Verification of the Questionnaire for the Level of Mental Models Building

Toshihisa Doi[1], Keisuke Ishihara[1], and Toshiki Yamaoka[2]

[1] Wakayama University Graduate School of Systems Engineering
930, Sakaedani, Wakayama-Shi, Wakayama, 640 8510, Japan
[2] Wakayama University Faculty of Systems Engineering
930, Sakaedani, Wakayama-Shi, Wakayama, 640 8510, Japan
info@toshihisadoi.com, k.ishihara62@gmail.com,
yamaoka@ja2.so-net.ne.jp

Abstract. In this study, the verification of the questionnaire for the level of mental model building was examined from viewpoint of the actual users' operation. The user testing is conducted to grasp the level of mental model building. The validity of the questionnaire was investigated in terms of (a) operation time of the digital camera, (b) operation errors of the digital camera and (c) Structural model / Functional mode (the test result for measurement the level of mental model building after the operation). Then, the correlation between the score of the user testing and the questionnaire score was calculated. As the result, the significant correlation is confirmed between each score and the questionnaire score. Then, we believed the proposed questionnaire can be measured the users' mental model building level in the user-interfaces operation.

Keywords: Mental model, Questionnaire, Usability testing.

1 Background

In user-interface design, the examination of users' mental model is important. However, we don't think that mental model is examined enough in design development process because mental model cannot be easily examined. Therefore, we proposed the questionnaire items for measurement of the level of mental model building which can examine easily in the previous study. The reliability and validity of this questionnaire is shown based on the questionnaire development methods. However, the relationship between the questionnaire and the actual users' operation still is not clarified by experiments.

2 Objective

The goal of this study is the verification of the questionnaire from viewpoint of the actual users' operation. We verified the questionnaire to use this mental model examining method for design development.

C. Stephanidis (Ed.): Posters, Part I, HCII 2013, CCIS 373, pp. 105–108, 2013.

3 Questionnaire for the Level of Mental Models Building [1]

The questionnaire for the level of mental models building is proposed by our previous study to estimate users' mental model building level quantitatively. This questionnaire consists of 36 items based on the elements for structuring mental model. This questionnaire is conducted using a 5-point scale (e.g., 5: strongly agree to 1: strongly disagree).

This questionnaire was made by questionnaire survey to 726 people. Besides, the reliability and validity are certificated based on questionnaire development method. However, this qualification method is the method which be used for psychological scale development. Our proposed questionnaire should be investigation method for usability and design development. So, we should show the relativity with users' operation to confirm the utility and the validity as usability investigation method.

4 Methods

In this experiment, (1) digital camera operation task, (2) Mental model measurement task of the digital camera, and (3) the proposed questionnaire were conducted to 24 people. The participants are the students (age: 21-25, ave: 23.21, SD: 1.10). Besides, the utility and the validity were considered in terms of (a) task complete time, (b) operation error, (c) mental model measurement task after operation.

4.1 Digital Camera Operation Task

Firstly, the mental model of the participants for the digital camera operation was constructed by 5 tasks of digital camera operation. Next, 4 tasks were conducted for the measurement of task complete time and operation error score.

4.2 Mental Model Measurement Test

The level of mental model structuring for the digital camera operation was investigated. This test was conducted in terms of Functional model and Structural model [2]. Functional model is the model regarding to understanding the contexts and the functions to understand "how to use it?" Structural model is the model regarding to understanding the structure and the principle to understand "how it works?" In this study, the test for the level of understanding the button function is conducted as the function model measurement [3]. In this test, the participants replay the operation procedure of the 4 tasks. The test for the level of understanding the hierarchy structure is conducted as the structural model measurement [3]. In this test, the participants conduct the card sorting of the card which is wrote each function of the digital camera. Then, the each scale is calculated to estimate the level of mental model structuring.

4.3 Proposed Questionnaire

After all tasks, the participants answered the proposed questionnaire for the digital camera. Then, correlation coefficient was calculated between the questionnaire scale and the score which are gotten from each test.

5 Results

The correlation coefficient between the questionnaire scale and 4 items (task complete time, operation error score, Functional model score, and Structural model score) were calculated. Firstly, we explain the score of each item.

- Task complete time score

This score is sum of 4 tasks operation times.

- Operation error score

This score detail is as below. This score use 5 level scale; 4: correct operation to 0: not complete.

— 4: Correct operation
— 3: Not smooth operation; Stop for a moment, dither for a moment, cheap mistake, etc.
— 2: Error operation; Stop, more noticeable error that 3, etc.
— 1: Critical error operation; clear error, repeating error, accidental complete, etc.
— 0: Not complete

- Structural model test

The scoring for structural model was conducted by the point deduction method. Correct hierarchy structure is perfect score (68 points).

- Functional model test

The scoring for functional model was also conducted by the point deduction method. The correct procedure is perfect score (36 points).

Table 1 shows the correlation analysis result between these 4 items and the questionnaire score. The significant correlation was confirmed with all 4 items.

Table 1. Correlation analysis result

Experiment items	Questionnaire score		
	Pearson correlation coefficient	p	
Operation error	0.6664	$p < 0.01$	**
Complete time	-0.4666	$p < 0.05$	*
Structural model	0.5919	$p < 0.01$	**
Functional model	0.4174	$p < 0.05$	*

**: $p<0.01$, *: $p<0.05$

6 Discussion

We confirmed the significant correlation between the questionnaire score and each item regarding to the level of mental model structuring. So, the questionnaire for mental model can estimate the users' mental model building level in user-interface operation. We think the questionnaire has the validity to measure users' mental model for user-interface operation. Besides, this questionnaire can quantitatively estimate the level of mental model structuring. We believe that the quantitative investigation for users' mental model is helpful to usability survey and user-interface design. This questionnaire can investigate usability in terms of mental model easily.

References

1. Doi, T., et al.: Fundamental Consideration of the Level of Constructing the Mental Model Measurement Scale in User Interface'. In: 13th JSKE Annual Conf. (2011)
2. Preece, J., et al.: Human-Computer Interaction, pp. 123–139. Addsion-Wesley Publishing Company (1994)
3. Doi, T., et al.: Analysis of Users' Knowledge Structures and Mental Models by the Difference of Attitude to Electrical Appliances. Transactions of Japan Society of Kansei Enginieering 9(4), 611–619 (2010)