ISSN (Print): 0974-6846 ISSN (Online): 0974-5645

The Components of Enjoyable Game Design for Motor Impaired Users: Expert Evaluation

Nurul Hidayah Mat Zain¹, Azizah Jaafar² and Fariza Hanis Abdul Razak^{1*}

¹Faculty of Computer and Mathematical Sciences, Universiti Teknologi MARA (UiTM), 40450, Shah Alam, Selangor, Malaysia; nurulmz@tmsk.uitm.edu.my, fariza@tmsk.uitm.edu.my ²Institute of Visual Informatics, Universiti Kebangsaan Malaysia (UKM), 43600 UKM Bangi, Selangor, Malaysia; aj@ftsm.ukm.my

Abstract

Facilitating enjoyable user experiences are significant in the design of computer games. To achieve this, we need to understand the composition of these components and how to evaluate it. However, studies which evaluate on the components of the enjoyable game design are limited, specifically in relation to motor-impaired users. The Motor-Impaired Users – GameFlow Model (MIU-GameFlow Model) rating scale in this study was developed based on GameFlow Model, EGame Flow Model, user experience literatures and an interview with motor-impaired users. MIU-GameFlow Model was developed to measure enjoyable game design for motor impaired users. Expert evaluation approach was implemented to refine the MIU-GameFlow Model's content, wordings and gaps in the rating scale. The data were analyzed using descriptive analysis.

Keywords: Expert Review, Enjoyable, Game Design, Motor-Impaired User

1. Introduction

In order to understand the user's experience in computer games, researchers are using a variety of theories and methods¹. However, evaluating the enjoyable game design for special needs remains an open challenge. The main issue making it difficult to create a good evaluation method is the need of a framework that specifically for special needs such as motor impaired users². The measures should be brief, clear, and easy to administer³.

Author in³ described validation becomes 36 s an important stage especially when a new measure is being developed where there is no existing measure that operationalizes the concept as the researcher intended. For instance, there are instrument measuring player enjoyment in games, however, an instrument that defines and measure enjoyable game design for motor impaired users is new and need to be validated. Validity looks at how well the items of an instrument represent a concept or domain of content^{3–5}.

A panel expert was invited during content validation will offer valuable feedback about the quality of a newly

developed measure. A research will use an untested measurement when conducting studies without validation process. The instrument needs revisions and the process would need to be redone with another pilot study for the revised instrument if the data from an untested measurement. If the components were validated early on, an instrument developed based on the framework would require less revision and need not be evaluated repeatedly.

The aim of this research is to analyze expert's evaluation of the contents of MIU-GameFlow Model rating scale. We define motor-impaired users as a user who have symptoms of wrist/hand, such as hand discomfort, numbness, tingling, pain or burning sensations while a computer game playing.

2. Theoretical Framework

A variety of ideas, techniques and different approaches were used to assess game experience and enjoyment⁶. Author in⁷ introduced a Flow Theory in 1960s as a description of the enjoyment derived from daily actions.

He defines flow as an emotional state of optimum pleasure which arises when people are engaged in activities. People in this state perceive their activity to be enjoyable, even if no goal is reached. The Flow Theory involves eight components: Completion of tasks, concentrating on tasks, clear goals of tasks, immediate feedback on tasks, control over actions, effortlessness that removes awareness of frustrations, self-conscientiousness disappears and a stronger sense of self-awareness arises and sense of time is distorted. Flow Theory is the main concept used to explain the experience of users while playing computer games⁸.

The tripartite media enjoyment model was introduced by 68 r's to conceptualize enjoyment as an attitude with affective, cognitive, and behavioral antecedents and consequences. The affective element focuses on empathy, positive and negative moods; cognitive aspect focuses on judgments of game characters' actions and the behavioral aspect connected to selective exposure in terms of the player's viewing intent as well as behaviors during viewing 10.

Author in¹¹ was proposed the GameFlow Model. The GameFlow Model is based on Flow Theory integrated with appropriate criteria from computer game usability and user experience literature²⁵. The GameFlow model consist eight core elements. The core elements are concentration, challenge, player skills, control, clear goals, feedback, immersion, and social engagement. The elements are summarized in Table 1.

EGameFlow Model was introduced by¹² based on authors in¹¹ framework. The study is to develop a more precise scale that measure learners' enjoyment of e-learning games. The scale developed in this study consists of eight

dimensions: Immersion, social interaction, challenge, goal clarity, feedback, concentration, control, and knowledge improvement. Four learning games employed in a university's online learning course were used as the instruments of scale verification.

Author in¹³ was presented Pervasive GameFlow Model, which is described and discussed in terms of additions and elaborations to the general GameFlow Model¹¹. This model proposed to serve as an argument for further empirical studies on player enjoyment in the pervasive game environment.

Some unique features of game design for motorimpaired users 96 s were emphasized. Author in¹⁴ proposed features that can adapt to different users' requirements, support a wide range of input devices, offer simple design that easy to understand and encourage further exploration. Additionally, the interface should be able to analyze the extraordinary user's interest and behavior and can adapt according to their need¹⁵; improve adaptive personalization mechanism with reduce the amount of navigation required to reach items^{16–18} and offer scanning mechanism to reduce repetitive and forceful hand movements.

3. Proposed Conceptual Framework

Designing computer games that are given an enjoyable experience for ordinary user is a challenging task. The methodology becomes even more complex when we design motor107 impaired users inclusive game. One of the main processes is to identify the user's abilities and limitation¹⁹.

Table 1.	The GameFlow model elements by ¹¹
Fla	

Elements	Definition
Concentration	Games should require concentration and the player should be able to concentrate on the game
Challenge	Games should be sufficiently challenging and match the player's skill level
Player Skills	Games must support the player skill development and mastery
Control	Players should feel a sense of control over their actions in the game
Clear Goals	Games should provide the player with clear goals at appropriate times
Feedback	Players must receive appropriate feedback at appropriate times
Immersion	Players should experience deep, but effortless involvement in the game
Social Interaction	Games should support and create opportunities for social interaction

Elements	Definition
Concentration	Games should require concentration and the motor-impaired player should be able to concentrate on the same
Challenge	Games should be sufficiently challenging and match the motor-impaired player's skill level
Player Control	Motor-impaired players should be able to control interaction in the game
Clear Goals	Games should provide the motor-impaired players with clear goals at appropriate times
Feedback	Motor-impaired players must receive appropriate feedback from the computer game at appropriate times
Immersion	Motor-impaired players should experience deep, but effortless involvement in the game
Flexibility	Games should accommodate a wide range of individual preferences and abilities

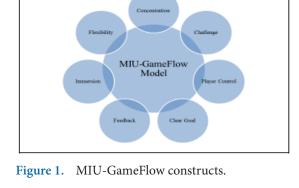
Table 2. Operational definition of MTU-GameFlow's construct

Few studies have developed the rating scale pertinent to the enjoyment of computer games. Therefore, the objectives of MIU-GameFlow Model rating scale are to measure enjoyable game design for motor impaired users. At first phase, scale items were generated based on GameFlow Model²⁰, Game Flow Model¹², user experience literatures and on interview with motor-impaired users. The instrument consists of the seven constructs specifically, concentration, challenge, player control, clear goal, feedback, immersion and flexibility. The operational definition for each construct was presented in Table 2.

4. Methodology

4.1 Develop Motor-Impaired Users GameFlow Model (MIU-GameFlow Model) Rating Scale

The Motor-Impaired Users Flow Experience rating scale was developed to measure enjoyable game design for motor-impaired users. MUI-GameFlow Model have seven potentials construct including concentration, challenge, player control, clear goal, feedback, immersion and flexibility. Figure 1 showed each construct used in the instrument.



4.2 Develop Response Items

Experts were asked to rate how important each item to enjoyable game design for motor 134 impaired users. The response option uses a five point scale format. Table 3 shows the condition to rate each of the items. If as the item is deemed as "1= Extremely unimportant" then the exclusion of that item does not affect enjoyable game design for motor impaired users in the games. On the contrary, if an item was rated as a "5 = Extremely Important" then the exclusion of that item would be detrimental to enjoyable game design for motor impaired users. An item with a rating of "2 = Unimportant", "3 = Less Important" and "4

Table 3. Condition rate each item	Tab	le 3.	Condition	on rate	each	item
--	-----	-------	-----------	---------	------	------

Rating	Definition
Extremely unimportant	The item is extremely unimportant to enjoyable game design for motor impaired users and can be excluded. Its absence would not affect enjoyable game design in the game.
Unimportant	The item is unimportant, but not critical to enjoyable game design for motor impaired users in the games. Although its absence would diminish enjoyable game design in games, the item needs major revision to be relevant.
Less Important	The item is less important to enjoyable game design for motor impaired users. Although its absence would diminish enjoyable game design in games the item needs minor revision to be relevant.
Important	The item is important and essential to enjoyable game design in games. It must be included and its absence would significantly hamper enjoyable game design for motor impaired users in the games.
Extremely Important	The item is extremely important and essential to enjoyable game design in games. It must be included and its absence would significantly hamper enjoyable game design for motor impaired users in the games

Paragraph	Sample text					
State purpose of study	You are invited to serve as a content expert because of your knowledge and contribute in (area of study). Your participation in the review process is valuable as a preliminary step to future studies that investigate strategies to (study objective).					
Briefly describe the instrument	The survey should take about (time to complete study) to complete by (response type e.g. ticking response boxes). It consists of items related to the construct of (study concept). The items will be assessed with a five-point rating scale, with 1 = 'Extremely unimportant'; 2 = 'Unimportant'; 3 = 'Less Important'; 4 = 'Important' and 5 = 'Extremely Important'.					
Describe how to contribute to a study	All responses are treated as anonymous, and in no case will responses from individual participants be identified. If you decide to participate, please referemail's attachment.					
Contact information and thank you	If you have any further questions about this study or your rights, or if you wish to lodge a complaint or concern, you may contact the researcher: (Researcher Name) by email (xxx:@email). I hope you will participate in the survey as the data will be very helpful in my studies.					

Table 4. Components of an invitation email for content experts. Adapted from (Source22)

= Important", may need a revision in terms of wording or reorganization to make it more relevant to enjoyable game design for motor impaired users.

4.3 Identify Potential Expert

Author in²¹ proposes that the choice of experts depends on the expertise related to the conceptual framework. Moreover, an expert publication, presentations and research experience in the area of interest can be used as the criteria for selection²². For example, the purpose of this study was to evaluate a framework for enjoyable game design for motor impaired users; expert members should be familiar with the construct of enjoyable game design, have experience in game development and at least one expert from psyiotheraphy department. Experts will evaluate every single of the item as well as the whole framework. The total number of experts involved in a content validity study range from three to twenty experts.

In this study, six experts, three academic game researchers, two professional game designers and one physiotherapy were selected. There were five female and one male experts ranging from 34 to 54 years of age. These experts were recruited on the basis of their experience and publications in game design.

4.4 Create Invitation Email for Expert Involvement

An invitation email was submitted after potential experts were identified. An email was sent to expert at least two weeks before the study start. The email invitation contained the purpose of study, a brief description of

the instrument, how to contribute to a study and contact information to the researchers. The detailed sample text that used for the invitation is shown in Table 4.

4.5 Develop Item Evaluation

In this study, three doctorate (Ph.D) in game design, two professional game developer and designer, and one from physiotherapist were contacted to review the initial pools of items. These experts were asked to rate the level of importance of each item for the constructs involved and provide feedback on the first version of the instrument. They were presented all the constructs, items and asked to make a choice out of five options (Extremely unimportant, Unimportant, Less Important Important, Extremely Important) for each item. An exemplar question as seen in Figure 3 showed an item for concentration construct.



Figure 3. An exemplar question rating for concentration construct.

Table 5. Demographic data of experts

	Range	Frequency (N)
Gender	Male	1
	Female	5
Experience in	5 – 9 years	-
Teaching / Industry:	10 – 14 years	4
N	15 – 19 years	2
	20 – 24 years	-
Software development experience	Yes	5
	No	1
Software evaluation experience	Yes	5
•	No	1

Table 6. Descriptive analysis for each item

Items	Mean	SD
The game grabs my attention	4.83	.408
The game activities are adequate for me	4.67	.816
The game workload is adequate for me	4.17	.983
The game provides content that stimulates my attention	4.67	.516
The game makes me remain concentrated on the game	4.33	.816
The game challenges are adequate for me	5.00	.000
The game levels of difficulty are adequate for me	5.00	.000
The game challenges are balanced with my skill levels	4.50	.548
The game offers "hints" to help me overcome the challenges	4.67	.516
The game offers different levels of challenges to tailor my needs	4.67	.816
The game is easy to play	4.67	.816
The game has simple interaction	4.67	.516
Part of the game's interaction is automated	4.67	.516
The game offers interaction based on users' preferences	4.50	.548
The game has a tutorial that is easy to follow	4.67	.516
The game offers familiar game's goals	4.67	.516
The main game's goals present clearly	4.83	.408
The intermediate game's goals present clearly	4.83	.408
The main game's goals present at the beginning of the game	4.67	.816
The intermediate game's goals present at the beginning of each scene	4.33	1.033
I receive feedback on my progress in the game	4.67	.816
I receive information on my success (or failure)	4.67	.816
I receive immediate feedback on my actions	4.50	1.225
I am notified of new activity immediately	4.33	1.033
I am alerted by break reminder at the appropriate time	4.67	.816
I feel imaginative	4.33	.816
I love a story that relates to my motor skills	4.50	.837
I forget about time passing while playing the game	4.33	1.033
I become unaware of my surroundings while playing the game	4.50	.837
I feel emotionally involved in the game	4.33	1.033
I love game offers user's preferences	4.83	.408
I love game offers switch keyboard 1	4.83	.408
I love game offers scanning mechanism	4.33	1.633
I love game offers voice recognition ³	4.83	.408
I love game enlarges the active area of the cursor	4.50	.837
I love game features that can adapt according my needs	4.00	1.673

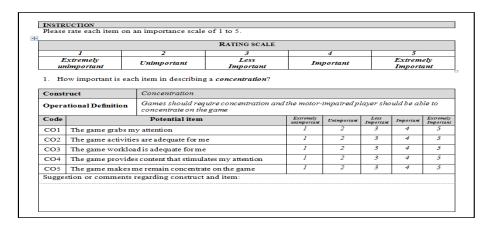


Figure 2. An exemplar question rating for concentration costruct.

4.6 Procedure of Expert Evaluation

Two weeks prior to the study, an email was sent to each expert, inviting them to participate in the study. If they agreed to participate, a second email containing an attachment of the instrument was sent. They were also advised that their participation was voluntary and all data gathered would remain confidential. The study lasted about two weeks and the procedure was as follows:

- Email invitations were sent to invite the experts involved in the evaluation process.
- Experts have agreed to involved in the evaluation process.
- Instruments sent to experts.
- Experts evaluate the instrument:
- Rate the importance of each item for the constructs involved.
- Refine the content, wordings and gaps in the

instrument.

- Experts and researchers will communicate if there is a misunderstanding in the instrument. In this study, there are experts who have been communicating by phone, email and face to face with researchers.
- After completing the questions, the expert will email an attachment of the instrument to researchers.

5. Result and Discussion

5.1 Descriptive Analysis

This section discusses on expert view based on constructing needed. There are seven construct to evaluate in determining enjoyable game design for motor impaired users. Those seven construct are: Concentration (CO), Challenge (CH), Player Control (PC), Clear Goal (CG), Feedback (FB), Immersion (IM) and Flexibility

Table 7. Summarization feedback from each expert

	Items	El		E2	E3	E4	E5			E6	
CO1	The game grabs my attention					-	-				
CO2	The game activities are adequate for me		-	-		-	-				
CO3	The game workload is adequate for me	Rephrase word 'workload'	-				-		Rephrase wo	d 'workload'	
CO4	The game provides content that stimulates my attention	•					-		Rephrase wo	rd 'consent'	
CO5	The game makes me remain concentrated on the game	Item similar with item IM33	-			-	-				
CH6	The game challenges are adequate for me		-	-		Relook w	hether -				
CH7	The game levels of difficulty are adequate for me		-	-		similar or					
		Change word	-	-		redundant					
CHS	The game challenges are balanced with my skill levels	balanced' to				епјоутнен					
CH9	The game offers "hints" to help me overcome the challenges	ewitable				constructs					
CH10	The game offers different levels of challenges to tailor my needs		-	-			-				
PC11	The game easy to play	Add word 'game is'	-	-		-	-				
PC12	The game has simple interaction	Rephrase item	-	-		-	-		Change at n		
PC13 PC14	Part of the game's interaction is automated. The game offers interaction based on users' preferences		-	-		-	-		Rephrase iten Explain word		
	The game has a tutorial that is easy to follow	:							Change 'a na		
PC15									playing"		
CG16	The game offers familiar game's goals		-	-		-					
CG17	The main game's goals present clearly	Adapt the level of	-	-		-	-		Change to 'T'	ke game's goals	
		wording according				-			Change to T	he intermediate	
CG18	The intermediate game's goals present clearly	to respondent level.							game's goals	are presented	
CG19	The main game's goals present at the beginning of the game					-			clearly'		
CG20	The intermediate game's goals present at the beginning of each scene		-	-		-	-				
FB21	I receive feedback on my progress in the game		-	-		-			Rephrase itea	_	
FB22	I receive information on my success (or failure)		-	-		-	-				
FB23 FB24	I receive immediate feedback on my actions I am notified of new activity immediately	-	-	-		-	-				
FB25	I am alerted by break reminder at the appropriate time		:								
IM26	I feel imaginative				-						
IM27	I love a story that relates to my motor skills									Rephrase item	
IM28	I forget about time passing while playing the game									Rephrase item	
IM29	I become unaware of my surroundings while playing the game				Ra	phrase item.					
		-					-	-		Change to 7 feel th	he changes
IM30	I feel emotionally involved in the game									of my emotion depe	end on the
										type of game I play	p*
FL31	I love game offers user's preferences	Change world	'love'	-	-		-	-		Add word 'game th	kat"
		to 'like'									
		The user must	easily								
		understand									
FL32	I love game offers switch keyboard			-			-	-		Add word 'game th	
FL33	I love game offers scanning mechanism			-	-			-		Add word 'game th	
FL34	I love game offers voice recognition			-			-	-		Add word 'game th	
FL35 FL36	I love game enlarges the active area of the cursor I love game features that can adapt according my needs					id the word		-		Add word 'game th	
FL30	r note forms requires may can soubt according inh peeds			-		coording to	-	-		Change to 7 can ac according my need	
		-Make bi-lang	1171070	-If needed.		Adapt the	Relook item.	Adapt	the level of	Update operational	
		(local language		rethink.		vel of wording	whether similar	wordin		for:	· ····································
	_	English)		reorganize		cording to	or redundant	accordi		- User Control	
	Comments	- Adapt the let	nel of			spondent	with other items		deut level	- Feedback	
						rel.					
		wording accer	(Timez		191	7 9 1.				 Flambility 	

(FL). In this study, expert will evaluate the importance of each item in every construct. The detailed demographic data are shown in

In total, six experts involved in this study and all of them were experienced in teaching or industry area. As shown in Table 5, all experts from academic game researchers and professional game designers are experienced in software development and software evaluation. The only one which is expert from psyiotheraphy area do not involve in software development and software evaluation.

The lowest value = 1, shows the item is extremely unimportant to enjoyable game design for motor impaired users and can be excluded and the highest value = 5, shows the item is extremely important and essential to enjoyable game design in games. It must be included and its absence would significantly hamper enjoyable game design for motor impaired users in the games.

The results of the descriptive analysis for each item based on a Likert Scale. Table 6 shows mean value and Standard Deviation (SD) that achieved as a result of the evaluation. For the overall finding, all items have mean value more than 3.00 which means experts agreed all 41 items were important to the components of enjoyable game design for motor impaired users.

5.2 Feedback from Expert

Experts' feedback is very important at this stage to ensure that the quality of a newly developed measurement and validate at how well the items of an instrument represent a concept or the domain of the content. Table 6 and Table 7 shows feedback from experts during evaluation process.

6. Conclusion

This paper discussed the expert's evaluation of the components of enjoyable game design for motor impaired users. The evaluation of this instrument shows that its use appropriate in gaining understanding of enjoyable game design for motor impaired users. A total of 36 items were generated and experts were asked to rate the importance of each item towards enjoyable game design for motor impaired users. Generally, experts agreed all 36 items were important to the components of enjoyable game design for motor impaired users. Some additions, changes, comments and explanations are suggested that result in an outline for a new model of enjoyable game design for motor impaired users, that is, MIU-GameFlow Model. This model needs to be empirically validated. Future work may include applications that have features of motor impaired users' interactions using the MIU-GameFlow Model to verify the model and identify further elaborations and extensions that may be needed.

7. Acknowledgements

We would like to thank the Ministry of Science, Technology and Innovation (MOSTI) for Sponsoring this research by using the funding of the e-Science Fund grant (06-01-02-SF0960). Their support is greatly appreciated. We also would like to express our gratitude to all experts who were directly or indirectly involved in this study.

8. References

- 1. Hidayah MZN, Azizah J. Integrating digital games based learning environments with eye gaze-based interaction. 2011 International Conference on Pattern Analysis and Intelligent Robotics (ICPAIR); 2011. p. 222-7.
- 2. Hidayah MZN, Azizah J, Hanis ARF. SGameFlow framework: How to experience enjoyment in Serious Game (SG) for Motor Impaired Users (MIU). 2012 International Conference on Computer & Information Science (ICCIS); 2012.
- 3. Rubio DM, Berg-Weger M, Tebb SS, Lee ES, Rauch S. Objectifying content validity: Conducting a content validity study in social work research. Soc Work Res. 2003 Jun; 27(2):94–104.
- 4. Gable RK, Wolf MB. Instrument development in the affective domain: Measuring attitudes and values in corporate and school setting. Massachusetts Kluwer Acad Publ; 1993.
- 5. Saw SM, Ng TP. The design and assessment 285 nt of questionnaires in clinical research. Singapore Med J. 2001; 42(3):131-5.
- 6. Hidayah N, Zain M, Hanis F, Razak A. Eye tracking in educational games environment: Evaluating user interface design through eye tracking patterns. Visual Informatics: Sustaining Research and Innovations. 2011; 7067:64–73.
- 7. Mihaly C. Flow: The psychology of optimal experience. Harper Collins. 1990; 1:991.
- 8. Boyle EA, Connolly TM, Hainey T, Boyle JM. Engagement in digital entertainment games: A systematic review. Comput Human Behav. 2012 May; 28(3):771-80.
- Nabi RL, Krcmar M. Conceptualizing media enjoyment as attitude. Implications for mass media effects research. Communication Theory. 2004; 14(4):288-310.

- 10. Feng X, Chan S, Brzezinski J, Nair C. Measuring enjoyment of computer game play. AMCIS 2008 Proceedings. 2008; 48:306.
- 11. Sweetser P, Wyeth P. GameFlow: A model for evaluating player enjoyment in games. Comput Entertain. 2005; 3(3):1–24.
- 12. Fu F-L, Su R-C, Yu S-C. EGameFlow: A scale to measure learners' enjoyment of e-learning games. Comput Educ. 2009; 52(1):101–12.
- 13. Jegers K. Pervasive game flow: Understanding player enjoyment in pervasive gaming. Comput Entertain. 2007; 5(1):9.
- 14. Norte S, Lobo FG. Sudoku access: A sudoku game for people with motor disabilities. Proceedings of the 10th international ACM SIGACCESS Conference on Computers and Accessibility; 2008. p. 161–8.
- 15. Gupta K, Khan UA. Critical analysis of the user interfaces for the disabled community. International Journal of Computer Applications. 2012; 42(16):40–4.
- 16. Findlater L. McGrenere J. Beyond performance: Feature awareness in personalized interfaces. Int J Hum Comput

- Stud. 2010 Mar; 68(3):121-37.
- 17. Gajos KZ, Weld DS, Wobbrock JO. Automatically generating personalized user interfaces with Supple. Artif Intell. 2010 Aug; 174(12-13):910–50.
- 18. Gajos KZ, Wobbrock JO, Weld DS. Improving the Performance of Motor-Impaired Users with automatically-generated, ability-based interfaces. Inf Syst. p. 1257–66.
- 19. Hidayah MZN, Azizah J, Hanis ARF. The impact of CTS on computer-games playing: A study among malaysian university students. Proc Conf on Future Trends in Computing and Communication; 2013. p. 50–4.
- 20. Sweetser P, Wyeth P. GameFlow: A model for evaluating player enjoyment in games. Technology. 2005; 3:1–24.
- 21. Grant JS, Davis LL. Selection and use of content experts for instrument development. Res Nurs Health. 1997; 20(3):269–74.
- 22. Ibrahim R. A conceptual framework for supporting gender inclusivity in games [Thessis]. University of Southampton, School of Electronics and Computer Science; 2011. p. 180.