance the tool's appearance and user experience, several adjustments are proposed. The design can be made more visually appealing and child-friendly by incorporating colorful and engaging elements. Safety can be improved by smoothing the edges to eliminate sharpness. Additionally, refining the power buttons and optimizing the battery indicator would enhance usability, making the tool easier to operate. Extending the tube length is also recommended to increase convenience during use. These recommendations aim to create a more user-friendly, attractive, and effective tool for clinical applications.

Based on feedback received during the evaluation, revisions were implemented. These included adjustments to design elements, layout modifications, and functionality improvements. The revision process was critical to ensure that the final product not only met user expectations and requirements but also minimized the risk of errors or issues during implementation.

A second-stage mockup was developed following the evaluation and revision of the initial version. This mockup incorporated the proposed changes and enhancements to achieve a more optimized design. The development process emphasized user experience,

functionality, and aesthetics, integrating input from potential users and aligning with the goals of the tool's development. Once the second-stage mockup met the evaluation criteria, the production process could proceed, ensuring that the tool aligns with the intended purpose and user needs.

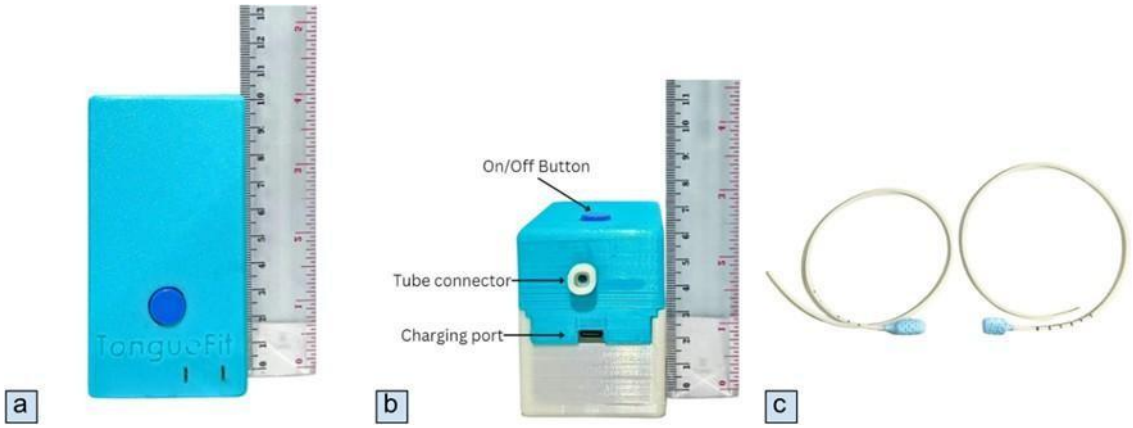

Figure 3. Final mockup of TongueFit. (a) the manometer (b) The body of the Tonguefit comprises of the manometer hardware, on/off button, tube connector, and a charging port. (c) The tongue bulb has 2 different sizes consisting of the 2 cm bulb (right) and 3 cm bulb (left).19

CONCLUSION

In summary, while Tonguefit demonstrates strong perceived usefulness and continuance intention, areas such as the ease of use, expectation alignment, satisfaction with the interface, and interface quality require attention and further development to improve overall user satisfaction and ensure the tool meets user needs effectively.

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