A USER-CENTERED DESIGN: METHODOLOGICAL TOOLS TO DESIGN AND DEVELOP COMPUTER GAMES FOR MOTOR-IMPAIRED USERS

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ABSTRACT. User-Centered Design (UCD) is a term to describe design processes which focus on designing for and involving users in the design of applications. The implementation of UCD in the game design process can enhance the user experience especially for special needs users such as motor-impaired users (MIU). This is very important, since the user experience will eventually be a significant element in the computer game's success. The main objective of this study is to investigate UCD as a methodological tool to design and develop enjoyable games for MIU. The findings of the study showed users' feedback on game design for MIU while applying UCD methods to game improvement and evaluation. Hopefully, the results of the study will emphasize the need for developing enjoyable game designs for MIU.

Keywords: user-centered design, game design, motor impaired users

INTRODUCTION

The implementation of UCD methodologies in game design has had a remarkable impact over the past few years. Besides that, UCD successfully made interaction with games faster, safer, and more efficient especially for MIU. MIU in this study is defined as a user who has a limitation of function in muscle control or a limitation in mobility (Yuan, Folmer, & Harris, 2011). MIU can be caused by a stroke, Parkinson's disease or a physical disability.

In order to design enjoyable games for MIU, it is important to identify what makes MIU enjoy games (Nurul Hidayah, Azizah, & Fariza Hanis, 2014). This is important because computer games have become an essential part of fun activities and are particularly engaging not only for ordinary users but also for MIU (Nurul Hidayah, Azizah, & Fariza Hanis, 2012). In general, the basic principles of the UCD process include: (1) involving the user in the design process, (2) focusing on users and their tasks, (3) measuring usability and (4) designing iteratively, whereby an application is designed, evaluated and modified with real users repeatedly in quick iterations.

THE CONCEPT OF USER-CENTERED DESIGN (UCD)

UCD is one of the essential concepts in usability engineering and areas that set designing interactive application as their goal (Baharum & Jaafar, 2014a, 2014b; Lerouge, Ma, Sneha, & Tolle, 2011). UCD is a design that is based on actual requirements of users, and comprises of task analysis, prototype development with users, evaluation, and iterative design.

Thimbleby (2006) in his study stated five objectives of UCD including (1) to identify and prioritise usability values with users (2) to match task requirements to design (3) to remove defects from the design, and from the requirements (4) to test against usability criteria and (5) to iterate design to continuously improve.

The UCD defined by Buurman (1997) is a design process that includes users in the entire design procedure in order to match the product to the user's requirements. Kontogiannis & Embrey (1997) stated a UCD approach increases user acceptance of new technologies. UCD also allows users to join in the design process that improves the usability of the product. Brown & Mulley (1997) verified that UCD also cuts development time and costs by reducing the number of changes required in the future stages of the design process.

The implementation of UCD method in this study involves four phases, namely : (1) **Analysis phase:** This phase is to analyse in depth the game design for MIU. We analyse elements and criteria of game design for MIU based on *MIU-GameFlow Model* (Mat Zain, Jaafar, & Abdul Razak, 2016). (2) **Design phase:** In this phase, the storyboard was designed based on the elements and criteria in the *MIU-GameFlow Model*. (3) **Implementation phase:** In this phase, we implement the design into working systems ready to go live based on *MIU-GameFlow Model* and storyboard that has received feedback from actual users and (4) **Evaluation phase:** In this phase, the MIU evaluates the game in usability testing sessions.

THE IMPLEMENTATION OF USER-CENTERED DESIGN (UCD)

Phase 1: Analysis Requirements of MIU

In the analysis phase, MIU requirements are taken into consideration prior to the start of the design phase. Table 1 shows the elements and criteria of game design for MIU based on *MIU-GameFlow Model.*

Table 1. Elements and Criteria in MIU-Gameflow Model

Element	Criteria
Concentration	The game grabs the user's attention
	The game's content stimulates the user's attention
	The game's activities are suitable for users
	The game makes users remain concentrated on it
Challenge	The game has different levels of challenges
	The game offers rewards for each challenge
	The game's difficulty levels are appropriate for the user
	The game's challenges are appropriate for users' ability levels
	The game offers "hints" to help users overcome the challenges
Player Control	The game is easy to play
	The game has simple interaction
	Part of the game's interaction is automated
	The game offers interaction based on users' preferences
	The game has a tutorial that is easy to follow
Clear Goal	The game has clear goals
	The game has clear intermediate goals
	The game's goals are presented at the beginning of the game
	The game's intermediate goals are presented at the beginning of scenes
Feedback	The game gives feedback on the user's progress
	The game gives feedback on the user's success or failure
	The game gives feedback on users' actions
	The user is notified of a new activity immediately
	The break reminder is notified at the appropriate time

Immersion	Users feel imaginative
	Users become unaware of surroundings while playing the game
	The game involves the user's emotion
	The game has a narrative
	The game makes the user forget about time passing
Flexibility	The game offers user preferences
	The game offers a switch keyboard
	The game offers the scanning mechanism
	The game enlarges the active area of the cursor

Phase 2: Screen Design

The design phase provides a comprehensive approach to the design of the game, ensuring the design meets all MIU requirements. This phase was carried out by design a storyboard to get early feedback from actual users. Table 2 shows the description of the screen design before getting feedback from MIU.

Table 2. Example of Screen Design Before User's Feedback

	MIU's feedback: • The interface is too crowded • Minimise the use of object • Enhance color variation
	MIU's feedback: • Enhance characters' appearance • Put text instruction at the top
	MIU's feedback: • Update the sub-headings • Enhance color variation

Phase 3: Implementation

This phase involves user testing, user interface integration and implements screen design into the working application. Computer games were developed based on elements and criteria in *MIU-Game Flow model* which is *Concentration, Challenge, User Control, Clear Goal, Feedback, Immersive and Flexible* (Mat Zain et al., 2016). Furthermore, a computer game was also developed based on feedback from actual users through storyboarding process. Figure 1 and 2 present the example of *Concentration* and *Feedback* elements that was implemented in the game design.

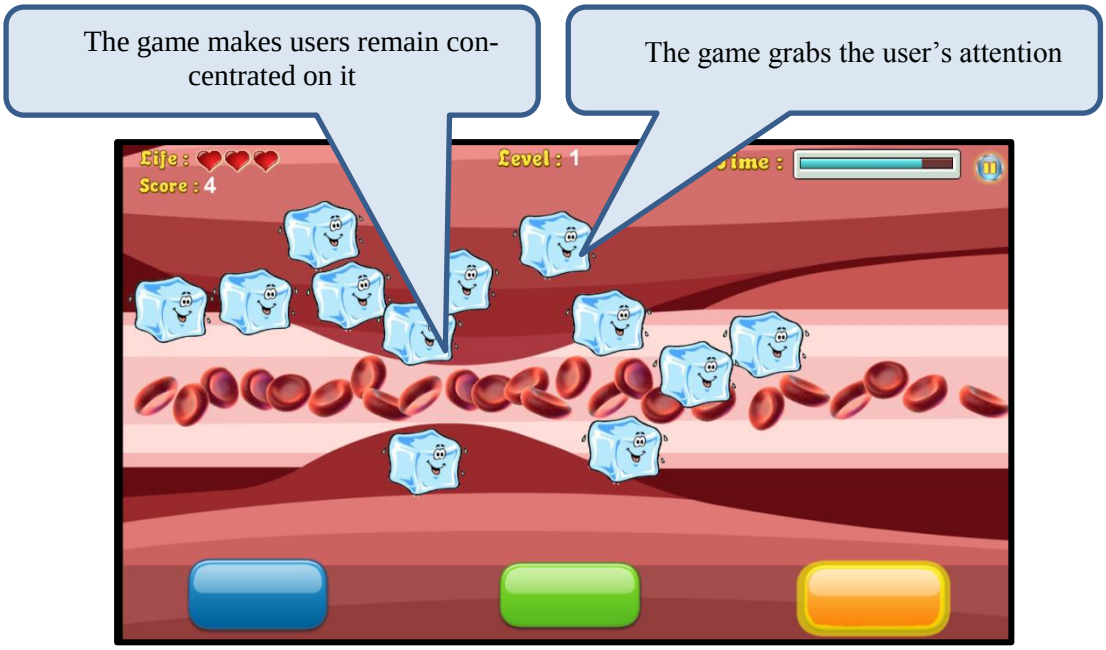


Figure 1. Example of *Concentration* Elements that was Implemented in Game Design

Figure 2. Example of *Feedback* Elements that was Implemented in Game Design

Phase 4: Evaluation

The evaluation phase involves continuous evaluation of the game and monitoring the performance against usability objectives. The MIU were involved in usability testing sessions and were required to play a prototype for 20 minutes. Feedback from the usability testing was reported and improvements have been carried out. This process occurs iteratively.

RESULT AND FINDING

Phase 2: Screen Design

Table 3. The Updated Screen Design after Feedback From MIU

Before user's feedback	After user's feedback
	
	
	

Phase 4: Usability Testing

Usability testing refers to the testing of an application by the users. Normally, during a test, participants will try to complete tasks while observers watch, listen and take notes. The goal is to identify any usability problems, collect qualitative and quantitative data and determine the participant's satisfaction with the application. Table 4 shows the part of responses received after usability testing was conducted.

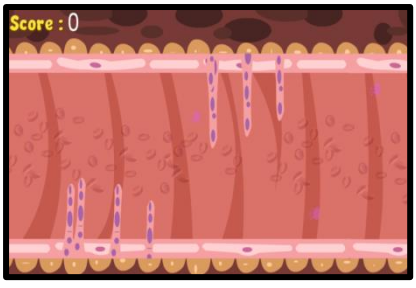
Table 4. One of example feedback from the usability testing

Positive feedback

- The concept of the game is easy to grasp.
- There is an option to choose level I, II or III
- The game is enjoyable

Negative feedback

- Audio should be more cheerful to contribute to enjoyable experience to the user



Positive feedback

- Easy to play but hard to master
- Blood character is very helpful in understanding the concept of the game

Negative feedback

- User must have high concentration in the game to win it.

CONCLUSION

MIU have special requirements, limitations and experience that affect their interaction with technology, specifically computer games. The implementation of UCD as methodological tools to design and develop computer games is one solution to lead to enjoyable game design for MIU. Besides, UCD provides strengthened focus on the users during the development process, reduces necessary changes at the end of the development process and helps to measure a design's effectiveness.

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