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THE IMPACT OF FLOW EXPERIENCE ON PERCEIVED VALUE AND USER STICKINESS: TAKING COMPETITIVE GAMES AS AN EXAMPLE

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Abstract. *Flow experience is regarded as an advanced form of experience. This viewpoint has become popular and has been practiced in many industries. Up to now, the game industry is one of the best fields for studying flow experience. As the competition in the game industry intensifies, meeting players' requirements for game experience and stimulating their flow experience will have a profound impact on the development of game companies. Taking competitive games as an example, this study focuses on the impact of flow experience (altered sense of time, loss of self-consciousness, and sense of control) on perceived value (hedonic value and utilitarian value) and user stickiness. Through the empirical research, it is verified that flow experience mainly affects user stickiness positively and indirectly through hedonic value. The research results not only enrich the research on flow experience, but also contribute to the research on the influencing factors of perceived value and user stickiness.*

Keywords: Flow experience, Perceived value, User stickiness, Hedonic value, Utilitarian value

1. **Introduction.** With the advent of experience economy era, the research and application of flow experience have received more attention. Flow experience theory is considered as an important part of user experience theory. At the beginning of the research on flow experience, some scholars used game experience to describe flow experience. However, over the last decade, there are few researches on flow experience in the competitive game industry, and there are fewer research results that used flow experience as an independent variable and used perceived value and user stickiness as dependent variables. Obviously, there is a lack of research on the combination of flow experience, perceived value and user stickiness. Therefore, there is still high value on this research.

With the development of the Internet, the game industry has entered a stage of rapid development. At the same time, mobile games and online games go hand in hand. In recent years, the sales revenue of China's game market has increased, but the growth rate of user scale has slowed down, and the game market has become fiercely competitive. Players' expectations of the game experience are escalating, which is one of the reasons for the above situation. In the game, players need to have more sense of control and accomplishment, forget about time and troubles, and get ease and pleasure. As far as the game company is concerned, it needs to let players get flow experience in the game, and then increase the players' user stickiness.

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Therefore, this study is based on the above research background, taking competitive games' players (Overwatch, Glory of Kings, etc.) as the research object, focusing on flow experience in competitive games. This study focuses on three aspects. The first one is whether the player's flow experience will affect perceived value. The second one is whether player's flow experience will affect the player's user stickiness. The last one is whether perceived value will affect the player's user stickiness. This study will use the methods of expert interview, pre-survey and formal survey, and analyze data by SPSS 26.0 and LISREL 8.70. So far, in the face of increasingly fierce competition, how to continuously strengthen the user stickiness of players is a practical problem that needs to be solved urgently for the game industry. Therefore, this study hopes that the final results of the relationship between flow experience, perceived value, and user stickiness can be enlightened for the development of the game industry.

2. Literature Review.

2.1. Literature review on flow experience.

2.1.1. *The concept of flow experience.* The concept of flow experience was first proposed by American famous psychologist Csikszentmihalyi in 1990. He believed that flow is a state in which a person is completely immersed in a certain activity, ignoring the existence of other things [1]. On this basis, other scholars combined their own research backgrounds to make corresponding interpretations of flow experience. Hsu defined flow experience as an extremely pleasant experience that allows users to experience complete participation, enjoyment, control, and concentration, and satisfy inner interests when participating in video game activities [2]. Wang believed that flow experience is a state of mind. In this process, users will fully focus on what they are doing [3]. Zhang believed that people will have a high sense of excitement and fulfillment when they are in the state of flow [4]. Jin and Wang believed that flow experience refers to the ability of an individual to concentrate and devote oneself to the activity when participating in an activity, and obtain a high sense of satisfaction [5]. Chen put forward in the research on flow experience of mobile game players that when a thing attracts all the attention and people are fully engaged in it, this state of continuous focus, happiness, and enjoyment is flow experience [6]. Based on the characteristics of competitive games, this study believes that flow experience is a kind of mental state that makes people concentrate and feel happy, even forget the time and themselves.

2.1.2. *Dimensions of flow experience.* The research on the dimensions of flow experience also began with Csikszentmihalyi. He believed that the process of obtaining flow experience needs to meet several or all of the following elements, namely the nine dimensions (or influencing factors) of flow experience that are generally recognized, which are loss of self-consciousness, altered sense of time, sense of control, clear goals, timely feedback, balance between challenges and skill, integration of behavior and consciousness, focus, and purposeful experience [1]. In subsequent studies, on the basis of the research of Csikszentmihalyi, scholars use these nine elements as the dimensions (or influencing factors) of flow experience to construct research models to study the performance of flow experience in different fields.

Pace divided flow experience into seven dimensions in the research on flow experience of network users. They are 'joy of discovery and learning', 'reduced awareness of physical surroundings, usual concerns and other irrelevant factors', 'distorted sense of time', 'merging of action and awareness', 'sense of control', 'mental alertness' and 'telepresence' [7]. When exploring the video game players' flow experience, Hwang et al. believed that

flow experience of interactive video games includes five dimensions which are 'control', 'clear goals', 'balance between challenges and skill', 'rewards', and 'concentration' [8]. Assessing flow experience, Beylefeld and Struwig used four dimensions to measure flow experience which are 'transformation of time', 'loss of self-consciousness', 'sense of control' and 'receiving of ambiguous feedback' [9]. Li divided flow experience into five dimensions in the research on the user experience of online games, which are 'transformation of time', 'loss of self-consciousness', 'sense of control', 'action-consciousness merging' and 'concentration' [10]. This study focuses on the classification of dimensions of flow experience by Li. Based on her research and through expert interviews, our study uses 'altered sense of time', 'loss of self-consciousness' and 'sense of control' as the measurement dimensions of flow experience.

2.2. **Literature review on perceived value.**

2.2.1. *The concept of perceived value.* Zeithaml defined perceived value as the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given [11]. El-Adly believed that perceived value of customers in the hotel context is a multi-dimensional construct, which not only includes price, quality, and transaction (i.e., cognitive dimensions), but also includes such affective dimensions as self-gratification, aesthetics, prestige, and hedonic value [12]. Wang and Huang believed that perceived value is a consumer's perceived preference and comprehensive evaluation of a product or service based on the existing subjective impression of the product or service [13]. Therefore, this study thinks that perceived value is the value perceived from product or service when consumers consume.

2.2.2. *Dimensions of perceived value.* Hedonic value and utilitarian value are considered to be the two basic components of perceived value. Batra and Ahtola found in their research that consumers' perception on products is manifested in two dimensions which are hedonic value and utilitarian value [14]. On this basis, Crowley et al. also used the two dimensions of hedonic value and utilitarian value to measure consumer attitudes towards different types of products [15]. Babin and Darden analyzed perceived value of shopping experience from two perspectives, namely hedonic dimension and utilitarian dimension [16]. Dai divided perceived value into hedonic value and utilitarian value when studying the impact of online shopping service quality on satisfaction [17]. Jia also divided the perceived value into two dimensions of hedonic value and utilitarian value in the research on consumers' shopping intention [18]. In this study, we also divide perceived value into two dimensions for follow-up research, which are hedonic value and utilitarian value.

2.3. **Literature review on user stickiness.**

The term "stickiness" was mainly used in the field of economics in the early days. With the development of Internet technology, stickiness has attracted widespread attention from scholars in many fields, and the concept of stickiness has been defined from the two perspectives of websites and users.

2.3.1. *From the perspective of websites.* Early studies on stickiness were mostly based on the perspective of websites to define the concept of stickiness. Zott et al. believed that stickiness is the ability of a website to attract and retain customers from the perspective of the website [19]. Koh and Kim believed that stickiness of e-commerce sites is reflected in attracting Internet users and making them stay on the site so that they can purchase goods and services or view more advertisements [20].

2.3.2. *From the perspective of users.* With the in-depth study of online user behavior by researchers, the consumption behavior of online users can be better analyzed from the perspective of users. Li et al. studied user stickiness of consumers on a specific website based on the user's perspective. They believed that stickiness is the revisit and reuse of the user's preferred website, and continued visit and use even faced with conversion pressure or other factors [21]. After studying user stickiness of online games, in the study of Wu et al., the proactive stickiness to an online game is defined as "the players' willingness to return to and prolong their duration of each stay in the online game" [22]. Bao believed that user stickiness refers to the behavior of users which is forming a sense of loyalty and dependence after using and experiencing a certain product and service, and resulting in continuous use [23]. Wang et al. believed that user stickiness refers to a user's intention, psychological preference and emotional dependence on continuing to use a website. It is a psychological and behavioral change that occurs after users use or enjoy website services, and is specifically manifested as an increase in users' visit time and frequency [24].

This study starts from the user's point of view and combines the current research background, defines user stickiness as psychological dependence and repetitive experience behavior after game players experience the competitive games.

3. Research Hypotheses and Model Construction.

3.1. Research hypotheses.

3.1.1. *The impact of flow experience on perceived value.* In the exploration of flow experience, many scholars believed that flow experience as an advanced form of consumer experience is the influencing factor of perceived value. Wang et al. found that Internet users can obtain HV (hedonic value) and UV (utilitarian value) from flow experience [25]. Cui believed that consumer experience can increase consumers' perceived value [26]. Li found that consumer experience can positively affect consumers' perceived value when studying the shopping behavior of college students [27]. Zhu et al. believed that flow experience gained by the public in the process of obtaining information has a significant positive impact on HV and UV [28].

Therefore, this study believes that all dimensions of flow experience positively affect all dimensions of perceived value. In other words, AST (altered sense of time), LSC (loss of self-consciousness) and SC (sense of control) have impact on HV and UV. The following hypotheses are developed:

H1. AST has a significant positive impact on HV.
H2. AST has a significant positive impact on UV.
H3. LSC has a significant positive impact on HV.
H4. LSC has a significant positive impact on UV.
H5. SC has a significant positive impact on HV.
H6. SC has a significant positive impact on UV.

3.1.2. *The impact of flow experience on user stickiness.* Many studies have found that flow experience has a significant positive impact on user stickiness. For example, Sui believed that flow experience of Internet users will influence user stickiness [29]. From the study of Zhao et al. on the stickiness behavior of Internet users, they found that flow experience has a significant positive impact on the users' intention of continuous use [30]. Barchino et al. asserted that the event (the MobiGame contest) will probably have a long life because participation, motivation and enthusiasm are guaranteed [31]. Xiong and Wang studied the influence of mobile social users' flow experience on user stickiness and found that the mobile social users' flow experience significantly and positively affects

user stickiness [32]. Duan et al. analyzed and proved the positive relationship between flow experience and user stickiness based on the game industry [33]. Hsu et al. confirmed flow experience has a significant moderating effect on the link between trusting beliefs and website loyalty in a gamification context [34]. In the research on VR game flow experience, Hao collated relevant literature and found that flow experience affects players' intention to play games and the tendency to play games later [35].

Therefore, this study believes that all dimensions of flow experience positively affect US (user stickiness), the following hypotheses are developed:

H7. AST has a significant positive impact on US.

H8. LSC has a significant positive impact on US.

H9. SC has a significant positive impact on US.

3.1.3. *The impact of perceived value on user stickiness.* Perceived value (including hedonic value and utilitarian value) significantly affecting customer satisfaction has been recognized by many scholars. Moreover, hedonic value and utilitarian value can positively affect consumer satisfaction, loyalty and repurchase intention, which has been verified by many scholars. Yang et al. found that perceived value has a significant impact on consumers' purchase intentions and behavior of repurchase [36]. Kesari and Atulkar verified that hedonic value and utilitarian value have a significant positive impact on customer satisfaction in their research on shopper satisfaction with shopping centers [37]. Dai divided perceived value into hedonic value and utilitarian value in her research, and verified that they positively affect customer satisfaction [17].

Therefore, this study believes that all dimensions of perceived value (HV & UV) positively affect user stickiness (US), the following hypotheses are developed:

H10. HV has a significant positive impact on US.

H11. UV has a significant positive impact on US.

3.2. **The theoretical model.** On the basis of the above research hypotheses, this study constructs a theoretical model of the impact of flow experience on perceived value and user stickiness. This model is shown in Figure 1.

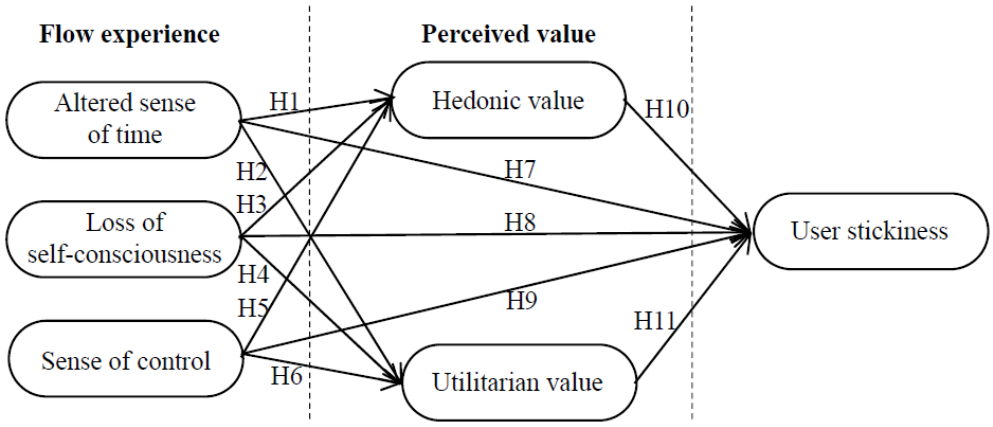


FIGURE 1. The theoretical model

4. **Data Analysis.** Pre-survey is needed to check whether the measurement scales are reliable before conducting the formal survey. We interviewed three experts first, and then designed a pre-survey questionnaire based on the interview and the measurement scales of other scholars such as Csikszentmihalyi [1] and Beylefeld and Struwig [9]. A total of 316 pre-survey questionnaires were distributed online and offline, of which 301 questionnaires

were valid, with an effective questionnaire rate of 95.25%. According to the Likert 5-Level Scale, 'very dissatisfied', 'dissatisfied', 'ordinary', 'satisfied', and 'very satisfied' are assigned a value of 1-5 in turn. After reliability analysis, exploratory factor analysis and confirmatory factor analysis, the unqualified items are eliminated. The remaining items constitute the measurement scales for the formal survey. The following content is the data analysis process of the formal survey.

4.1. **Descriptive statistical analysis.**

4.1.1. *Descriptive statistical analysis of the samples.* In the formal survey, the samples are mainly from online competitive game players, which were distributed and collected through paper questionnaires, questionnaire web links and questionnaire QR codes. A total of 530 questionnaires were distributed, of which 507 questionnaires were valid, and the effective questionnaire rate was 95.66%. The age of respondents was mainly concentrated in the range of 20 to 30 years old, and was dominated by students, accounting for 55.6% of the total samples. Among them, male respondents accounted for 54.6% and female respondents accounted for 45.4%. 60.5% of the respondents in these samples had a bachelor degree, and their income or monthly consumption levels were mostly concentrated in the range of CNY 1,000 to 3,000, accounting for 42% of the total samples. According to relevant statistics [38], the ages of competitive game players are concentrated in 19-22 years old, accounting for 39.7%, 11.4% of users are between 23 and 25 years old. Among competitive game players in China, male players account for 64% and female players account for 36%. The proportion of female user groups will continue to show an upward trend in the next few years. University undergraduate players are the main group of competitive game players in China. 43.5% of users' personal monthly consumption is CNY 1,000 to 3,000. In short, the respondents belong to the main player group in the game industry and these samples have a good representation.

4.1.2. *Descriptive statistical analysis of the variables.* As shown in Table 1, we encode items according to variable names (such as AST1, and AST2), and then find the mean value and standard deviation of each item.

From the analysis results in Table 1, it can be seen that the mean values of all items are between 3.40 and 4.02 and the values of standard deviation are between 0.780 and 1.100, which are higher than standard value of 0.5. Therefore, the questionnaire is considered to be good.

4.2. **Reliability and validity analysis.**

4.2.1. *Reliability analysis.* The analysis results in Table 2 show that the value of Cronbach's α of each variable is between 0.680 and 0.813, which is higher than 0.6. Although the CITC values of AST1, AST2, SC1, and SC2 items are lower than 0.5, deleting these items will reduce the values of Cronbach's α, so they are retained. The CITC values of other items are between 0.513 and 0.682, which are higher than the standard value of 0.5. In summary, the reliability of the research variables is considered to be good.

4.2.2. *Exploratory factor analysis.* The analysis results in Table 3 show that the KMO (Kaiser-Meyer-Olkin) value is 0.873 with a significance probability of 0.000. The cumulative variance explanation rate is 60.195%, and the factor loading values are between 0.572 and 0.841, which are all greater than the standard value of 0.5, and there is no cross-loading. The overall Cronbach's α value of the scale is 0.842. Therefore, the reliability is considered to be good.

The analysis results in Table 4 show that the KMO value is 0.861 and the significance probability is 0.000. The cumulative variance explanation rate is 65.038%, these factor

TABLE 1. The mean and standard deviation of each measurement item

Research variable	Items coding	Mean	Standard deviation
AST (Altered sense of time)	AST1: When I play the game, I forget my troubles.	3.82	0.780
	AST2: When I play the game, it seems that time flies quickly.	3.87	0.808
	AST3: I forget the flow of time during the game.	3.93	0.894
	AST4: I am totally immersed in the game, ignoring that the time changes.	3.63	0.916
LSC (Loss of self-consciousness)	LSC1: I enjoy the game and forget myself.	3.40	1.100
	LSC2: Playing the game can arouse my curiosity.	3.64	1.073
	LSC3: I seem to blend in with the characters in the game.	3.54	1.094
	LSC4: I think I have a sense of control and influence over the game world.	3.41	0.977
SC (Sense of control)	SC1: I can control my role, activities and interactions in the game.	3.65	0.942
	SC2: I can play the game freely according to my own methods and strategies.	3.77	0.832
	SC3: When I play the game, I feel everything is under my control.	3.55	0.975
HV (Hedonic value)	HV1: In the game, I feel very relaxed.	3.82	0.852
	HV2: In the game, I feel completely relaxed mentally.	3.66	0.918
	HV3: I really enjoy the process of playing the game.	4.02	0.838
	HV4: I feel endless fun in the game.	3.91	0.853
	HV5: Playing the game can meet my needs (relaxation, making friends, etc.).	3.73	0.841
UV (Utilitarian value)	UV1: The game is a necessity in life for me.	3.50	1.028
	UV2: By playing the game, I become more confident.	3.62	0.993
US (User stickiness)	US1: Overall, the game experience is successful.	3.91	0.835
	US2: Overall, it is worth spending some time on the game.	3.62	0.845
	US3: I often play games in my spare time.	3.72	1.025
	US4: I will maintain or even extend the time playing games.	3.51	1.043
	US5: Overall, I am satisfied with the game experience.	3.82	0.829
	US6: I will enjoy playing such games for a long time in the future.	3.71	0.868

Table 2. Reliability analysis results of research variables

Research variable	Items coding	CITC (Corrected item-total correlation)	Cronbach's α after deleting this item	Cronbach's α
AST	AST1	0.430	0.705	0.722
	AST2	0.494	0.670	
	AST3	0.596	0.606	
	AST4	0.528	0.651	
LSC	LSC1	0.575	0.727	0.777
	LSC2	0.559	0.735	
	LSC3	0.657	0.682	
	LSC4	0.536	0.746	
SC	SC1	0.468	0.620	0.680
	SC2	0.495	0.590	
	SC3	0.524	0.545	
HV	HV1	0.603	0.776	0.813
	HV2	0.609	0.775	
	HV3	0.629	0.769	
	HV4	0.659	0.760	
	HV5	0.513	0.802	
UV	UV1	0.584		0.737
	UV2	0.584		
US	US1	0.549	0.785	0.810
	US2	0.550	0.785	
	US3	0.682	0.753	
	US4	0.585	0.778	
	US5	0.550	0.785	
	US6	0.514	0.792	

Table 3. Exploratory factor analysis results of flow experience

Research variable	Items coding	Factor loading		
		1	2	3
AST	AST1	0.134	**0.572**	0.337
	AST2	−0.027	**0.798**	0.077
	AST3	0.274	**0.749**	0.113
	AST4	0.402	**0.645**	0.042
LSC	LSC1	**0.741**	0.359	0.034
	LSC2	**0.683**	0.179	0.202
	LSC3	**0.790**	0.093	0.249
	LSC4	**0.603**	0.056	0.428
SC	SC1	0.320	0.108	**0.633**
	SC2	0.018	0.136	**0.841**
	SC3	0.369	0.161	**0.653**
Initial eigenvalues		4.273	1.346	1.002
% of extraction variance		38.848	12.240	9.108
% of rotation variance		22.691	19.716	17.788
Number of items		4	4	3
Cronbach's α		0.722	0.777	0.680

TABLE 4. Exploratory factor analysis results of perceived value

Research variable	Items coding	Factor loading	
		1	2
HV	HV1	**0.836**	0.029
	HV2	**0.771**	0.165
	HV3	**0.654**	0.417
	HV4	**0.639**	0.499
	HV5	**0.604**	0.289
UV	UV1	0.146	**0.876**
	UV2	0.232	**0.825**
Initial eigenvalues		3.549	1.004
% of extraction variance		52.702	14.336
% of rotation variance		36.701	28.337
Number of items		5	2
Cronbach's α		0.813	0.737

TABLE 5. Mean and standard deviation of sub-indicators

Research variable	Sub-indicator	Including items	Mean	Standard deviation
AST	ASTa	AST1, AST2	3.84	0.654
	ASTb	AST3, AST4	3.78	0.792
LSC	LSCa	LSC1, LSC2	3.52	0.931
	LSCb	LSC3, LSC4	3.48	0.906
SC	SCa	SC1	3.65	0.942
	SCb	SC2, SC3	3.66	0.771
HV	HVa	HV1, HV2	3.74	0.765
	HVb	HV3, HV4, HV5	3.89	0.683
UV	UVa	UV1	3.50	1.028
	UVb	UV2	3.62	0.993
US	USa	US1, US2, US3	3.75	0.722
	USb	US4, US5, US6	3.68	0.704

loading values are between 0.604 and 0.876, which are all higher than the standard value of 0.5, and there is no cross-loading. The overall Cronbach's α value of the scale is 0.833. Therefore, the reliability is considered to be good.

4.2.3. *Confirmatory factor analysis.* Each research variable contains several items. This study draws on the data processing method used by many scholars, which combines the items of each research variable into fewer sub-indicators according to the mean values. The revised sub-indicators are generally the two sub-indicators [39].

It can be seen from Table 5 that the average value of all items is between 3.48 and 3.89, indicating that the items are recognized by the surveyed. The values of standard deviation are between 0.654 and 1.028, which are higher than the standard value of 0.5. In summary, the research variables are suitable for modeling analysis.

4.2.3.1. *The degree of fit between the data and the model.* Combining the analysis results in Figure 2 and Table 6, it can be seen that the factor loading values are between 0.63 and 0.93, which are greater than the standard values of 0.6. The fit index standard in

this study refers to the research of Hair et al. [40]. All fit indices meet the standard value, indicating that the data and the model fit well.

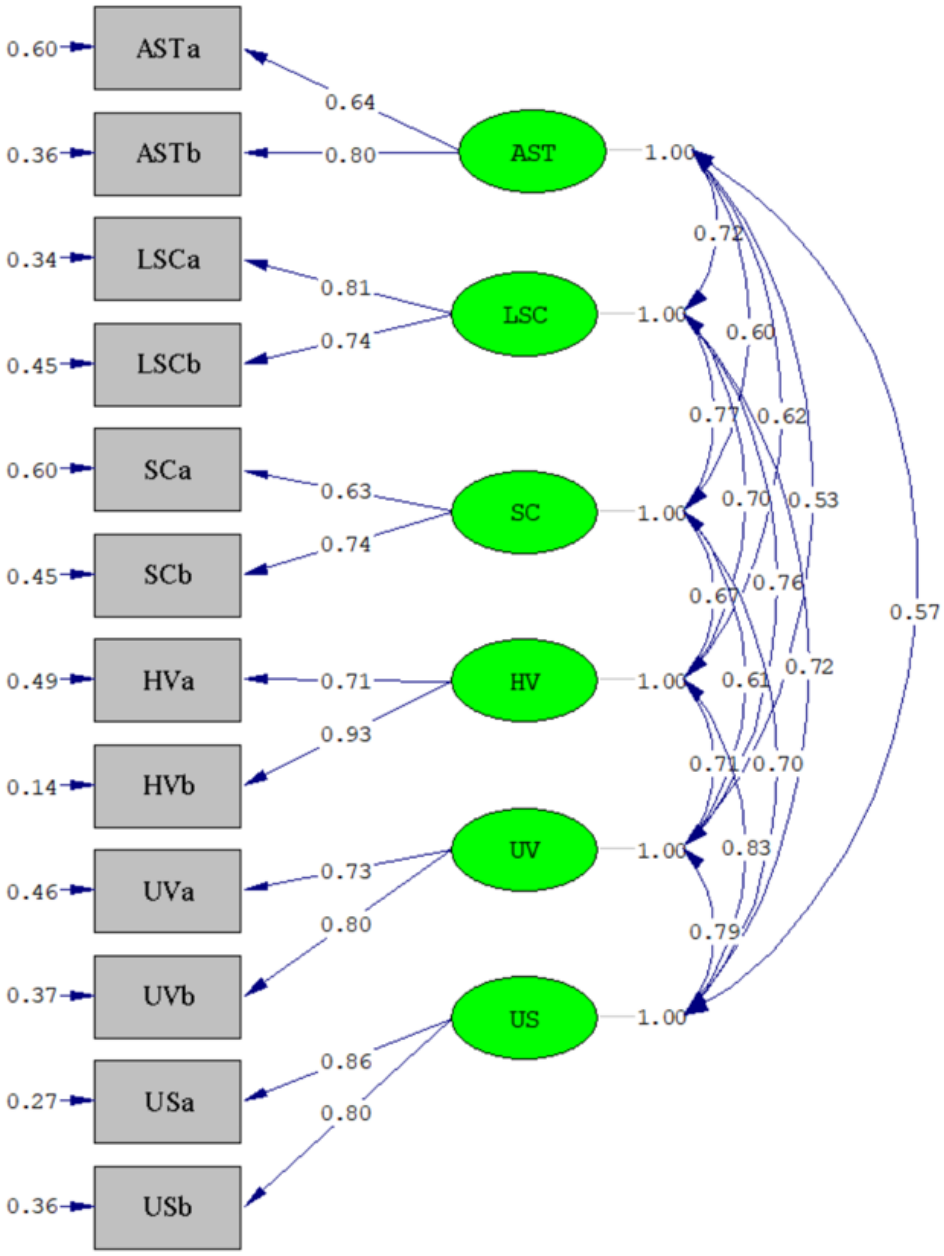


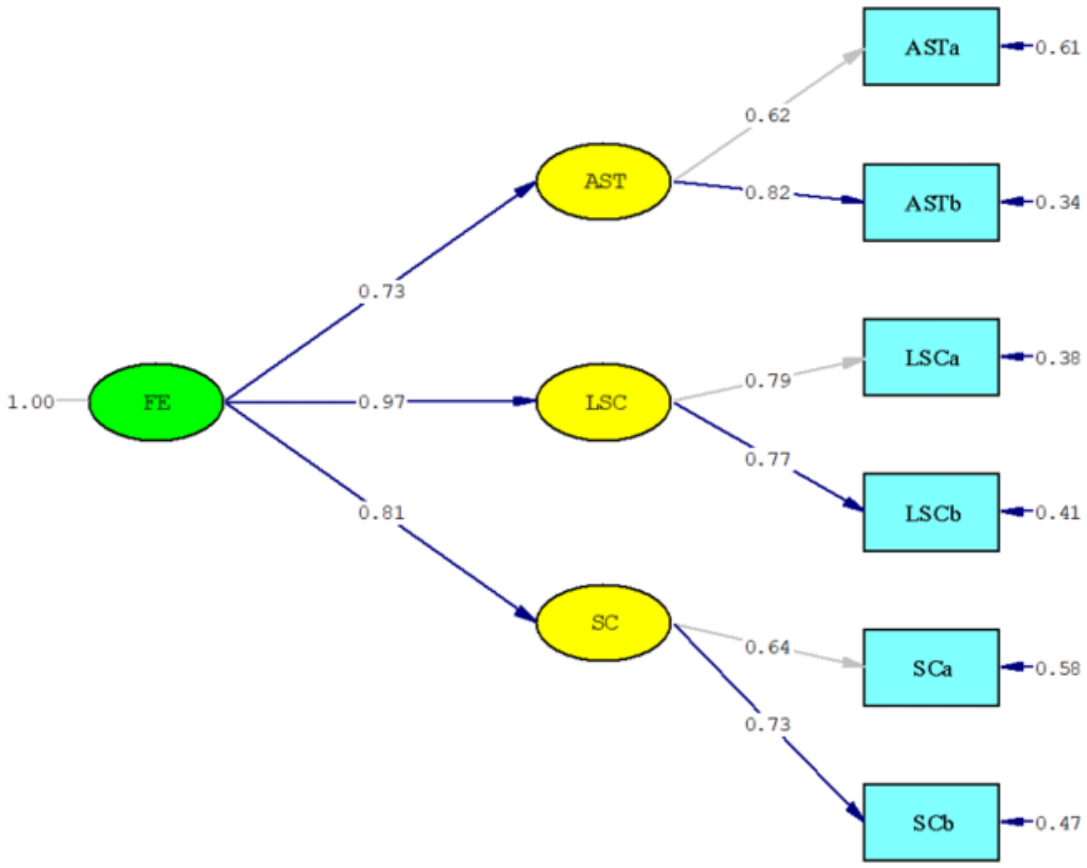
FIGURE 2. Confirmatory factor analysis results of research variables

TABLE 6. Model fit index of research variables' confirmatory factor analysis

Index	χ^2/df	GFI	AGFI	IFI	CFI	NFI	RMSEA	RMR	NNFI	RFI
Value	2.54	0.97	0.94	0.99	0.99	0.98	0.055	0.023	0.98	0.97
Standard	< 5	> 0.9	> 0.9	> 0.9	> 0.9	> 0.9	< 0.08	< 0.05	> 0.9	> 0.9

Notes: GFI, Goodness of Fit Index; AGFI, Adjusted Goodness of Fit Index; IFI, Incremental Fit Index; CFI, Comparative Fit Index; NFI, Normed Fit Index; RMSEA, Root Mean Square Error of Approximation; RMR, Root Mean square Residual; NNFI, Non-Normed Fit Index; RFI, Relative Fit Index.

According to the analysis results in Figure 3 and Table 7, it can be seen that the standardized factor loading values between the second-order factor and the first-order factor are 0.73 to 0.97, which are greater than the standard value of 0.7. The rest of the standardized factor loading values are between 0.62 and 0.82, which are greater than the standard value of 0.6. And all fit indices almost reach the standard (except RMSEA which is slightly higher than 0.08), indicating that the model has a great degree of fit. It can be seen that AST, LSC and SC can be used as the dimensions of flow experience.



Note: FE, Flow experience.

FIGURE 3. The results of second-order confirmatory factor analysis of flow experience

TABLE 7. Model fit index of second-order confirmatory factor analysis of flow experience

Index	χ^2**/df**	**GFI**	**AGFI**	**IFI**	**CFI**	**NFI**	**RMSEA**	**RMR**	**NNFI**	**RFI**
Value	4.71	0.98	0.94	0.98	0.98	0.98	0.086	0.022	0.96	0.94
Standard	< 5	> 0.9	> 0.9	> 0.9	> 0.9	> 0.9	< 0.08	< 0.05	> 0.9	> 0.9

4.2.3.2. *Convergent validity analysis.* Convergent validity analysis measures the correlation between research variables and all the items. It is mainly tested by the two indicators of standardized factor loading and average variance extraction (AVE). The specific analysis results are as in Table 8.

The analysis results in Table 8 show that the standardized factor loading values of the items are all between 0.63 and 0.93, which is greater than the standard value of 0.6.

Table 8. Convergent validity analysis results

Research variable	Coding	Standardized factor loading	T-value	Standardized error	Composite reliability	AVE
AST	ASTa	0.64	13.59	0.654	0.686	0.525
	ASTb	0.80	16.59	0.792		
LSC	LSCa	0.81	19.97	0.931	0.751	0.602
	LSCb	0.74	17.85	0.906		
SC	SCa	0.63	13.62	0.942	0.640	0.472
	SCb	0.74	15.61	0.771		
HV	HVa	0.71	17.48	0.765	0.810	0.685
	HVb	0.93	24.45	0.679		
UV	UVa	0.73	17.31	1.028	0.739	0.587
	UVb	0.80	18.89	0.993		
US	USa	0.86	22.43	0.721	0.816	0.690
	USb	0.80	20.48	0.702		

Table 9. Discriminant validity analysis results

Research variable	AST	LSC	SC	HV	UV	US
AST	0.725					
LSC	0.507	0.776				
SC	0.396	0.545	0.687			
HV	0.502	0.556	0.489	0.828		
UV	0.386	0.555	0.392	0.509	0.766	
US	0.427	0.571	0.502	0.657	0.614	0.831

The AVE of each research variable is between 0.472 and 0.690, which is basically higher than the standard value of 0.5. It can be seen that convergent validity of the variables is qualified.

4.2.3.3. *Discriminant validity analysis.* The analysis results in Table 9 show that the values on the diagonal are the square root of each AVE, and the others are the correlation coefficients. The square roots of each AVE are higher than the correlation coefficient. Therefore, convergent validity of the research variables is better.

4.3. **Hypothesis testing and modeling analysis.** In this study, LISREL 8.70 is used to analyze the structural equation model to test whether the three dimensions of flow experience, namely AST, LSC and SC can affect HV, UV and US.

As shown in Figure 4, some standardized path coefficients are less than 0, so the path coefficients with T-values less than 1.96 are deleted in order from small to large, and the final model is obtained, as shown in Figure 5.

From the analysis in Figure 5 and Table 10, it can be seen that the standardized path coefficients are all greater than 0, and all fit indices reach the standard, and the model fits well. The following results are obtained that AST has a significant positive impact on HV; LSC has a significant positive impact on HV and UV; SC has a significant positive impact on HV; HV and UV have a significant positive impact on US. Therefore, the hypotheses of H1, H3, H4, H5, H10, and H11 are supported.

In summary, the hypotheses proposed in this study have been tested, and the testing results are shown in Table 11.

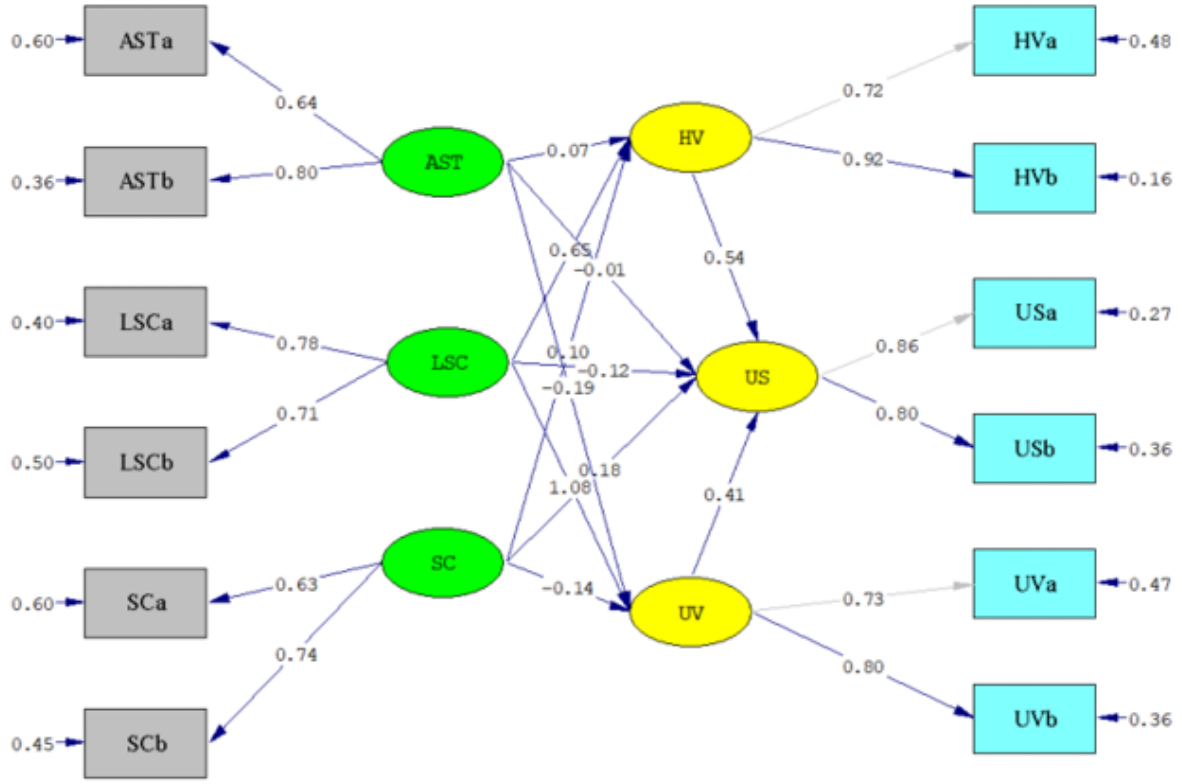


FIGURE 4. The initial results of structural equation modeling analysis

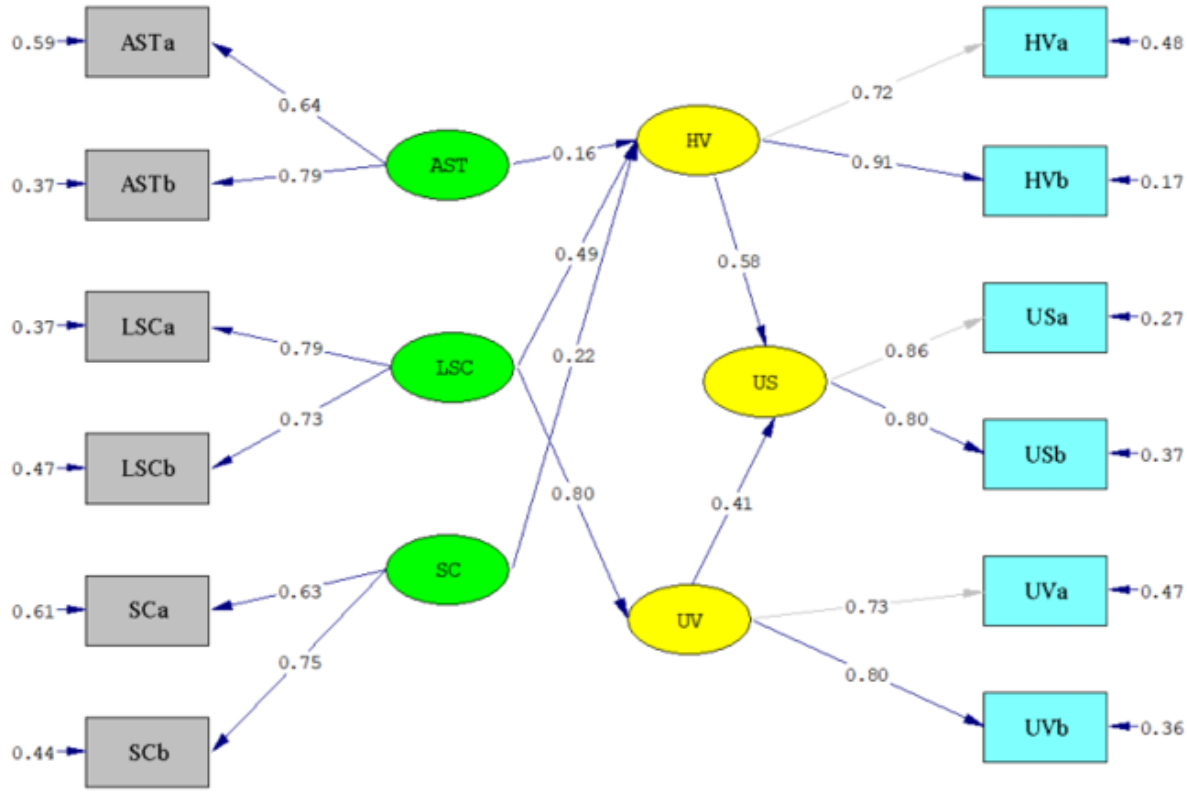


FIGURE 5. The final result of structural equation modeling analysis

TABLE 10. Model fit index of structural equation modeling analysis

Index	χ^2**/df**	**GFI**	**AGFI**	**IFI**	**CFI**	**NFI**	**RMSEA**	**RMR**	**NNFI**	**RFI**
Value	2.82	0.96	0.93	0.99	0.99	0.98	0.060	0.025	0.98	0.97
Standard	< 5	> 0.9	> 0.9	> 0.9	> 0.9	> 0.9	< 0.08	< 0.05	> 0.9	> 0.9

TABLE 11. Testing results of research hypotheses

Research hypothesis	**Testing result**
H1. Altered sense of time has a significant positive impact on hedonic value.	Supported
H2. Altered sense of time has a significant positive impact on utilitarian value.	Unsupported
H3. Loss of self-consciousness has a significant positive impact on hedonic value.	Supported
H4. Loss of self-consciousness has a significant positive impact on utilitarian value.	Supported
H5. Sense of control has a significant positive impact on hedonic value.	Supported
H6. Sense of control has a significant positive impact on utilitarian value.	Unsupported
H7. Altered sense of time has a significant positive impact on user stickiness.	Unsupported
H8. Loss of self-consciousness has a significant positive impact on user stickiness.	Unsupported
H9. Sense of control has a significant positive impact on user stickiness.	Unsupported
H10. Hedonic value has a significant positive impact on user stickiness.	Supported
H11. Utilitarian value has a significant positive impact on user stickiness.	Supported

4.4. **Discussion.** The verification of the above research hypotheses may provide effective measures for the development of the game industry. The first thing is focusing on the role of hedonic value. Hedonic value plays a bridge role in the relationship between flow experience and user stickiness. In other words, whether players perceive hedonic value in game products is the key to user stickiness. Second, the role of utilitarian value cannot be ignored. Compared with hedonic value, the performance of utilitarian value in game products is relatively weak. Only when the player feels 'loss of self-consciousness', can it be possible to perceive utilitarian value in the game. However, the positive effect of utilitarian value on user stickiness proves that utilitarian value should also be paid more attention. The third thing is to guide players to gain flow experience. When players continue to gain flow experience in the games, and perceive hedonic value and utilitarian value, it will increase the players' user stickiness and promote the vigorous development of the game industry.

5. Conclusions.

5.1. **Research findings.** In this study, SPSS 26.0 is used to test the reliability and validity of six research variables which are altered sense of time, loss of self-consciousness,

sense of control, hedonic value, utilitarian value and user stickiness. The testing results meet the research standards. In order to ensure the diversification of data analysis, this study then uses LISREL 8.70 to conduct the structural equation modeling analysis and the following research results are found. First, in the relationship between flow experience and perceived value, altered sense of time has a significant positive impact on hedonic value, but there is no significant positive impact on utilitarian value; loss of self-consciousness has a significant positive impact on hedonic value and utilitarian value; sense of control has a significant positive impact on hedonic value, and has no significant positive impact on utilitarian value. Second, in the relationship between flow experience and user stickiness, 'altered sense of time', 'loss of self-consciousness', and 'sense of control' have no direct influence on user stickiness. Third, in the relationship between perceived value and user stickiness, both hedonic value and utilitarian value have a significant positive impact on user stickiness.

To sum up, players' flow experience of the competitive games must perceive hedonic value and utilitarian value in order to increase their user stickiness.

5.2. **Research limitations.** This study takes the game industry as the research background. Considering that each industry has its own characteristics, the result of this research may not be applicable to other industries. It requires further research to test whether these findings apply to other industries. In the future, we can study how flow experience affects perceived value and user stickiness in other industries.

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