Usability Testing of Digital Memory Game Applications Based on ISO 9241-11 Test Instruments

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Abstract. Currently, there is no cure for cognitive decline in the elderly in the form of Alzheimer's and dementia. According to certain research, cognitive and physical exercise can help lower the risk and symptoms of dementia and Alzheimer's disease. The advancement of dementia and Alzheimer's disease can be prevented or slowed down by using smart games as an effective tool to support cognitive and physical fitness through brain stimulation. In addition to Smart games can also entertain and encourage older people to keep exercising and practicing to keep their brains healthy. Author previous research have developed a crosswords memory game application with artificial intelligence features as a refresher as one of the refreshing mediafor cognitive therapy for the elderly, but it is still in the form of a prototype so that further testing is needed for the application. In the form of a prototype so that further testing is needed to produce a product that is industry standardand can fullfil user expectations before release. This research aims to ensure the application has met international standards, both design and implementation. The method used was quantitative research using a questionnaire instrument based on ISO 9241-11 which generally consists of four testing criteria, specifically user happiness, usability, ease of use, and ease of learning. The test results of each instrument show results above 70%, to be precise the average of 76.55%. The details are usability 76.2%, ease of using the application 72.8%, ease of learning the application 80.4% and user satisfaction 76.8%. Based on these results, there is nothing that must be improved on the application features, but the convenience aspect is a top priority such as the font size and screen size.

Keywords: Digital memory game, ISO 9241-11, usability testing, Cognitive Therapy, Dementia.

1 Introduction

Degenerative disorders that impair cognitive function in the elderly include dementia and Alzheimer's disease. These disorders are undesirable because they reduce quality of life. Alzheimer's disease is the most prevalent type of dementia, often known as senility disease [1]. Although there is currently no known cure for the illness, there are a number of treatments

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that help boost the immune system and lower the risks and symptoms [2]. Smart games can be a useful tool for helping older people engage in physical and cognitive activity. Reading the holy book and learning the Koran are two examples of activities that can improve brain function and prevent senility and dementia [3]. and engaging in brainteasers. Playing brain-stimulating games can help prevent or reduce the progression of dementia and Alzheimer's disease. Additionally, intelligent games can encourage and motivate elders to continue their physical activity and maintain their mental healthPrograms for computer cognitive training are a useful and efficient means of enhancing cognitive performance in senior citizens, and they may help to delay the decline of dementia-related cognitive function [4]. 4,885 participants who were 50 years of age or older participated in the study. The findings demonstrated that playing intelligent games can assist older adults' cognitive capacity over time.

In older adults with depression, games can also help enhance mental health and cognitive function [5]. Furthermore, intelligent games created especially to support cognitive training in the aged can enhance cognitive function in the elderly and assist prevent or slow the course of dementia and Alzheimer's disease [6]. Puzzle games, memory games involving matching cards, and crossword puzzles are some of the activities used to help persons with dementia and Alzheimer's disease improve their cognitive performance [7, 8]. However, these are conventional games that have not yet been made digital. In 2023, research aims to develop an artificial intelligence-powered digital "memory game" that can help people with dementia and Alzheimer's disease enhance their cognitive functioning. The findings of the study of the research is a digital crossword game prototype in the Indonesian version. The game is implemented with four levels difficulty [9].). The interface of the application interface is shown in Figure 1.

(a) (b)

Fig. 1. (a) memory game user interface page (b) loading page

The problem encountered is that the application prototype is not ready to be released and published in generalbecause the testing has only been carried out. released and published in general because the testing carried out isonly alpha testing, which is testing carried out by internal developers to test the prototype. alpha testing, which is testing carried out by internal developers to ensure the designed features can run properly. The next process that must be carried out is beta and usability testing conducted by users of the application. Testing is done to ensure the design of the application is appropriate, functional, and fullfil industry standards and has met user expectations. If the test results do not meet the satisfactory criteria, then redesign and implementation will be carried out before further distributed on the playstore and steam platform.

2 Methodology

This research method goes through several stages of research. The stages of the research methodare illustrated in Figure 2, with the following details:

1. Study of recent research
   Research activities begin with a study of the latest research aimed at collecting literature and the latest research on usability testing. to collect the latest literature and research on usability testing in game applications, especially in the context of puzzle games such as Memory Game Crosswords. Memory GameCrosswords. This study helped in understanding the best practices, methodologies, and tools used in usability testing.

2. Problem formulation
   Formulate a research question or problem that you want to answer through usability testing, namely :
   a. How to test the digital crosswords game prototype according to the ISO 9241-11 standard?
   b. How to make improvements to the prototype based on the test results so that it meets userexpectations?

3. Determination of usability test method
   Choose a test method that suits the research needs, such as direct user testing, interviews, questionnaires, or a combination of several methods. In addition, determine the task scenarios to be tested and the successmeasurement criteria.

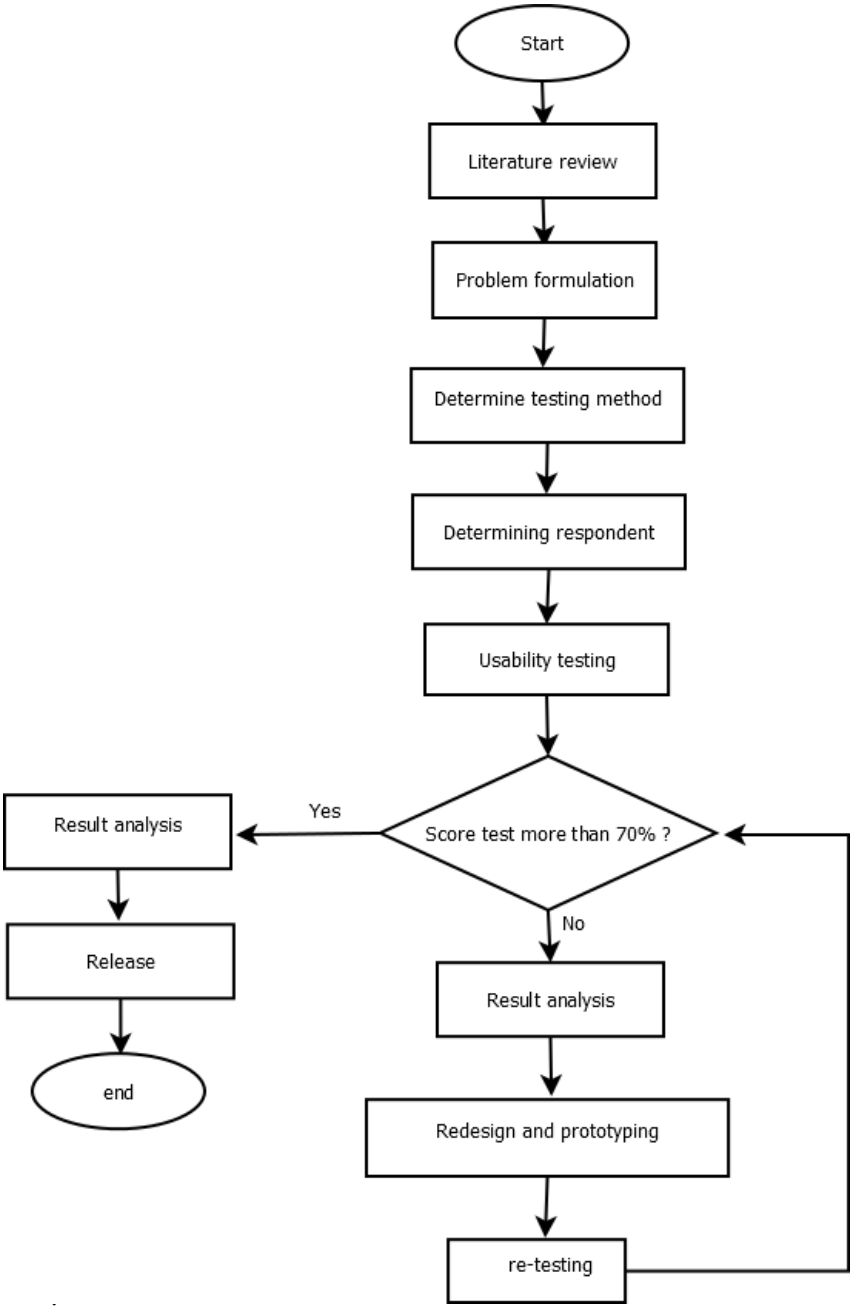

Fig. 2. Research method

4. Determine the profile of respondents who represent the target users of the application namely respondentsover 50 years old. Respondents have the skills using a smartphone or tablet device. The number of respondents targeted is at least 30 people.

Table 1. ISO 9241-11 Instrument

Criteria	Label	Kind of Questions
Useful	$X_{1.1}$	Helps to be more effective
	$X_{1.2}$	Helps to be more productive
	$X_{1.3}$	Useful
	$X_{1.4}$	Gives control over activities
	$X_{1.5}$	Helping task more easier
	$X_{1.6}$	Saves the time
	$X_{1.7}$	Meet my needs
	$X_{1.8}$	Meet the expectation
Ease Of Use	$X_{2.1}$	Easy to use
	$X_{2.2}$	Simple
	$X_{2.3}$	User Friendly
	$X_{2.4}$	Needs fewer steps
	$X_{2.5}$	Flexible
	$X_{2.6}$	Effortless to use
	$X_{2.7}$	Can be used without instruction
	$X_{2.8}$	Always consistent
	$X_{2.9}$	Both occasional and regular users would like it
	$X_{2.10}$	Can recover from mistake easily
	$X_{2.11}$	Can be used successfully every time
Ease of Learning	$X_{3.1}$	Easy to understand
	$X_{3.2}$	Easy to remember
	$X_{3.3}$	Easy to learn
	$X_{3.4}$	Helps to be skillful
Satisfaction	$X_{4.1}$	Satisfied
	$X_{4.2}$	Recommended
	$X_{4.3}$	Fun to use
	$X_{4.4}$	It works
	$X_{4.5}$	Wonderful
	$X_{4.6}$	Needed
	$X_{4.7}$	Pleasent to used

5. Implementation of usability test

The implementation of the usability test is carried out by inviting respondents who have been determined to participate in usability testing. The procedure procedure is to provide instructions to respondents and facilitate during the sessions, recording user interactions, and observing user reactions and behaviors duringtesting. behavior during testing.

6. If the test results show a score below 70% or if there are significant complaints or needs from the users, then it is necessary to significant complaints or needs from users, it is necessary to conduct an in-depth analysis of these issues.This may require further interviews or surveys to understand the causes of the problems and user needs. The success rate of users is used to gauge effectiveness and efficiency levels. This is how efficacy and efficiency are determined [10][11] :

$$Effectiveness, Efficiency\ (\%) = \frac{\sum_{i=1}^{n} X_i}{n} \times 100\% \quad (1)$$

Where X_i is user's success rate, $X_i = \{0,1\}$

Staisfaction is the precentage comparison between the satisfaction score of the respondent with the multiplication of the maximum weight of the Likert scale with the number of respondents (n),

$$Satisfaction\ (\%) = \frac{\sum_{i=1}^{n} X_i}{5\ x\ n} \times 100\% \quad (2)$$

Where X_i is user's success rate, $X_i = \{0,1,2,3,4,5\}$.

According to the following formulas, usability of programs is the average of effectiveness, efficiency, and satisfaction:

$$Usability\ (\%) = \frac{(Effectiveness+Efficiency+Satisfaction)}{3} \times 100\% \quad (3)$$

The user must then deliver questionnaires to 38 respondents after finishing all current dutiesRespondents can easily understand the language used in the questionnaire's design and taken from [12]. Following the execution of the assigned trial, the detailed computation of the usability value is presented in Tables 2, 3, and 4.

7. Design and redesign the game application (if the test result is below 70%)
Based on the analysis of the test results, a redesign of the interface of the game application to address the usability issues identified to meet user needs. This process involved interface remodeling, prototype testing, and design iterations.

8. Usability test prototype (if the test result is below 70%)
After redesigning, retesting was carried out using the updated application prototype. At this stage, the same method as the previous test to check whether the design changes succeeded in improving the userexperience.

9. Analysis of results and conclusions.
Analysis of the data collected from usability testing is used to evaluate the effectiveness of the design changesand provide conclusions about success of the application in meeting user needs and preferences.

10. Deployment to playstore and steam platform.
    After ensuring that the app meets the required usability standards and the design changes have been successfullyimplemented, the app is deployed to distribution platforms such as Google Play Store and Steam for the application to distribution platforms such as Google Play Store and Steam to be accessed by users or players.

3 Result and Discussion

The issue at hand is that, after limited testing, the application prototype is not yet ready for public release and publication. released and publicized generally since the prototype has only undergone alpha testing, which is testing done by internal developers. Internal developers conduct alpha testing to verify that the features they have built function as intended. The next step that needs to be completed is beta and usability testing, which is done by application users. Testing is done to make sure the application's design fits user expectations and is suitable, functional, and complies with industry standards. Should the test findings fall short of the acceptable standards, redesign and implementation will be necessary.

(a) (b)

Fig. 3. (a) level menu (b) gameplay

Table 2, Table 3, Table 4, and Table 5 show the results of the detailed computation of the usefulness value following a trial based on the assigned task.

Table 2. Result Of Usefulness

Criteria	Label	Kind of Questions	Usefulness (%)
Useful	$X_{1.1}$	Helps to be more effective	78
	$X_{1.2}$	Helps to be more productive	78
	$X_{1.3}$	Useful	79
	$X_{1.4}$	Gives control over activities	78
	$X_{1.5}$	Helping task more easier	74
	$X_{1.6}$	Saves the time	68
	$X_{1.7}$	Meet my needs	79
	$X_{1.8}$	Meet the expectation	74
Average			**76,2**

Table 3. Result of Ease Of Use

Criteria	Label	Kind of Questions	Usefulness (%)
Ease Of Use	$X_{2.1}$	Easy to use	76
	$X_{2.2}$	Simple	69
	$X_{2.3}$	User Friendly	66
	$X_{2.4}$	Needs fewer steps	74
	$X_{2.5}$	Flexible	65
	$X_{2.6}$	Effortless to use	67
	$X_{2.7}$	Can be used without instruction	72
	$X_{2.8}$	Always consistent	76
	$X_{2.9}$	Both occasional and regular users would like it	78
	$X_{2.10}$	Can recover from mistake easily	74
	$X_{2.11}$	Can be used successfully every time	80
Average			**72,8**

Table 4. Result Of Usefulness

Criteria	Label	Kind of Questions	Usefulness (%)
Ease Of Learning	$X_{3.1}$	Easy to understand	78
	$X_{3.2}$	Easy to remember	82
	$X_{3.3}$	Easy to learn	81
	$X_{3.4}$	Helps to be skillful	80
Average			**80,4**

Table 5. Result of Satisfaction

Criteria	Label	Kind of Questions	Usefulness (%)
Satisfaction	$X_{4.1}$	Satisfied	76
	$X_{4.2}$	Recommended	80
	$X_{4.3}$	Fun to use	77
	$X_{4.4}$	It works	81
	$X_{4.5}$	Wonderful	77
	$X_{4.6}$	Needed	70
	$X_{4.7}$	Pleasent to used	76
Average			**76,8**

The following is an explanation of how to interpret the usability score:

Table 6. Analysis of the usability score

No	Percentage	Interpretation
1	0% - 20%	Very Bad
2	21% – 40%	Bad
3	41% – 60%	Pretty good
4	61% – 80%	Good
5	81% – 100%	Very Good

It can be seen from the usability score results obtained, all items exceed the score limit value, which means there are nofeatures that must be overhauled. However, respondents were asked about things that need to be improved, including fontsize and gadget screen responsiveness. So that the font size will be fixed with a larger size.

4 Conclusion

The method used was quantitative research using a questionnaire instrument based on ISO 9241-11 which generally consistsof four testing criteria, specifically user happiness, usability, ease of use, and ease of learning. The test results of each instrumentshow results above 70%, to be precise the average of 76.55%. The details are usability 76.2%, ease of using the application 72.8%, ease of learning the application 80.4% and user satisfaction 76.8%. Based on these results, there is nothing that mustbe improved on the application features, but the convenience aspect is a top priority such as the font size and screen size.

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