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ABSTRACT

Effective measurement of the enjoyment of computer game play will assist game designers to understand the strength and flaw of the game from players' perspective. We argue that flow experience in computer game play contributes to enjoyment. This paper reports on the development of an instrument for measuring flow experience in computer game play. The instrument was developed based on the flow theory (Csikszentmihalyi, 1993) and a rigorous method introduced by Moore and Benbasat (1991). The results show that the validity and reliability of the instrument are satisfactory. This instrument will help IS researchers to further investigate the application of flow theory in computer games.

Keywords

Computer games, enjoyment, flow theory.

INTRODUCTION

As popularity of computer games soars in people's daily life, they attract more academic research in different fields on games. As a form of entertainment, the construct of enjoyment is central to research frameworks that examine interactions between computer games and their players, and thus facilitate game application and design. A validated measurement of enjoyment of computer game play seems critical to large-scale IS research on computer games. The flow theory (Csikszentmihalyi, 1993) suggests that a flow state leads to enjoyment. The objective of this research is to develop an instrument to measure flow experience in computer game play. We argue that measuring flow experience, a known contributing factor of enjoyment, will help researchers better assess enjoyment of computer game play. In order to make this instrument applicable to a broad range of games such as traditional video games and games played on a computer, we define computer game play as play of computer-controlled games with interaction mediated principally by computers. Generally speaking, such games refer to videogames, console games, mobile games, and online games. We previously presented the original research proposal in another conference as a research-in-progress paper (Zhang et al., 2010). This paper presents the entire instrument development process, data analyses, and final testing results.

BACKGROUND LITERATURE

Our literature review examines prior research on flow theory and measurement of flow experience.

Csikszentmihalyi (1993) investigated what would create optimal experience when conducting studies on the creativity of artists and musicians. Csikszentmihalyi expanded his studies to people doing daily work or leisure and found that they would experience enjoyment if they were immersed in the same manner as those artists. Based on a series of field studies, Csikszentmihalyi (1993) created the flow theory to examine the process in which certain behaviors would make life more enjoyable. In this flow theory, he proposed eight major components for the phenomenology of enjoyment: (1) A challenging activity that requires skills; (2) The merging of action and awareness; (3) Clear goals and feedback; (4) Concentration on the task at hand; (5) The paradox of control; (6) The loss of self-consciousness; (7) The transformation of time; and (8) Autotelic experience.

Flow theory has been widely adopted in IS and HCI research. Webster, Trevino, and Ryan (1993) adapted flow theory to measure the user's playfulness in human-computer interactions and proposed measuring flow in four dimensions: (1) control, (2) attention focus, (3) curiosity, and (4) intrinsic interest. Ghani and Deshpande (1994) used flow theory to describe the experience of individuals using computers in the workspace. They measured two dimensions of flow: sense of control and the level of challenge received. Hoffman and Novak (1996) presented a model of flow in computer–mediated environments (CME). Their flow model included "positive affect," "exploratory behaviors," and "challenge/arousal," which could be considered as elements of enjoyment. Subsequently Novak, Hoffman, and Yung (2000) conducted a large-scale online consumer survey of a structural model based on flow. Koufaris (2002) applied flow theory to online consumer behavior and measured 4 constructs of flow: concentration,

challenge, skills, and perceived control. Finneran and Zhang (2005) argue that most existing flow studies in CME do not differentiate between factors that are related to the task and those related to the artifact. Accordingly they proposed a conceptual model for flow antecedents: the Person-Artifact-Task (PAT) model.

Flow theory has also been widely adopted in studies on games. Smith (2006) argues that flow, a psychological state, contributes to the enjoyment of playing video games and suggests that individuals derive enjoyment from the experience of flow, and the occurrence of flow can be stimulated by the use of interactive media. Grodal (2000) explains that much of the fascination with video games can be attributed to the ability of players to control the game in terms of outcomes (i.e., deciding how the "plot" will unfold), the speed at which the game progresses, and mastery of the game or mastery over other players. Sherry (2004) argues that video games are likely to create flow state because they frequently (1) have concrete goals and manageable rules; (2) can be adjusted to players' capabilities; (3) provide clear feedback in terms of running scores, collections of artifacts, or progress reports; and (4) have visual and audio effects that helps screen out distraction and facilitate concentration.

Sweetser and Wyeth (2005) constructed a model, GameFlow, based on flow theory to evaluate player enjoyment in games. The GameFlow model consists of eight constructs: concentration, challenge, player skills, control, clear goals, feedback, immersion, and social interaction. Several researchers have cited this concept to explain how to facilitate flow experiences in computer games. Chen (2007) used the concept of GameFlow to develop the idea of the Flow Zone. Fu, Su, and Yu (2009) adapted GameFlow model in E-learning games and developed an EGameFlow model that introduced a new factor of increasing knowledge. These authors validated the scale via surveys. However their research focused only on E-Learning games.

Cowley, Charles, and Black (2008) developed a framework, user-system-experience (USE) based on the person-artefact-task (PAT) model (Finneran & Zhang 2005). They argued that application of flow theory to games could improve understanding of the relationship between a player and the complex game system. However, they did not validate this framework.

Although numerous studies have attempted to apply flow theory in computer games and related fields, the majority of them are still in the conceptual stage. None of these studies has actually developed a validated instrument to measure flow experience based on the original theory following a rigorous development process. Our research attempts to fill in this gap and provide researchers in computer games a useful tool to more effectively apply flow theory.

THEORETICAL FRAMEWORK

With the mounting research applying flow theory to studies of computer games (e.g., Cowley et al. 2008; Sherry, 2004; Smith, 2006; Sweetser & Wyeth, 2005), there seems a consensus that flow (Csikszentmihalyi, 1993) applies to computer game player experiences and it leads to enjoyment. Therefore, we argue that measuring flow experience in computer game play will help measure game players' enjoyment. In this study, a survey instrument was developed to measure all eight elements of flow.

INSTRUMENT DEVELOPMENT

In this study, we adopt the instrument development method suggested by Moore and Benbasat (1991) which consists of three stages. The first stage is item creation. Its purpose is to create pools of items for different constructs. The next stage is scale development. The basic procedure is to have game play experts sort items from the first stage into separate categories based on the similarities and differences among items. In the final instrument testing stage, the instrument is tested through a few rounds of surveys.

Item Creation

The objective of this stage is to ensure content validity. We followed these steps:

1) A review of relevant studies was conducted to compile tested scales and items that have been used to measure flow experience.

2) All the items identified in the existing instruments were categorized according to the Csikszentmihalyi's (1993) eight elements of flow. Similar or identical items were consolidated. Table 1 lists the numbers of items for all eight flow elements and their sources.

3) Items considered not applicable to computer game play were removed.

4) New items were created for those flow elements with fewer than three items.

5) Wording of the items in the pool was modified to reflect the context of computer game play.

As a result, 38 items were created and became Version 1 of the questionnaire.

Scale Development

The goals of this stage are twofold: to assess the construct validity of the various scales being developed, and to identify any particular items which may be ambiguous. Experienced computer game players were recruited as judges for two-rounds of card sorting sessions from students in computer gaming courses in a university in the Midwestern region of the US. These game players were asked to sort the 38 items created in "Item Creation" stage into nine categories: 1) A challenging activity that requires skills; 2) The merging of action and awareness;

Flow Element	Number of Items	Source
A challenging activity that requires skill	1	Ghani, 1994
	2	Haworth, 1995
	12	Novak, Hoffman, and Yung, 2000
	11	Sweetser and Wyeth, 2005
	4	Guo, 2004
	2	Koufaris, 2002
The merging of action and awareness	7	Novak, Hoffman, and Yung, 2000
	4	Sweetser and Wyeth, 2005
	9	Guo, 2004
Clear goals and feedback	5	Sweetser and Wyeth, 2005
	8	Guo, 2004
Concentration on the task at hand	3	Webster, Trevino, and Ryan, 1993
	4	Ghani, 1994
	4	Guo, 2004
	6	Sweetser and Wyeth, 2005
	1	Moneta and Csikszentmihalyi, 1996
	2	Peterson and Miller, 2004
	3	Lu, 2009
The paradox of control	3	Webster, Trevino, and Ryan, 1993
	2	Ghani, 1994
	4	Egbert, 2003
	2	Koufaris, 2002
	4	Novak, Hoffman, and Yung, 2000
	6	Sweetser and Wyeth, 2005
	1	Shernoff and Csikszentmihalyi, 2003
	1	Peterson and Miller, 2004
	3	Mathwick, 2004
	3	Wu, Li, & Rao, 2008
	4	Guo, 2004
The loss of self-consciousness	7	Guo, 2004
The transformation of time	2	Novak, Hoffman, and Yung, 2000
	9	Guo, 2004
	2	Wu and Chang, 2005
	1	Sweetser and Wyeth, 2005
Autotelic experience	4	Guo, 2004

Table 1. Items from Existing Instruments

3) Clear Goals; 4) Clear Feedback; 5) Concentration on the task at hand; 6) The paradox of Control; 7) The loss of self-consciousness; 8) The transformation of time; and 9) Autotelic experience. In his publications, Csikszentmihalyi (1993) sometimes separated the third element in the original flow theory, "Clear Goals and Feedback", into two separate elements: "Clear Goals" and "Clear Feedback". We *temporarily* treated "Clear Goals and Feedback" as two different elements in the scale development stage in order to ensure that the instrument would cover all elements in the flow theory. Cohen's Kappa (Cohen, 1960) was used to measures the level of agreement among all the judges in categorizing items. As suggested by Moore and Benbasat (1991), no general authority exists with respect to required Kappa scores and scores greater than 0.65 would be considered acceptable.

1) Card Sorting Round 1

Twenty-three experienced game players participated in the first round of card sorting. Prior to sorting the cards, participants were given the definitions of the nine categories corresponding to the nine elements in the flow theory. These definitions were used to sort the items. A detailed example illustrating the sorting process was also provided. Version 1 of the instrument containing 38 items obtained from the "Item Creation" stage was used in this first round of card sorting. Participants were instructed to sort the cards into the nine predefined categories. Each card could only and must be placed in one of the nine categories.

Table 2 shows Cohen's Kappa values of the nine categories. Unfortunately, only one category, "the transformation of time," has Kappa value above an acceptable level of 0.65. In order to improve the quality of the instrument, we revisited questions items from prior studies and removed 16 ambiguous ones. The remaining 22 items constitute Version 2 of the instrument. Table 3 shows Cohen's Kappa values of Version 2.

Element of Flow	**Number of Items**	**Cohen's Kappa**
A challenging activity that requires skill	8	0.56
The merging of action and awareness	5	0.23
Clear goals	3	0.48
Clear feedback	4	0.45
Concentration on the task at hand	4	0.41
The paradox of control	4	0.41
The loss of self-consciousness	3	0.33
The transformation of time	3	0.83
Autotelic experience	4	0.41

Table 2. Cohen's Kappa values for the first round of card sorting

As shown in Table 3, the removal of 16 ambiguous items indeed improved the agreement among judges, but it was not enough. Two of the categories ("the merging of action and awareness" and "the loss of self-consciousness") still had a Kappa value far below 0.65 and five other categories were floundering with a Kappa value around 0.60. However, the research group felt that the existent items in Version 2 were not enough to boost the quality of the instrument to an acceptable level. The group went back to the original pool (see Table 1) of items and constructed eleven new items with consultation of experienced game players. These eleven new items spread across the majority of the nine categories in the flow theory. The combination of these new items and the previously created 22 items (total 33 items) made the Version 3 of the instrument.

Element of Flow	Number of Items	Cohen's Kappa
A challenging activity that requires skill	4	0.74
The merging of action and awareness	1	0.35
Clear goals	3	0.54
Clear feedback	3	0.66
Concentration on the task at hand	2	0.63
The paradox of control	2	0.60
The loss of self-consciousness	1	0.34
The transformation of time	3	0.88
Autotelic experience	3	0.53

Table 3. Cohen's Kappa values of Version 2

2) Card Sorting Round 2

The purpose of this round of card sorting was to identify ambiguous items in Version 3 of the instrument and further improve its quality. Six experienced game players were recruited in the second round of card sorting. The sorting procedure was same as the one used in the first round. We went through the same filtering procedure as we did in the first round. As a result, six ambiguous items were identified and removed. The remaining twenty-seven items make the Version 4 of the instrument. Table 4 presents the Kappa values of this version. By now, we were confident that the instrument had reached an acceptable quality with all Kappa values above 0.65.

Element of Flow	Number of Items	Cohen's Kappa
A challenging activity that requires skill	4	0.90
The merging of action and awareness	2	0.65
Clear goals	4	0.91
Clear feedback	3	0.81
Concentration on the task at hand	2	0.82
The paradox of control	2	0.90
The loss of self-consciousness	2	0.81
The transformation of time	3	0.93
Autotelic experience	5	0.87

Table 4. Cohen's Kappa values of Version 4

Instrument Testing

The goals of this stage are to assess the reliability of the scales and to ensure the construct validity. We conducted an online survey testing the fourth version of instrument containing 26 items resulted from the card sorting procedure (1 item in "Clear Goal and Feedback" category was accidentally omitted due to a system problem). The survey was posted on the Web and contained three sections. The first section presented general information about the survey and purpose of the research. If the respondent was not a game player, the survey asked him/her to stop. Demographic information of the participant was collected, such as gender and age. The second section contained 105 items covering personality questions. The third section listed the 26 items covering the nine elements of flow.

An email invitation was sent to all the students in a college of computer science and information systems at a university in the Midwest region of the US. In the e-mail, a direct link to the survey on the Web was provided. Only game players were qualified for participation in this survey. Each person was only allowed to respond to the survey once. Responses from 260 participants were received and used in the data analysis.

Table 5 shows survey respondents' background information.

Variable		Value
Gender	Male (%)	82.6
	Female (%)	17.4
Age	Mean (Years)	25.2
	Std.	7.53
How long have you been playing computer games?	Mean (Years)	15.1
	Std.	8.41
Every time when you play computer games, how many hours on average do you play?	Mean (Hours)	2.9
	Std.	2.10
How often do you play computer games?	Daily (%)	37.5
	Weekly (%)	49.8
	Monthly (%)	5.4
	Seldom (%)	7.3

Table 5. Survey Respondents' Background Information

Moore and Benbasat (1991) have suggested that in early stages of research, scale reliabilities of 0.50 to 0.60 would suffice. Thus, the target level of minimum reliability was set in the 0.60 to 0.70 range. Factor analysis with VARIMAX rotation was also conducted to assess construct validity. The rotated factor matrix was examined for items which either did not load strongly on any factor (<0.30), or were too complex (which loaded highly or relatively equally on more than one factor). These items were candidates for elimination.

Based on the result of the Cronbach Alpha and factor analyses, two items from autotelic experience and one item from the transformation of time were removed from the scale. Table 6 presents the Cronbach's Alpha values of the remaining 23 items. These 23 items made the Version 5 of the instrument.

As shown in Table 7, factor analysis with VARIMAX rotation indicates that six factors had eigenvalues greater than 1.0. All the items for categories "Control," "Concentration," "A challenging activity that requires skills," and "Autotelic experience" emerged as separate

clean clusters. It is interesting to observe that three items for "Clear Goals" and three items for "Clear Feedback" converged into the same factor. Given the fact that "Clear Goals" and "Clear Feedback" are considered as one element in the original flow theory (Csikszentmihalyi, 1993), this is not a surprise but indeed a comforting news. From Table 8, it is also found that the items for "Loss of self-consciousness," "The merging of action and awareness," and "The transformation of time" were all highly loaded on the same factor (>0.40). After consulting with experienced game players, it is clear that game players have a strong sense of immersion. It is possible that game players have perceived "Loss of self-consciousness," "The merging of action and awareness," and "The transformation of time" as different but related aspects of immersion.

Element of Flow	Number of Items	Cronbach's Alpha
A challenging activity that requires skill	4	0.86
Immersion (The merging of action and awareness, The loss of self-consciousness, and The transformation of time)	6	0.78
Clear goals and feedback	6	0.88
Concentration on the task at hand	2	0.90
The paradox of control	2	0.69
Autotelic experience	3	0.81

Table 6. Cronbach's Alpha Values of Version 5

The above analyses lead to the final or the fifth version of the instrument for measuring flow experience in computer game play.

CONCLUSIONS

Our research has resulted in an overall instrument to measure flow experience in computer game play. The creation process involved surveying existing instruments, creating new items, and then undertaking an extensive scale development process. The method of scale development followed a rigorous process and provides a high degree of confidence in the content and construct validity of the instrument. The result is a parsimonious, 23-item instrument, comprising six scales, all with acceptable level of reliability. This instrument provides a useful tool for researchers to apply flow theory in game design and it also contributes to the measurement of enjoyment of computer game play. In addition, it was also noted that the three elements in flow theory: Loss of self-consciousness, The merging of action and awareness, and, The transformation of time, are perceived by game players as one factor: immersion.

Item		Component					
Category	Question Item	1	2	3	4	5	6
Clear goals	I knew what I wanted to achieve in this game	.811	-.019	.192	.101	.051	.101
Clear goals	I knew clearly what I wanted to do in this game	.798	-.072	.193	.124	-.033	.132
Clear feedback	I was aware of how well I was performing in this game	.786	.064	.037	.168	.242	.041
Clear goals	My goals were clearly defined	.776	-.026	.112	.070	-.076	.054
Clear feedback	While playing this game, I had a good idea about how well I was doing	.741	.014	.062	.128	.261	.036
Clear feedback	I receive immediate feedback on my actions	.660	.202	.058	.098	.021	.204
Loss of self-consciousness	I lost the consciousness of my identity and felt like melted? into the game	.037	.771	.104	.052	.138	-.153
Loss of self-consciousness	I kind of forgot about myself when playing this game	-.045	.736	.038	.140	.167	.069
The merging of action and awareness	I often find myself doing things spontaneously and automatically without having to think	.010	.711	.019	.149	-.040	.018
The transformation of time	When I play this game, I tend to lose track of time	.091	.661	.046	-.001	.007	.313
The merging of action and awareness	When I play the game, I feel I am in a world created by the game	-.043	.551	.117	.256	.322	.119
The transformation of time	When I played this game, I sometimes felt like things were happening in slow motion	.147	.519	.267	-.032	.128	-.344
A challenging activity that requires skills	Playing this game could provide a good test of my skills	.149	.151	.883	.072	-.025	.049
A challenging activity that requires skills	I find that playing this game stretches my capabilities to my limits	.109	.159	.860	-.004	.095	.016
A challenging activity that requires skills	Playing this game challenges me.	.138	-.025	.763	.120	.186	.167
A challenging activity that requires skills	I was challenged by this game, but I believed I am able to overcome these challenges	.180	.082	.657	.271	.197	.035
Autotelic experience	I enjoyed the experience	.152	.071	.100	.837	.120	.130
Autotelic experience	Playing this game is rewarding in itself	.167	.247	.087	.821	.016	.030
Autotelic experience	I loved the feeling of that performance and want to capture it again	.377	.168	.231	.650	.117	.023
Concentration	When playing this game, I was totally concentrated on what I was doing	.169	.174	.153	.079	.882	.049
Concentration	My attention was focused entirely on the game that I was playing	.115	.218	.204	.112	.859	.046
Control	I feel comfortable with the controls of this game	.208	.028	.097	.138	.078	.808
Control	When playing this game, I felt in control over what I was doing in the game	.431	.125	.222	.029	.067	.660

Table 7. Factor Analysis of Version 5

REFERENCES

References will be made available upon request.