Cognitive process to evaluate serious games for the elderly

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ABSTRACT

This paper aims to propose a cognitive evaluation model to be utilized in designing game devices and developing relevant software with the purpose of the prevention of dementia of the elderly among various types of serious games for the elderly intending to improve their physical, mental or social capability. Firstly, a serious game for the elderly has been developed based on the guidelines of the areas pertaining to existing hardware, software and contents. Secondly, a pre-experiment of the game targeting specialists has been conducted in order to re-establish a cognitive evaluation model for the developed result. Thirdly, the cognitive evaluation model for the serious game for the elderly that intends to improve their cognitive capacity has been materialized based on the experiment results. Given the fact that the scope of game contents, most of which used to be focused on teenagers, have been gradually expanding to cover wider range of social classes than ever before, it is expected that the results of this study could be utilized as a model that can verify the games and their contents with special purposes based on the cognitive evaluation of the users.

Keywords: *Serious Game for the Elderly, Dementia Precaution, Usability Evaluation*

1. INTRODUCTION

Thanks to the advance of medicine and science, our societies are gradually aging. The Korean government statistics agency reported in 2007 that one out of ten people or 9.9% of Korea's population was senior citizens (65 years old or more). Cultural spaces where senior people can spend their spare time have become one of essential matters; furthermore, the development of games which intend to achieve special purposes such as training, mentality, treatment or health improvement through game elements, not just a typical playing method based on traditional ways, has been demanded. Among such serious games, in particular, a game that aims to help improve physical health is generally called "Health Game" locally and abroad. Of course, the target of any health improvement scheme must not be limited to senior people. Therefore, it will be correct to say that the most practical attitude in developing a health game is to focus on creating a game that can be equally enjoyed by both young and old generations, although the consideration of the characteristics of the elderly in developing such a game should be a prerequisite. Human beings tend to express their emotions, relieve tension and develop capabilities to deal with trauma or stress while playing. Since playing provides the player with pleasure most of all, anyone can easily indulge in playing without rejecting or resisting feeling; moreover, when a person becomes a player who can operate and make decisions for himself or herself on the play, he or she can develop self-esteem, achieve compensation for those activities that are not feasible in reality and seek for alternatives for adaptive behavior. With these reasons, a serious game for the elderly can be accepted as a method to prevent and treat physical, mental and social aging in consideration of their characteristics.

Most game platforms have been designed to meet young people's desires as they have been the main user group of games. "Table 1" contains the summary of the result of a survey research carried out by Andy Robertson ("What Gamers Want: Silver Gamers", Gamasutra Magazine, in July of 2008). It shows the overall cases of faulty program operation, places where games were played, issues related to the interface between a player and game devices, etc. through visual recording and in-depth interview with 50 male and 25 female game players [1].

Table 1. Game methods that silver gamers prefer

Experiment Details	Preferred	Not preferred
1. Repetitive tutorial	○	
2. Detailed instructions	○	

3. Text size, time allowed for reading	Large, Long	Small, Short
4. Use of technical game terms		○
5. Variety and distinction of game materials	○	
6. Multi−play and communication functions	Activated	Not activated
7. Posture during playing the game	Sitting	Standing
8. Place set for game playing	○	
9. On−line based play with other family members	○	
10. Game duration		Short (Several minutes)	Long

Even the summarized data in "Table 1" shows that there are differences between youth and silver generation in playing games, hence the interface and contents of a game, which meet requirements for hardware and software based on silver generation, must be reflected to the designing of a game. In other words, in order to develop a game for the elderly, existing game platforms need to be modified or transformed to meet their requirements, creation of new platforms and interfaces is necessary and, furthermore, in software aspect, the criteria for data recognition on the screen are required to be modified as well.

Among the commercialized games, Nintendo DS's brain training and Wii Fit's exercise game, which have been widely accepted by senior citizens, can be considered as the games that intend to deal with mental and physical aging matters, respectively. There are a wide variety of games besides them. In order to facilitate serious games for the elderly, what is required is to clearly define the categories of the games for the silver generation and to clarify the scope of each category, as exiting games have their own game genre depending on their purposes apart from the necessity for considering the issues pertaining to game platforms. According to Video Games and Health published by the U.S. Entertainment Software Association (ESA) in 2008, health games were classified into four categories[2][3].

"Table 2" shows that more systematic approach to the targets and more contents are required in order to promote serious games for the elderly while sharing necessary data and cooperating with relevant organizations for each category. While one of primary goals of normal games is providing 'Fun', the biggest target of serious games is 'functionality', hence effectiveness and efficiency - the evaluation criteria of those games are the most significant matters. According to the data in "Table 2", brain training games which belong to the category of Health Habits tend to have higher preference ratio in senior people than young people. This study has compared the results of the problem solving process using a pen and paper and using video game device; the problem solving process is the key part of the brain training game in the research of Lennart E. According to the test result, the group using a pen and paper was able to reduce task completion time with less error rates. However, it is also revealed that problem solving using a game device has aroused much higher metal stimulation (attention) and concentration than pen and paper. The evaluation criteria of such serious games are composed of Task Completion Time, Efficiency as Error Rate, Self-Assessment Measures: Arousal, Pleasure, Dominance and Game Experience: Challenge, Flow, Competence, Tension, Positive and Negative Effect[4].

Table 2. Categories of Health Games

Category	Goal	Applied to / Developed by
Physical Fitness	To Improve perception (balance), physical strength and joint movement through physical motions	−Pennsylvania state, Connellsville Area School District −Newyork, Parsippany Troy Hills School District −Dallas, Grace Presby Terian Village −Gold's Gym, YMCA
Healthy Habits	To encourage healthy habits	−Robert Wood Johnson Foundation −Kaiser Permanente Foundation −visual impairments 'EYE SPY' −HopeLab
Rehabilitation Programs	To help rehabilitation from certain disease or the aftermath of an accident	−USC, Virtual Iraq −Duke Univ., Zack Rosenthal −Psychologist, Deborah Stokes,
Medical Training	Provide information on treatment and health care	−The Office of Naval Research, BreakAway, 'Pulse' −The Entertainment Technology Center at Carnegie Mellon, 'Hazmat'

2. PRECEDING STUDY

In "Serious Game Design for the Elderly using Arcade Game Machines"[5], which was the preceding study of this thesis, first, 'Three principles for utilizing anthropometric data' and the standard body types of Korean males and females in their 60s were used as models for designing machinery structure; second, applicable items among the evaluation criteria presented by 'Jacob Nielsen and Melissa A. Federoff' were adopted for the purpose of contents architecture; third, standards meeting the contents of 'dementia rehabilitation program', which has three stage program of cognitive, memory and reflexive abilities as medical experiment models were presented.

Based on these standards, hardware structures (see Figure 1.) was designed and contents for improving cognitive ability of senior people (see Table 3.) were developed into three different stages.

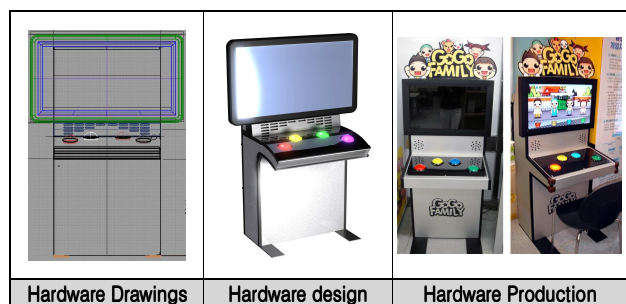| Hardware Drawings | Hardware design | Hardware Production |

Fig. 1. Hardware design for serious games for the elderly[5]

Table 3. Software design for serious games for the elderly [6]

Stage	Graphic Design	Design Rule
Cognition Game (Basic Level)	Visual Stimulus → Memory → Differentiation → Impression ⇒ Result	−Is there any unnecessary information for the game? −Is it possible to do immediate timing and feedback? −Is there a consistency in the visual interface? −Would it increase the skill through repetition? −Is it easy and convenient to control?
Simple Recognition	− Cognitive ability heavily affects various types of aged people's psychological processes defining cognitive elements including intelligence and memory ability. − Training helps them increase abilities to study, judge the situation and recognize places and time.	
Memory Game (Middle Level)	Visual and Auditory Stimulus → Memory → Differentiation → Memory → Differentiation → Repetition →Recollection ⇒ Result	−Would it increase the skill through repetition? −Is there a consistency in the visual interface? −Does it minimize the memory burden for a user and does it help to improve concentration and attention and have clear targets? −Can a user check real−time the score and level and Is the layer−menu well arranged?
Synthetic Recollection	−Memory refers to the ability to recollect what a person has studied and experienced; aging is chiefly related to short−term memory loss. −It increases the time duration of keeping experiences in memory and the ability to study and solve recognized problems.	
Reaction Game (Advanced Level)	Visual and Auditory Stimulus → Memory → Differentiation → Memory → Differentiation → Repetition →Recollection ⇒ Result	−Is it possible to do immediate timing and feedback in the gaming situation? −Does it consist of interesting visual and audio effects? −Would it increase the skill through repetition? −Is there a consistency in the visual interface?
Comprehensive Brain Function/Reaction	−Reflexive ability indicates the capacity to understand new concepts with respect to the reaction velocity to stimulation; new neuropsychological skill (such as capability to play an instrument) decreases as growing old. −Capabilities to save information, make a judgment on an unexpected situation and react instantly are improved.	

3. THEORETICAL BACKGROUNDS

3.1 Consideration of Usability Evaluation

Usability means to measure the experience degrees of users'

interactions with product's system and is composed of the elements affecting the experience of the users. Products, which are made by the commercial viability complying with the users' desire for using, need to meet those desires and promote a smooth interaction between users and products. In order to achieve that, basic design principles that make a product easy to understand and use for human beings. First, a good conceptual model has to be provided; second, a visual result, which can be verified by visually, has to be made; third, correspondence relationship has to be fixed to ensure behavior and its results, operation and its effects, and system status to be visually recognized; fourth, a sufficient amount of feedback on the results of behavior must be constantly provided to users. Both usability test and social science research belong to 'empirical method' in that they observe actual behaviors [7].

3.2 Reference Model for Evaluation

Quality in use indicates overall qualities including effectiveness, efficiency and satisfaction that users feel when they performing tasks using system in various actual operation environment including social, physical and technological environment. ISO9241-11 specifically addresses the definition of usability as effectiveness, efficiency and satisfaction[8]. Also, those criteria that are related to the easiness of study, which becomes the goal of usability, the achievement of convenience and the attributes of usability including efficiency, accuracy, meaning, flexibility and consistency, are widely accepted as bases in developing software. The direction of cognitive evaluation model is set on the basis of factors meeting reference items for Nielsen's questions to evaluate the usability, which were set as references of development model of serious games for the elderly.

Table 4. Nielsen's usability evaluation criteria meeting experimental task

Reference model	Description
Learnability	−An item which is to be considered in the beginning of use, in particular. However, high initial learnability doesn't always mean the high efficiency in long−term performance. −Programs for beginners tend to be learned quickly; however, the efficiency is not increased even if they are fully learned. On the other hand, programs for experts take longer time to learn initially but have high efficiency rate once proficiency is attained.
Efficiency	−The performance level that can be shown by a user who has correctly learned how to use −An efficient system indicates a system that allows users who have attained proficiency to accomplish task goals within short period of time making less effort[9].
Memorability	−In case of a product or software that is used not very often, people tend to be troubled often because they cannot remember how to use it. In order to prevent such problem, the use of product has to be easy to remember. −Memorability is not a huge issue in case of a product that is used frequently because the use of the product is not forgettable; however, it is an important issue for those products that have to be used only once in a certain period of time.
Error tolerance	−Programs with less possibility of error occurrence are recommended, if possible. However, the occurrence of errors is unavoidable, the system has to ensure that the occurrence of an error is easily recognizable and fixed so that the result

	of an unavoidable error won't result in a critical failure. −For example, Microsoft's Windows allows an easy restoring deleted files from Recycle Bin'.
Satisfaction	−It refers to the degree of the satisfaction or pleasure given to users when using a product or system; it is considered to be an important factor for entertainment or home shopping channels[10].

3.3 Evaluation Methods

Selecting a proper test method is an essential process to guarantee a smooth progress of evaluation and acquire a reliable result by securing more accurate information on quality. In this study, we've selected such methods as questionnaire surveys, interviews, user preferences on questionnaires and question-asking protocol which meet the purpose of this experimental task among the ways to secure usability utilized in HCI research. When conducting questionnaire surveys, interviews and user preferences on questionnaires, the length and amount of questions have been decided and a brief explanation on the questions that were not understood easily has been provided in consideration of low capacity of senior people to read and understand.

Question-asking protocol method means to react more actively rather than simply waiting for the responses of users. In order to help senior people understand questions better, an experiment conductor asked questions orally. Users could listen to and understand the questions through auditory function and give their answers orally, which have been marked or recorded by the conductor.

4. COGNITIVE EVALUATION MODEL

Based on the reference model and evaluation methods presented in Chapter 3, this study provides a concrete evaluation model on the hardware structure and software architecture of the serious game for the elderly developed through preceding study in Chapter 3 and cognitive evaluation processes (see Table 5).
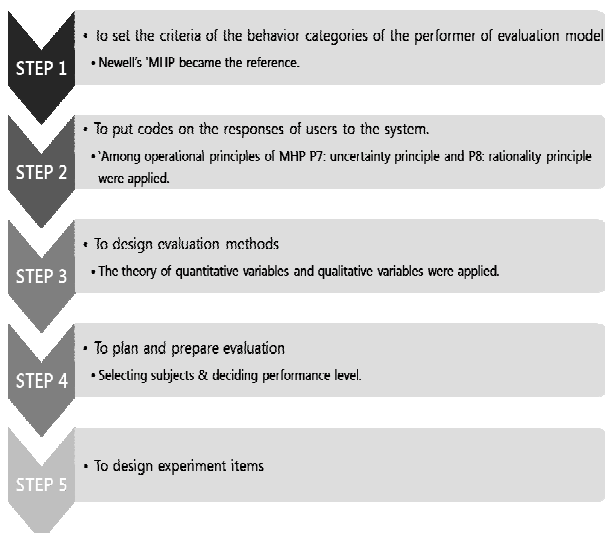

Fig. 2. The development procedure of a cognitive evaluation model

4.1 Category of Cognitive Behavior

The model human processor of Newell has been selected as the reference to categorize the behaviors of performers in order to establish cognitive evaluation model of serious games for the elderly. The model to put codes on the responses of users to the system is composed of P7: uncertainty principle and P8: rationality principle among operational principles of the model human processor (MHP) [11].

The cognitive reactions of users' behavioral processes have been coded into 5 categories as shown in "Table 5"

Table 5. Putting codes on users' cognitive reactions

Behavioral Category		Code	Reaction; users
SEE		S	look at the screen
Simple cognitive		SC	listen to the instructions on how to play the game
Listen to		L	listen to background music of the game. listen to button sound of the game.
Complex cognitive		CC	play a game.
Reaction	By pressing the button	R−PB	show a reaction of pressing the button after complex cognitive.
	Non Reaction	R−NR	show no reaction after complex cognitive.
	Question	R−Q	request an explanation on the situation again after complex cognitive

4.2 Empirical Evaluation Methods

The evaluation methods to acquire the value of user reactions through experiment have been presented in "Table 6". For both areas of hardware and software, 'quantitative variables and qualitative variables theories' of Schneier and Mehal, which are widely used in evaluating human and machinery usability, were used.

Table 6. Empirical evaluation methods

Quantitative Variables Theory	Qualitative Variables Theory
User preferences on questionnaires	Protocol analysis
Evaluation in laboratory	
Evaluation of achievement	Evaluation of process
Comprehensive evaluation of system's final performance	Formative evaluation for correction and improvement
Quantitative evaluation based on surveys of multiple number of groups	Qualitative evaluation based on in−depth analysis on small number of groups

The experiment utilizes evaluation in laboratory, which is mainly used for conducting an accurate assessment of specific parts such as standards or regulations under a properly controlled environment among empirical evaluation methods that the system is evaluated by actual users. A Laboratory evaluation is divided into process evaluation and performance evaluation depending on the purpose of the assessment. The process evaluation is used to find out what users thought or what difficulties they encountered during the use of a certain system. It is also considered to be a formative evaluation

method that intends to correct or improve the system based on the analysis results and will be applied to the protocol analysis method of qualitative variables theory. On the other hand, performance evaluation is a method to assess how fast the users of the system have accomplished given tasks while making how many errors during the performance. It is a summative evaluation method to assess the appropriateness of system's performance level; user preferences on questionnaires based on quantitative variables theory will be applied.

4.3 Selection of Testees

Subjects to be tested will be senior citizens who will become the main user group of serious games in fact and the user group will consist of only one group composed of beginners who have no prior experience of playing the game. It is because of the characteristics of silver generation. Since they have very less likely experienced those new contents – games, if they have to be classified into smaller groups in accordance with detailed criteria, few game users meeting the requirements of each group may exist. It will make the process of survey more difficult. The experiment will examine the performance rate of novice users under the currently given restrictions. Based on the results, the basis for a game design method for beginners can be prepared[12]. Every testee will be required to participate in the experiment after being given instructions on how to play game one time only without having any prior experience in all the experimental stimuli. The maximum number of users to be asked will be no more than 12 people. It is because the possibility of finding additional system errors dramatically decrease when there are more than 12 participants[8]. Subject groups will be selected from the senior citizens who are in between 50 years old or older and 75 years old or younger, regardless of their educational background or living conditions, and classified into the groups of Young-old, Middle-old and Old-old, respectively.

4.4 Performance Level Decision

The experiment results of each platform have been classified into three units in order to decide their performance level. For example, it means a hypothesis that their performance shall reach a certain level albeit they are in silver generation who are not familiar with game contents. More specifically, provided current level is 0, users shall reach at least more than 5/1 (20%) within the three-stage time limit. Adequate level is 5/3 (60%) which means that users with no prior experience can achieve more than half success or it indicates the achievement rate of its final goal or functional effect that can be obtained by the users within a short period of time. If testees can achieve more than 5/3 after having only one time of explanation without any prior experience at all, the content structure, configuration, interface and designing architecture taking into account user interactions of the game are considered to have suitable level and applied to the result analysis on the experiment. The highest goal is over 5/4 (80%). The maximum level has been set to rather high because it is a mini-scale game for senior people that doesn't necessarily draw a conclusion based on judgment and recognition on complex situation for long period of time.

Table 7. Performance criteria of cognitive evaluation model

Performance level	Expected effect
Lowest	Minimum level that can be achieved whenever playing the developed game [Over 1/5 (20%)]
Adequate	Suitable level that has reached the actual goal of the game; no additional evaluation or modification is required. [Over 3/5 (60%)]
Highest	Well developed and can positively affect the users; completely ready to be commercialized. [Over 4/5 (80%)]

5. LABORATORY EVALUATION

This study only contains the results of laboratory experiment conducted on an expert group prior to carrying out experiment on senior people. A laboratory experiment is considered to be a preliminary verification to prepare a main experiment on multiple number of subjects. Experiment method is presented in "Table 6" and concrete survey questions are made.

5.1 Experiment Details

The expert group for the laboratory evaluation is composed of those people who are recommended for 'constructing usability evaluation team'. Two samples were selected from each group of HCI expert (assessor), system developer (planning), designer (graphic) and programmer. In order to draw calculation results of evaluation results to make behavior categories, 5 points are given to each question and the full marks of the 20 questions is 100 points.

Questions about software are constructed at three stages (cognitive, memory and reflexive abilities), each of which contains 5 questions making total 15 questions. Questions about hardware are composed of 5 questions throughout the entire stage. All questions are multiple choices using 5-point scale evaluation. Qualitative analysis experiment will be conducted for those testees who belong to the medium group of the satisfaction distribution that has been drawn from the satisfaction ratio against playing time based on quantitative analysis experiment.

"Table 8" shows the reference contents of questionnaire for quantitative and qualitative analyses on hardware and software. GOMS[13], which is one of the best quantitative analysis methods on interface area, will be used for hardware analysis. GOMS modeling allows forecasting how much time a user spends carrying out a certain task through given interface.

Table 8. Criteria of cognitive evaluation model questionnaire

Key feature of system	Selection basis for experiment task	Questions about
Learnability	System's basic value	whether functional aspects have been realized? [Software]
		familiarity with the device before playing the game [Hardware]
Efficient system	System's basic value	whether each cognitive cycle has been processed smoothly [Software]
		satisfaction level after finishing each game

		stage for cognitive, memory and reflexive abilities. [Hardware]
Memorability	Issue forecasting	errors expected by the developer through Heuristic assessment [Software]
Low error rate	Require improvement	frequent disconnection due to low understanding level of game contents; unexpected question. [Software]
User satisfaction	System's final goal	satisfaction level on game's configuration in each stage [Software]
		satisfaction level on the use of the device after completing the game [Hardware]

5.2 Questionnaire Composition

Quantitative and qualitative methods have been applied to each stage question based on "Table 6" and "Table 8". In this study, any overlapped matters per each stage will not be repeated and be recorded one time only.

5.2.1 Quantitative Evaluation: Software

What is your overall feeling about the game? (User's satisfaction level) [Common]				
5	4	3	2	1
5: Similar to very easy / very convenient / very satisfied				Marked by the conductor, considering testers are senior citizens
4: Similar to easy / convenient / satisfied				
3: Similar to Okay / I don't know/ Normal				
2: Similar to inconvenient / difficult / not satisfied				
1: Similar to very inconvenient / very difficult / Never want to do it again				
Was there anything unnecessary in the game? [Stage 1]				
Was the content understandable when playing the game in repetition? [Stage 2]				
Was the game process smooth enough? [Stage 3]				
5	4	3	2	1
Was the game process smooth enough? [Stage 1]				
Was the display configuration consistent? [Stage 2]				
Did rhythm, actions, character design attract your interest? [Stage 3]				
5	4	3	2	1
Was the display configuration consistent? [Stage 1]				
Was it difficult to remember the flow of the game due to too high difficult level? [Stage2]				
Was it easy to understand the contents of the game when played in repetition? [Stage 3]				
5	4	3	2	1
Was it easy and convenient to manipulate? [Stage 1]				
Was overall menu configuration formed well, so that you could check score at any time? [Stage 2]				
Was the visual configuration consistent? [Stage 3]				
5	4	3	2	1

5.2.2 Quantitative Evaluation: Hardware

Was the exterior of the device designed to properly respond to user's operation? [Operator]				
5	4	3	2	1
5: Similar to very easy / very convenient / very satisfied				Marked by the conductor, considering testers are senior citizens
4: Similar to easy / convenient / satisfied				
3: Similar to Okay / I don't know/ Normal				
2: Similar to inconvenient / difficult / not satisfied				

1: Similar to very inconvenient / very difficult / Never want to it again				
Was it possible to manipulate everything you want? [Intention]				
5	4	3	2	1
Was the exterior designed to attract your interest in the game? [Goal]				
5	4	3	2	1
Was it designed to let you know the current status of the game? [Selected rule model]				
5	4	3	2	1
Was there any difficulty or inconveniency? [Method]				
5	4	3	2	1

5.2.3 Qualitative Evaluation: Software

What is your overall feeling after completing this stage? [User satisfaction]				
5	4	3	2	1
5: Similar to very funny / very interesting / very satisfied				Marked by the conductor, considering testers are senior citizens
4: Similar to funny / interesting / satisfied				
3: Similar to expected / I don't know / normal				
2: Similar to not funny / difficult / not satisfied				
1: Similar to too boring / very difficult / never want to do it again				

Reaction Code	Situation explanation	Feature	Question				
(S)– (SC)– (R–PB)	After completing a practice game	Learnability	Did you understand the explanation on the game?				
			5	4	3	2	1

Reaction Code	Situation explanation	Feature	Question				
(S)– (CC)– (R–PB)	After completing more than 2 times of playing	Efficient system	Were the game process smooth and the play time adequate?				
			5	4	3	2	1
(S)– (CC)– (R–NR)			Were the game process smooth and the play time adequate?				
			5	4	3	2	1
(S)– (CC)– (R–Q)			Were the game process smooth and the play time adequate?				
			5	4	3	2	1

Reaction Code	Situation explanation	Feature	Question				
(S)– (SC)– (R–PB)	When a wrong answer is given during playing	Low error rate	Was the game difficult? (Give 5 points if there is no wrong answer)				
			5	4	3	2	1
(S)– (CC)– (R–NR)			Was the game difficult? (Give 5 points if there is no wrong answer)				
			5	4	3	2	1

Reaction Code	Situation explanation	Feature	Questions about experiment tasks expected to be incurred by

(S)–(L)	After completing a game	**Memorability**	How much did you feel difficult in distinguishing alphabets and character images?				
			Was there any problem in playing the game due to low sound?				
			Was the movement of the ball in the game too fast?				
			5	4	3	2	1

5.2.4 Qualitative Evaluation: Hardware

What is your over feeling about the device after when you completed entire game? [User satisfaction]				
5	4	3	2	1
5: Similar to very easy / very convenient / very satisfied				Marked by the conductor, considering testees are senior citizens
4: Similar to easy / convenient / satisfied				
3: Similar to Okay / I don't know/ Normal				
2: Similar to inconvenient / difficult / not satisfied				
1: Similar to very inconvenient / very difficult / Never want to do it again				
Did you have any reluctance about the game device before starting the game? [Learnability]				
5	4	3	2	1
What was the uncomfortable level of using the device (buttons and posture) when completing 1 stage? [Ease of use]				
5	4	3	2	1
What was the uncomfortable level of using the device (buttons and posture) when completing 2 stage? [Ease of use]				
5	4	3	2	1
What was the uncomfortable level of using the device (buttons and posture) when completing 3 stage? [Ease of use]				
5	4	3	2	1

5.3 Evaluation Results

The qualitative laboratory experiment on an expert group has been conducted on selected four subjects whose quantitative results of satisfaction level are the most approximate to the average value. The results are as shown in "Table 10".

Table 9. Percentage of quantitative evaluation results

Classification	Cognitive	Memory	Reflexive	S/W	H/W	Total
HCI expert 1	23	23	23	69	22	91
HCI expert 2	20	18	20	58	22	80
Planning 1	24	25	23	72	23	95
Planning 2	20	20	20	60	20	80
Graphic 1	23	20	22	65	24	89
Graphic 2	20	17	23	60	19	79
Program 1	24	23	23	70	24	94
Program 2	19	17	22	58	18	76
%	83.2	86.5	81.5	88	86	85.5

Table 10. Percentage of qualitative evaluation results

Classification	Cognitive	Memory	Reflexive	S/W	H/W	Total
HCI expert 1	23	24	21	68	25	94
HCI expert 2	25	24	22	71	24	95
Planning 2	21	21	23	65	21	86
Graphic 1	24	24	21	65	23	88
%	93	93	87	89.4	93	90.7

6. CONCLUSION AND FURTHER DISCUSSIONC

This thesis describes the cognitive evaluation model of those games that have special functional purposes for senior citizens by separating them into hardware and software parts. In order to propose an evaluation model, an actual game has been developed as a part of preceding research and I've proposed a cognitive evaluation model meeting the requirements of serious games for the elderly through conducting analyses on previous usability evaluation models and laboratory evaluation. . Given the fact that the scope of game contents, most of which used to be focused on teenagers, have been gradually expanding to cover wider range of social classes than ever before, it is expected that the results of this study could be utilized as a model that can verify the games and their contents with special purposes based on the cognitive evaluation of the users.

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