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A Flow Theory Perspective on Learner Motivation and Behavior in Distance Education

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Motivating learners to continue to study and enjoy learning is one of the critical factors in distance education. Flow theory is a useful framework for studying the individual experience of learning through using computers. In this study, I examine students' emotional and cognitive responses to distance learning systems by constructing two models to test the students' flow states. The first model examines the cause and effect of the flow experience when students use distance learning systems. The second model considers the impact of three types of interaction on the flow experience. A questionnaire-based field survey is used to test the two models. Data from 253 distance learning students are examined under each of the two models. The results from Model 1 indicate that flow theory works well in a distance learning environment. The results from Model 2 point out that learner–instructor and learner–interface have a positive relationship with flow experience, whereas learner–learner interaction has not shown a significant relationship with flow experience.

Introduction

Distance education can deliver well-designed content and materials to learning groups through computer technologies and communication media. Now, due to the rapid development of computer technologies, this learning type has changed from the low interaction of printed correspondence to the high interaction of the Internet (Moore & Kearsley, 1996).

Prior research has shown that flow theory is a useful construct to understand the impact of user cognition on computer-mediated technologies (Webster & Martocchio, 1992). Csikszentmihalyi (1975) proposed flow theory as a way of understanding motivation. Flow theory has subsequently been applied in many other fields including sports, leisure, etc. Initially, researchers employed flow theory to explain the optimal

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state of athletes. But these days, more researchers study users' flow experience in human–computer interaction.

Flow theory, as first proposed by Csikszentmihalyi in 1975, considers flow as a psychological state describing the optimal feeling of people who are cognitively efficient, motivated, and happy (Csikszentmihalyi, 1990). Flow is a complex construct which attempts to integrate motivation, personality, and subjective experience.

This study applies flow theory in the distance learning environment. It constructs two models to explain the phenomenon of flow state and further verifies the conclusions by empirical investigation. The objectives of this study are to: (a) establish empirical models to test the theoretical construct of flow in the distance learning environment; (b) discuss the impact of interaction types on flow construct. The results of this study are of significance for both system designers and educators.

Both of the models proposed are based on a questionnaire survey. The first model is made to verify flow theory applied in a distance learning environment. The second model is for discussing the effect of interaction types on flow experience.

This article is organized into eight sections. Following this introduction there is a literature review of flow theory. Then, we describe the first model and formulate the proposed hypotheses for testing. In Section 4, we present the analysis and findings from the field survey for Model 1. In Section 5, we discuss the significance of the findings and implications. In Section 6, we elaborate on the distinctions of interaction types in a distance learning environment; and, based on the literature of interaction types, we develop and further formulate the second model. In Section 7, we describe the analysis and findings for Model 2. Finally, we conclude with a discussion of this article's contributions and suggestions for future research.

Literature Review

Csikszentmihalyi (1975) proposed flow theory to better understand motivation. Due to lack of study on how to motivate students through tools usage, many instructional designers believed that good quality systems alone can motivate students (Chan & Ahern, 1999). This study applies flow theory in the distance learning environment. Herein, the functions and operations of distance learning systems are more complicated than those of traditional computer technologies such as Web or email systems. This is because distance learning education requires a great deal of interaction between learners, teachers, and systems.

In recent years, many researchers have applied flow theory in computer-mediated technology (Chen, Wigand, & Nilan, 1999; Ghani & Deshpande, 1994; Koufaris, 2002; Novak, Hoffman, & Yung, 1998; Trevino & Webster, 1992; Webster, Trevino, & Ryan, 1993). As an example, Webster et al. (1993) used flow theory to explain the experience of subjective human and computer-mediated communication (CMC) technology interaction. They considered that such interaction is a playful and exploratory experience. Later, Novak et al. (1998) applied flow theory to comprehend customer navigation behavior in online environments such as the World Wide Web.

Flow Theory

Flow is an intrinsic motivation. Motivation itself is often divided into two broad classes: "extrinsic motivation" and "intrinsic motivation." Extrinsic motivation refers to engaging in an activity because of its outcomes, such as job performance, pay, or promotion. Intrinsic motivation refers to engaging in an activity without receiving any apparent reinforcement, such as simply for enjoyment (Davis, Bagozzi, & Warshaw, 1992). However, self-motivated learning is considered the best way to learn (Ghani & Deshpande, 1994). When students are intrinsically motivated to learn, they not only want to learn more, but also achieve more positive results (Chan & Ahern, 1999).

Flow was originally defined by Csikszentmihalyi (1990) as "the state in which people are so intensely involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it." The subjective experience is a function of two variables: the perceived challenges and the perceived skills. People experience anxiety when their perceived challenges are greater than their skills; they feel bored when their perceived skills are greater than the challenges they face; and they are apathetic when both perceived skills and challenges are low. In contrast, people experience flow when their perceived skills and challenges are both high.

Skill and challenge are the most important variables in flow theory. However, flow is more complicated than these two variables. Csikszentmihalyi constructs flow into nine dimensions: sensing that one's skills are balanced to the challenges, merging action and awareness, engaging clear goals, directing unambiguous feedback, concentrating on the task at hand, feeling in control, loss of self-consciousness, transforming of time, and having an autotelic experience (Jackson & Marsh, 1996).

Trevino and Webster (1992) studied the interactive experience between subjective human and CMC technologies of electronic mail and voice mail which involve the user's interaction with the technology. They defined the core flow experience while interacting with CMC technology. The four characteristics of core flow experience are: feeling in control, focusing attention on the activity, feeling curiosity, and having intrinsic interest. They evaluated the impacts of flow on communication-related work outcomes and found that flow can result in positive attitudes and high effectiveness.

Novak et al. (1998) defined flow as the states of feeling a seamless sequence of responses with machine interactivity, perceiving intrinsic enjoyment, loss of self-consciousness, and sensing self-reinforcing during network navigation. They structure flow experience to investigate the behavior of the consumer's navigation on the Web. This structure includes core experience of flow; close correlation of flow such as playfulness; antecedents of flow such as skill, challenge, interactivity, focus attention, arousal, and telepresence; and consequences of flow such as positive affect, exploratory behavior, and control.

Ghani and Deshpande (1994) studied individual's experiences of using computers in the workplace with reference to job characteristics and optimal flow theory. They defined two key characteristics of flow: concentration in an activity and the enjoyment. Their results show that both concentration and enjoyment were associated with flow, and that flow itself is linked with the behavior of exploratory use.

Chan and Ahern (1999) applied flow theory in instructional design. While the goal of instruction was to help students acquire knowledge or skills; thus motivating students to learn is important in instructional design practice. Students should be happy to learn, and gain attention and learning orientation before they start learning. Nonetheless, when people are intrinsically motivated to learn, they will have a positive attitude and willingness to learn.

Research Model

Motivating learners to continue study and enjoy learning is one of the critical factors to success in distance education. Our first model is constructed to understand the learner flow experience. In the first model, the variables of perceived skill, perceived challenge, perceived control, and perceived interactivity are structured as the flow antecedents. Skill and challenge are the most important factors in flow theory. In a distance learning environment, learners need to operate a complex system, so the feeling of control and the degree of interactivity are important. For the purpose of this study, we want to evaluate the extent of intention to learn, the exploratory use of the system, and the degree of time distortion (Liao, 2004). Figure 1 illustrates the framework.

In this study the core latent construct is the flow experience. The antecedent latent constructs are the perceived skill, perceived challenge, perceived control, and perceived interactivity. The consequences of core latent constructs are the intention to use, exploratory use, and time distortion.

Flow Experience

Flow is a state of feeling, where external factors do not seem to matter. Flow theory is a useful framework for studying an individual's experience of learning and using

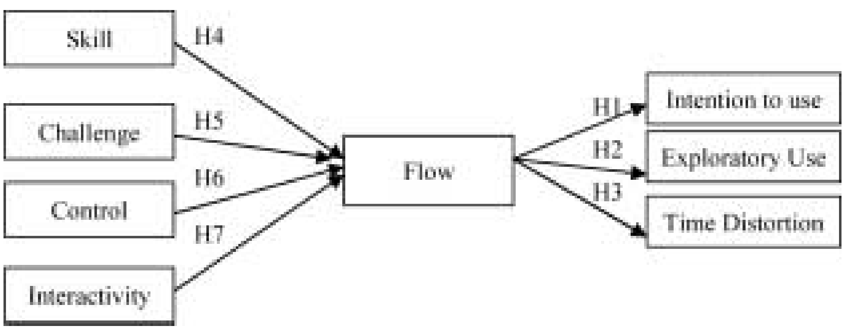

Figure 1. Flow experience in distance learning environment

computers (Ghani & Deshpande, 1994). Self-motivated learning is one of the best ways to learn, and the flow state is an intrinsic motivation which can stimulate users to do an activity with inner joy.

The core flow experience in this study is adopted from the definition of Ghani and Deshpande (1994), in which flow experience has two key characteristics: total concentration in an activity and the enjoyment of engaging in an activity. Here, concentration means the degree to which a student's attention focuses on an involving activity (Trevino & Webster, 1992). Enjoyment is here defined as the extent of computer usage being perceived as enjoyable, regardless of the consequences that may come out (Davis et al., 1992). Items for this test are adopted from Ghani and Deshpande (1994).

After people sense flow they would have common experiences. Studies of human–computer interaction indicate that common experiences include the expectation of use, positive affect, exploratory use, and time distortion (Chen et al., 1999; Ghani & Deshpande, 1994; Novak, Hoffman, & Yung, 2000; Webster et al., 1993).

Intention to use refers to Fishbein and Ajzen's (1975) definition of behavioral intention. It is the subjective probability of the individual's intention to do an activity. In this study, intention to use is defined as a student's subjective probability of participating in a distance learning course. Exploratory use means the degree of a student's exploration in the new functions of a system. Perceived time distortion indicates the degree to which a student loses the sense of time during a learning activity (Csikszentmihalyi, 1990). As shown below, the first three hypotheses are:

H1: Flow experience is positively related to intention to use.
H2: Flow experience is positively related to exploratory use.
H3: Flow experience is positively related to perceived time distortion.

Perceived Skills

Perceived skills are defined as an individual's own judgment of their capabilities for using a computer. This definition is similar to computer self-efficacy (Compeau & Higgins, 1995). In this study, perceived skills are defined as a student's subjective judgment of their own capability to use a distance learning system. The level of an individual's skills is one of the most important antecedents of flow (Csikszentmihalyi, 1990; Ghani & Deshpande, 1994; Koufaris, 2002; Novak et al., 1998, 2000; Trevino & Webster, 1992; Webster et al., 1993). The test items, which are adopted from Novak et al. (1998), are measured with a seven-item scale. Therefore, the fourth hypothesis is:

H4: Perceived skill is positively related to flow experience.

Perceived Challenge

Perceived challenge is defined as the level of challenge which a student perceives when manipulating a distance learning system. Like perceived skills, perceived challenge is one of the most important antecedents of flow (Csikszentmihalyi, 1990; Ghani & Deshpande, 1994; Koufaris, 2002; Novak et al., 1998, 2000; Trevino & Webster, 1992; Webster et al., 1993). Much research in human–computer interaction found that a positive challenge can affect individual response to the flow experience. The operation of distance learning systems is more difficult than Web navigation, email transmission, or voice mail systems. It is necessary for students to operate system functions good enough to achieve educational goals. Therefore, positive challenges are an important factor for students using a distance learning system. Thus, the fifth hypothesis is:

H5: Perceived challenge is positively related to a user's flow experience.

Perceived Control

Perceived control is defined as the level of one's control over the environment and one's own actions (Koufaris, 2002; Trevino & Webster, 1992). In this current research, perceived control is defined as the level of a student's control over a distance learning system. Perceived control was put in different positions in flow structure in prior research. For example, Novak et al. (1998) classified perceived control as the consequences of flow, Trevino and Webster (1992) considered perceived control to be one of the core flow constructs, and Ghani and Deshpande (1994) studied perceived control as an antecedent of flow.

Ghani and Deshpande (1994) defined perceived control as one of the factors affecting the experience of flow. There are many other studies which claim that one of the reasons why people enjoy playing computer games is the powerful sense of control. For students who learn in a distance learning system, the environment is quiet different from the traditional face-to-face classroom, and students demand more control over the system. So in our current study, perceived control is considered as one of the determinants of the flow experience in a distance learning environment. Test items are adopted from Ghani and Deshpande (1994). The sixth hypothesis is:

H6: Perceived control is positively related to flow experience.

Perceived Interactivity

Interactivity is an important factor in human–computer interaction. Trevino and Webster (1992) described the interaction between human and computer and explained such interaction as being an experience of enjoyment and exploration. Novak et al. (1998) considered that interactivity in Web navigation can be made by three dimensions, namely, speed, mapping, and range. Mapping of interaction indicates a perceived natural and intuitive interaction. Speed and range of interaction refers to the number of possible actions in a given time. Thus, the seventh hypothesis is:

H7: Perceived interactivity is positively related to flow experience.

Research Methodology

To test nomological models, a field survey was conducted. Subjects were tested in face-to-face meetings of a distance learning program. Data gathered from the survey were examined by structural equation model (SEM) for Model 1, and regression analysis for Model 2. The unit of analysis was the individual student. The survey items for Model 1 and Model 2 were both incorporated into the same questionnaire.

Data Collection

The survey items were developed and adopted by the existing measures. The instrument was then reviewed and revised by two MIS professors to enhance the face and content validity (Nunnally, 1978). To avoid misunderstanding the meaning of the instrument, 3 experienced distance learning students were pre-tested, and 23 graduate students in the Department of Computer Science and Information Engineering at the National Central University were pilot-tested. The survey questions are listed in Appendix B.

For the main survey of this study, we selected the research context from the National Chengchi University and the National Chiao-Tung University in Taiwan. Subjects were the undergraduate students who enrolled and engaged in studying a distance learning course. With 290 questionnaires distributed, there were 271 responses received; a response rate of 90.3%. Out of the 271 responses, 18 were eliminated due to incomplete data or irregular answers. Consequently, 253 responses were used in the final analysis. Table 1 shows the demographic information for the subjects in terms of gender, school year, and duration of attending distance learning course(s).

Analysis and Findings

The SEM is used for Model 1. The SEM is used mainly to explain the pattern of a series of interrelated dependence relationships between a set of latent constructs measured by one or more manifest variables (Chin, 1998). Model 1 is tested by

Table 1. Demographic information of subjects

Gender			School year		
Male	Female	Freshman	Sophomore	Junior	Senior
123 (48.6%)	130 (51.4%)	86 (34%)	47 (18.6%)	91 (36%)	29 (11.5%)
Duration of attending distance learning course(s)					
1–3 months	4–6 months	7–12 months	More than 1 year		
212 (83.8%)	17 (6.7%)	11 (4.3%)	13 (5.1%)		

Table 2. The results of confirmatory factor analysis

Measure	Composite reliability	Variance extraction
Skill	0.9188	0.736
Challenge	0.8403	0.728
Control	0.8002	0.842
Interactivity	0.8489	0.741
Flow	0.8587	0.890
Intention to use	0.9101	0.880
Exploratory use	0.8084	0.633
Time distortion	0.7374	0.538

measurement model and structural model. This measurement model tests the psychometric properties of the scales used to measure the variables in the model. The structural model uses path analysis to analyze the strengths and directions of the relationships among the variables (Chin, 1998). To analyze data, the statistical software tools LISREL 8.52 and SPSS 10.0 were used. The recommended sample size for the SEM is at least 10 times the number of independent variables that affect a dependent variable. There are four independent variables in this model. The total number of samples for data analysis is 253, which is well above the threshold.

The test of the measurement model includes internal consistency and the convergent and discriminate validity of the instrument items. Convergent validity is assessed by confirmatory factor analysis (CFA) and maximum likelihood (ML) estimation. Table 2 illustrates the results of CFA. Composite reliability and variance extraction are estimated for the unidimensionality test of a construct. The composite alpha range is from 0.7374 to 0.9188, which is higher than 0.7, and satisfies Nunnally's criteria for reliability. For variance extraction by measures, an acceptance level is 0.5 (Fornell & Larcker, 1981). The values of variance extracted are in the range from 0.538 to 0.880, which exceeds the recommended value, and is acceptable.

The test of discriminate validity is used to check on multicollinearity. A measure should correlate with all measures of the same construct far more than any measures of other constructs (Chin, 1998). To ensure the variables in this study are in a different category, Pearson's correlation is shown here. Table 3 displays the correlations among the determinants of flow experience. The highest correlation between skill and control was 0.646, while other correlations range from –0.150 to 0.584. Although several variables showed significant correlations, their tolerance values range from 0.621 to 0.957, indicating that multicollinearity is not a likely threat to the parameter estimates (Hair, Anderson, Tatham, & Black, 1995).

Hypothesis Test

Path coefficients are performed in the test of the structural model, which indicate the strengths of the relationships between the dependent and independent variables.

Table 3. Correlations between variables

Variables	Skill	Challenge	Control	Interaction	Flow	Intention	Exploratory
Skill	1.000						
Challenge	–0.015	1.000					
Control	0.646	0.018	1.000				
Interactivity	0.337	0.265	0.223	1.000			
Flow	0.395	0.262	0.406	0.569	1.000		
Intention to use	0.560	0.207	0.474	0.447	0.584	1.000	
Exploratory use	0.512	0.160	0.461	0.339	0.402	0.412	1.000
Time distortion	0.210	0.234	0.273	0.494	0.580	0.361	0.379

Here, the R^2-value represents the amount of variance explained by the independent variables, and the interpretation of R^2 is just the same as in regression analysis. A 5% level of significance is used for all statistical tests.

The results of the analysis are presented in Figure 2, which contains the path coefficients, *t*-value and R^2-value. As hypothesized, a user's flow experience in using a distance learning system is significantly related to the user's intention to use, exploratory use, and perceived time distortion. In the figure, the flow experience explains 34.2% variance of the intention to use, 16.1% variance of exploratory use, and 37.7% variance of perceived time distortion. According to Hypotheses 1, 2, and 3, perceived flow experience does have a significant positive relationship on perceived intention to use ($\beta = 0.87$; $t = 8.62$; $p < 0.01$), perceived exploratory use ($\beta = 0.54$; $t = 6.96$; $p < 0.01$), and perceived time distortion ($\beta = 0.78$; $t = 9.89$; $p < 0.01$).

According to the test of Hypotheses 4, 5, 6, and 7, perceived flow experience is associated with skill, challenge, control, and interactivity; which together explain 40.8% of the variance of flow construct. All paths have positive effects, which supports H4: user perceived skills are positive to flow experience ($\beta = 0.13$; $t = 2.22$; $p < 0.05$); supports H5: user perceived challenge is positive to flow experience ($\beta =$

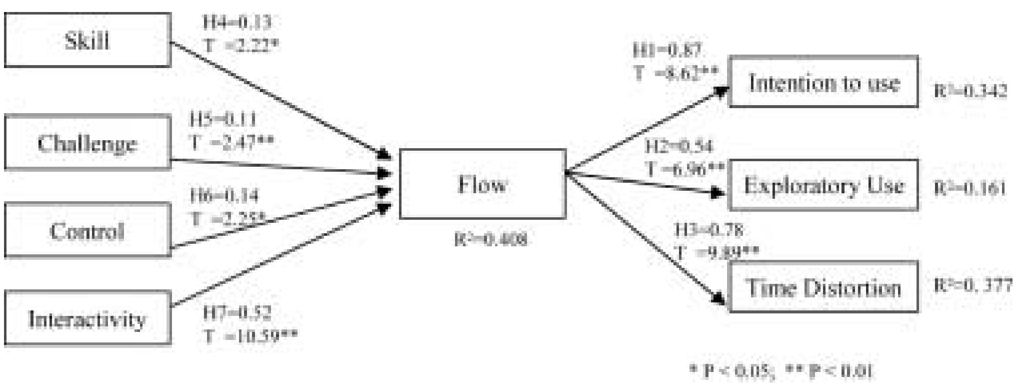

Figure 2. Model results on flow experience

0.11; $t = 2.47$; $p < 0.01$); supports H6: user perceived control is positive to flow experience ($\beta = 0.14$; $t = 2.25$; $p < 0.05$); and supports H7: user perceived interactivity is positive to flow experience ($\beta = 0.52$; $t = 10.59$; $p < 0.01$). This demonstrates that flow theory works well in a distance learning system environment.

Discussion and Implications

The findings of this study are consistent with the findings of a number of previous studies. After a student experiences flow, many positive attitudes will be developed. According to prior research, a user will intend to continue engaging in an activity and will want to explore new functions/features of the activity, ignoring the sense of time. Webster et al. (1993) indicated that flow is positively related with experimentation, voluntary use, and actual use. Novak et al. (1998) demonstrated that flow is significant with positive affect and exploratory behavior.

The results of student-perceived skills and challenge are positively related with flow experience and are similar to the results of Ghani and Deshpande (1994), Koufaris (2002), Novak et al. (1998), and Webster et al. (1993). Skills and challenge are the most important factors in flow theory, and the results in Model 1 evidence the same consequence.

Interactivity is an important factor in human–computer interaction (Novak et al., 1998; Trevino & Webster, 1992). The path coefficient of interactivity in Model 1 is 0.52; it is the highest among all the independent variables. This coefficient illustrates that interactivity has the greatest effect over flow experience in a distance learning environment. However, computer-mediated distance learning is a kind of collaborative learning (Alvai, 1994). The content of interactivity in distance learning is not only that of human–computer interaction, but also with other learners or teachers.

The objectives of interactions with other people to achieve academic goals are different from using the Web or an email system. It is important to examine the contents of interaction in a distance learning system. Therefore, the next model focuses on interaction types.

Interaction Types

Moore (1989) proposed three types of interaction in distance education: learner–content interaction, learner–instructor interaction, and leaner–learner interaction. The first type, learner–content interaction is defined as the process of “intellectually interacting with content,” thus changing a learner’s understanding, perspective, or cognitive structure. Interaction with content is when learners “talk to themselves” about information or ideas in a text, radio/television program, audiotape, videotape, or computer software (Moore, 1989). The second type of interaction is learner–instructor interaction, where an instructor stimulates or maintains students’ interests, motivating them to learn and clarifying any misunderstandings of the content. The third type of interaction is learner–learner interaction, which is between learners, individually or in group settings, with or without the real-time presence of an instructor (Moore, 1989).

Hillman, Willis, and Gunawardena (1994) expanded Moore's three types of interaction, considering that the nature of distance education requires some form of mediated communication involving the use of print, electronic, mechanical, or other devices. Learner–interface interaction is the process of manipulating tools to complete a task, where learners must interact with the technological medium in order to interact with the content, instructor, or other learners (Hillman et al., 1994).

Model 2

Based on the results of Model 1, Model 2 studies the impact of interaction types to flow experience. According to Moore's three types of interaction and Hillman et al.'s extension interaction type, Model 2 studies students' flow experiences affected by the interaction types of learner–instructor, learner–learner, and learner–interface. Learner–content interaction is omitted because the content itself is different from subject to subject (Liao, 2004). Figure 3 illustrates the model of interaction types to flow experience. Therefore, Model 2 tests the following three hypotheses:

H8: Learner–instructor interaction is positively related to flow experience.
H9: Learner–learner interaction is positively related to flow experience.
H10: Learner–interface interaction is positively related to flow experience.

Measures

Model 2 is tested with regression analysis. The instrument is validated using factor analysis. Data are analyzed by principal component extraction with varimax rotation, as shown in Appendix A. The summary statistics and reliability test are presented in Table 4. The values of Cronbach's alpha ranged from 0.8061 to 0.8290, satisfying the criteria of 0.7 (Nunnally, 1978). Table 5 presents the results of Pearson's bivariate correlations among interaction types, of which the highest is 0.449 and the lowest is –0.090. Thus this instrument is acceptable for validating the scales of interaction types.

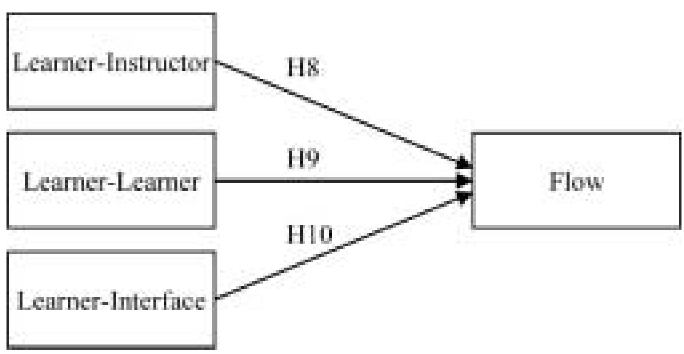

Figure 3. Interaction types to flow experience (Model 2)

Table 4. Summary statistics and Cronbach's alpha values

Measure	Mean	SD	Reliability
Learner–instructor	3.707	1.000	0.8105
Learner–learner	3.551	1.255	0.8061
Learner–interface	3.653	1.183	0.8290

Analysis and Findings

Table 6 shows the results of linear regression model with interaction types. As hypothesized, the flow experience is associated with interaction types, which together explain 48.1% of the dependent construct's variance. Hypotheses 8 and 10, learner–instructor interaction ($\beta = 0.163$; $t = 3.225$; $p < 0.01$) and learner–interface interaction ($\beta = 0.591$; $t = 11.550$; $p < 0.01$) show significant positive relationship with flow experience. This means that with more between learner–instructor and learner–interface interaction, there is higher likelihood that users perceived flow experience.

Contrary to our expectations, the learner–learner interaction ($\beta = 0.079$; $t = 1.750$; $p > 0.05$) has no significant effect on flow experience. Therefore, Hypothesis 9 is not supported. The results are illustrated in Figure 4, where the dotted line indicates no support for the hypothesis.

Successful interaction in mediated education is highly dependent upon how comfortable the learner feels in working with the delivery system (Hillman et al., 1994). The learner–interface interaction has highest impact on flow experience among the three types of interaction. During learning, students spend much time and effort working with systems. The more fluently a student interacts with a system, the more flow the student gains. Besides, instructors can encourage or stimulate learners, and make learners feel happy to learn.

However, the result of learner–learner interaction is unexpected. This is unlike the study by Chen et al. (1999), which indicated that Web users feel flow through talking with other users via Internet relay chat (IRC). Laurillard (1993) pointed out that student–student interaction undoubtedly has some important educational characteristics. However, discussions between students are controlled by students; they may

Table 5. Correlations between independent variables

Variables	Learner–instructor	Learner–learner	Learner–interface
Learner–instructor	1.000	–	–
Learner–learner	–0.109	1.000	–
Learner–interface	0.449**	–0.090	1.000

**$p < 0.01$.

Table 6. Linear regression model for interaction variables

Independent variable	Standard β	Standard error	*t*-Value	*p*-Value
Learner–instructor	0.163	0.052	3.225	0.001**
Learner–learner	0.079	0.037	1.750	0.081
Learner–interface	0.591	0.045	11.550	0.000**

$F = 76.872$; $R^2 = 0.481$; $^{**}p < 0.01$.

flounder in mutually progressive ignorance. This is a significant difference from the feedback of teachers.

In this study, the subjects attended literacy courses presented via a distance learning program, instead of a professional course. Generally speaking, students pay less attention to a general knowledge course, which would lower students' intention to communicate with each other. This could be one of the reasons why learner–learner interaction has no effect on flow experience.

Although the results of interaction types to flow experience are reported here, the conclusion must remain tentative. However, based on these results, interaction types seem to be critical factors to perceived flow experience in a distance learning environment.

Discussion and Conclusion

From this empirical study, we find flow theory is well adapted in a distance learning environment. According to flow theory, skill and challenge are the most important variables. However, in the results of Model 1, the most important antecedent variable is interactivity. It could be interesting to deeply discuss what kind of interaction types would influence student flow experience. The results of Model 2 indicate learner–instructor and learner–interface have positive significant effects on flow experience.

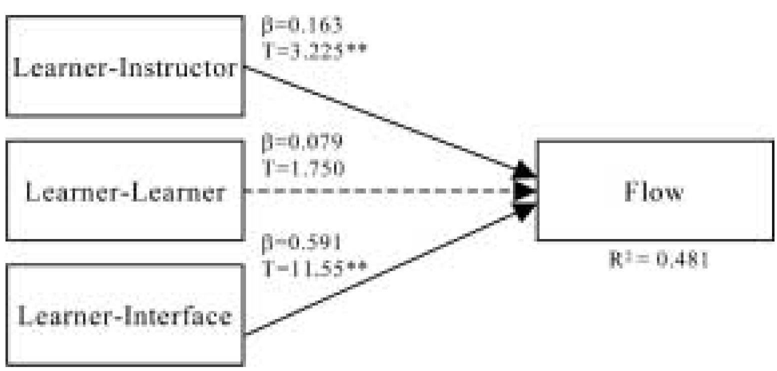

Figure 4. Results of interaction types to flow experience

However, learner–learner interaction does not show significant influence. It would be interesting to probe the reasons why learner–learner interaction does not support the hypothesis.

This study has three major goals. One is to introduce the conceptualization of flow theory in a distance learning environment; the second is to assess the relationship impact on learner flow experience; and, the third is to evaluate the impact of interaction types on learner flow experience.

The primary contribution of this study is its demonstration of the importance of the flow experience in a distance learning environment. Based on the literature review, this study synthesized and applied the concept of flow theory in a distance learning environment. Although the evidence supports most of the hypotheses, more analysis of the flow experience in a distance learning environment is required.

A second contribution of this study is to evaluate the importance of three interaction types on learner flow experience, since interaction is an important factor in distance education. This study is perhaps the first empirical research attempting to develop and validate the relationship between interaction types and flow experience. Prior studies have focused on the human–machine interaction, but without mentioning any other types of interaction. However, the results on interaction types are still exploratory.

A third contribution of this study is the result indicating that flow experience could develop many positive attitudes and behaviors, including intention of use and exploratory use. In order to keep students learning in a distance environment, encouragement is important. Flow theory provides an essential direction to probe intrinsic motivation.

The results also have important implications for systems practitioners and educators. To motivate students to learn enthusiastically is an important job for teachers and instructional designers. Instructional designers must construct and implement a learning system by providing sufficient interaction functions. Educators need to encourage, stimulate, and provide opportunities to interact within the learner group.

Since this study has a number of limitations, further study is needed. First, this study uses a self-report scale under instructors' agreements to measure the proposed variables, which may cause some bias for some of the results. For further investigation, it would be appropriate to develop a more direct and objective measure for flow experience. Second, though the variables in Model 1 were carefully selected, there were some other variables omitted from the framework, such as focus attention, arousal, and telepresence. Thus, further study may investigate those variables missed in this current study.

Third, according to the results of Model 2, learner–learner interaction has no significant effect on learner flow experience. A further study focusing on interaction types is needed, especially to analyze learner–learner interaction. Finally, the sample is restricted to university students in Taiwan, so replication is required to validate the effect of flow experience in a distance learning environment for other groups.

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Note on Contributor

Li-Fen Liao is an assistant professor in Ching Yun University. Her topics of interest are distance learning, knowledge sharing, and business management.

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Appendix A

Table A1. Rotated component matrix

Items	Factor 1 (learner–learner)	Factor 2 (learner–instructor)	Factor 3 (learner–instructor)
Learner–learner (1)	0.879		
Learner–learner (2)	0.900		
Learner–learner (3)	0.823		
Learner–learner (4)	0.838		
Learner–instructor (1)		0.785	
Learner–instructor (2)		0.843	
Learner–instructor (3)		0.775	
Learner–instructor (4)		0.665	
Learner–interface (1)			0.890
Learner–interface (2)			0.880
Learner–interface (3)			0.7851
Learner–interface (4)			0.8215

Appendix B

Skill (Novak et al., 1998)

1. I am very skilled at using the distance learning system.
2. I consider myself knowledgeable about good techniques for the distance learning system.
3. I know less about using the Web than most other users.
4. I know how to find what I want with a search engine.

Challenge (Novak et al., 1998)

1. Using the distance learning system challenges me.
2. Using the distance learning system challenges me to the best of my ability.
3. Using the system provides a good test of my skills.
4. I find that using the system stretches my capabilities to the limits.

Control (Ghani & Deshpande, 1994)

1. I feel I have the ability to control the distance learning system to learn.
2. I feel I am fully capable of controlling the distance learning system.
3. I know clearly the right thing to do.
4. I feel calm to use the system.

Interactivity (Daft & Lengel, 1986)

1. The interactivity functions (mail, BBS, group discussion, immediate discussion, etc.) on the distance learning system can satisfy my communications requirements.
2. The interactivity functions could let me express my opinions or thoughts easily.
3. The interactivity functions could let me use words, graphs, and other symbols freely.

Flow (Ghani & Deshpande, 1994)

1. It is very interesting when I use the distance learning system.
2. I feel very enjoyable when I use the distance learning system.
3. I am deeply engrossed in learning when I use the distance learning system.
4. My attention is focused on learning when I use the distance learning system.

Exploratory use (Ghani & Deshpande, 1994; Novak et al., 1998)

1. I try out new commands when I use the distance learning system.
2. I experiment with commands when I use the distance learning system.
3. I enjoy browsing the system to see what is out there.
4. I like to click on a link just because it looks interesting.

Intention to use (Davis, Bagozzi, & Warshaw, 1989)

1. If I want to take a course, I will take a distance learning course.
2. If I take a course, I must take a distance learning course.
3. Overall, I have a high willingness to take a distance learning course.

Time distortion (Novak et al., 1998)

1. Time seems to go by very quickly when I use the distance learning system.
2. When I use the distance learning system, I tend to lose track of time.

Learner–instructor interaction (Sherry, Fulford, & Zhand, 1998)

1. The instructor frequently offers opinions to students.
2. Students often state their opinions to the instructor.
3. The instructor frequently asks the students questions.
4. Interaction between the instructor and the class is high.

Learner–learner interaction (Sherry et al., 1998)

1. The students seldom ask each other questions.
2. There is little interaction between students.
3. In class, students seldom state their opinions to each other.
4. Students seldom answer each other's questions.

Learner–interface interaction (Novak et al., 1998)

1. When I use the distance learning system there is very little waiting time between my action and response from the computer.
2. Interacting with the system is slow and tedious.
3. Navigation of the system is natural.
4. Interacting with the system is intuitive.