THE CHALLENGES OF STUDYING FLOW WITHIN A COMPUTER-MEDIATED ENVIRONMENT

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Abstract

Flow theory has been borrowed from psychology to address positive user experiences with personal computers, and more recently, the Internet. The flow experience has been correlated to increased exploratory behavior, communication, learning, positive affect, and computer use. This paper reviews the flow studies within computer-mediated environments to gain a more coherent understanding. The authors identify ambiguities in the conceptualization of flow, challenges in the operationalization of flow constructs, and difficulties in data collection.

Introduction

Csikszentmihalyi eloquently depicts the holistic experience of flow in his books (Csikszentmihalyi 1975; Csikszentmihalyi 1990). Once described, the flow experience is easily recognizable to avid rock climbers, composers, and even Web surfers. Flow theory has been borrowed from psychology to address positive user experiences with personal computers (Ghani 1995; Ghani & Deshpande 1994; Ghani et al. 1991; Trevino & Webster 1992; Webster et al. 1993), and more recently, the WWW (Chen 2000; Chen et al. 1999; Hoffman & Novak 1996; Nel et al. 1999; Novak et al. 2000). Within a computer-mediated environment, the experience of flow has been shown to lead to increased exploratory behavior (Ghani 1995; Ghani & Deshpande 1994; Webster et al. 1993), communication (Trevino & Webster 1992), learning (Ghani 1995), positive affect (Chen 2000; Trevino & Webster 1992), and computer use (Ghani & Deshpande 1994; Trevino & Webster 1992; Webster et al. 1993). Computer-mediated environments that are conducive to flow will yield positive attitudes and outcomes for users, and have broad implications for e-commerce (Hoffman & Novak 1996) and learning (Guru & Nah 2001). The practical implications are clear. However, is it not well understood why particular environments or interfaces are more conducive to yielding flow among users. In order to propose recommendations for designers, we need to be able to rigorously study the flow phenomenon within the computer-mediated context.

Our goal is to enhance the understanding of flow and how to study it within computer-mediated environments by reviewing past studies of such environments. As this paper shows, the flow experience has been difficult to isolate and study because of its situatedness and holistic nature. We identify both the conceptual and methodological challenges that researchers in this arena have faced. Finally, we introduce a conceptual framework that we hope will guide future flow studies within computer-mediated environments.

The Flow Model and Conceptual Challenges

One of the most challenging aspects of flow theory is its holistic nature, as described by its founder Csikszentmihalyi (1975). An activity that may lead to an optimal experience must be done for the satisfaction of the activity itself; the person must be motivated intrinsically to do the activity, or autotelic, literally meaning self-goal (Csikszentmihalyi 1990). In addition to being autotelic, the activity must challenge and require skill, merge action and awareness, provide feedback, and require full concentration on the task at hand. The person experiencing flow will have clear goals, exercise control, lose their self-consciousness, and experience a distortion of time (Csikszentmihalyi 1990). Though Csikszentmihalyi lists factors that contribute to flow, he does not intend them to serve as the exclusive factors of flow, but more as the most commonly exhibited ones.

Review of Major Flow Models Involving Human-Computer Interaction (HCI)

Csikszentmihalyi (1975) describes flow as "the holistic sensation that people feel when they act with total involvement." Precisely defining this holistic sensation and its contributing factors has been difficult for HCI researchers, as evident from the various constructs included in major models and the discrepancy of their placement within the models. Below we will briefly review flow models that have made contributions to flow within a computer-mediated context.

In his 1995 study, Ghani develops a model of flow in human-computer interaction. His model places fitness of task (difference between challenges and skills), perceived control, and cognitive spontaneity ("playfulness") as the antecedents of flow. Flow itself is measured through the constructs of enjoyment and concentration. The consequences of flow are increased learning, increased creativity, and a focus on the process. Ghani's work illustrates the complexity of the balance of a user's skills and challenges. With an excess of skills, the user feels more in control, which can lead to flow. However, when the skills greatly exceed challenges, boredom will likely result, providing a negative influence on flow. After testing the model, Ghani learns that the construct of fit influenced flow indirectly, mediated through perceived control.

Hoffman & Novak (1996) develop a theoretical model of flow within the hypermedia environment of the Web. Following Csikszentmihalyi's work, Hoffman & Novak indicate that the primary antecedents to flow are challenges, skills, and focused attention. From the literature on communication media, they add secondary antecedents: interactivity and telepresence. According to Steuer (1991), "telepresence is the extent to which one feels present in the mediated environment, rather than in the immediate physical environment." Steuer further identifies vividness and interactivity as the two dimensions that determine the degree of telepresence within a particular technology. Hoffman & Novak incorporate these two dimensions into their model as content characteristics that directly influence telepresence and focused attention. Furthermore, Hoffman & Novak add the construct of involvement, which encompasses intrinsic motivation and self-reliance and is influenced by whether the activity is goal-directed or experiential. Their 1996 model shows the consequences of flow are increased learning, perceived control, exploratory mind-set, and positive subjective experience.

In a more recent work, Novak et al. (2000) make some adjustments to their 1996 theoretical model and test it empirically using structured equation modeling. Instead of measuring flow, the authors replace flow with playfulness, stating that playfulness will relate to the antecedents and consequences similarly to flow. Other important changes are that the control construct is moved from a consequence to an antecedent of flow. The construct arousal is added as an antecedent of flow, and is a dependent variable of challenge. The revised structural equation model shows that the importance construct directly influenced not only focused attention, but also the level of challenge and skill. Interactive speed influenced control, challenge, and focused attention. Telepresence was removed from the empirically-derived model. Thus, in the revised model the primary antecedents of playfulness are control, arousal, and focused attention. The secondary antecedents are challenge, skill, interactive speed, and importance. The consequences are positive affect and exploratory behavior.

In Chen's dissertation (2000), he finds a correlation between a Web user's flow experience, which was measured with flow quotations from Csikszentmihalyi, and ten flow dimensions. These ten dimensions are broken down with factor analysis into three factors labeled flow antecedents, flow experience, and flow consequences. The flow antecedents are clear goals, immediate feedback, potential control, and merger of action and awareness. The flow experience dimensions are concentration, telepresence, time distortion, and loss of self-consciousness. The flow consequences are positive affect and autotelic experience. The merger of action and awareness is the only dimension that does not clearly fall into one factor. Its highest loading was in the flow experience factor, so Chen places it there.

Discrepancies within the flow models

As these few models illustrate, the reliability of flow indicators between studies is low. In a review of the constructs used in major flow studies from 1977 to 1996, Novak et al. (2000) list the thirteen constructs that surface within these major studies. The thirteen constructs are as follows: challenges, skills, focused attention, control, positive affect, involvement, interactivity, playfulness, time distortion, arousal, exploratory behavior, optimum stimulation level, and telepresence. Of the sixteen studies reviewed, each study on average only considers four of the thirteen constructs. Novak et al. attempt to incorporate these thirteen constructs in their model. However, these thirteen are by no means all of the flow constructs. In Chen's dissertation, three out of the ten dimensions he studies arguably are not within Novak et al.'s list. The three missing dimensions (clear goals, merger of action and awareness, and loss of self-consciousness) are hardly unimportant; they are directly from Csikszentmihalyi's work.

In addition to discrepancies about what constructs are important within the flow model, some models place the constructs in different stages of the flow model. Ghani (1991, 1994) considers concentration and enjoyment as the flow experience itself, while others (Chen 2000; Novak et al. 2000) place concentration as an antecedent to flow and enjoyment as a consequence of flow. Structured equation modeling has enabled researchers to break down the aspects of flow and show the direct and indirect influences of the many dimensions on flow. Nonetheless, inconsistent models persist.

Individual Factors

Individual differences can yield very different flow experiences from the same activity. The differences among individuals is not merely in their skills, but also in their underlying life attitude, or their 'autotelic personality' (Csikszentmihalyi 1990). In a study of high-schoolers faced with their first ever term paper exercise, the quality of the term paper was more dependent on the student's overall emotional state toward the exercise than the student's prior grades and writing experience (Larson 1988). Another study directly compared models that incorporate individual personality difference with models that do not and found that individual difference account for as much as 20% of the variance (Ellis et al. 1994). Clearly, accounting for individual personality differences is important for a robust flow model.

Though individual differences in skills is accounted for in most models, few researchers have included aspects of the 'autotelic personality.' Hoffman & Novak (1996) incorporate an individual's optimum stimulation level (OSL) in their model. They hypothesize that individuals with higher OSLs are more likely to have the 'autotelic personality' trait. In Novak et al.'s (2000) empirically derived structured equation model, they found that OSL did not influence playfulness, which they used as a surrogate for flow, but instead influenced exploratory behavior, an outcome of flow. 'Autotelic personality' is probably more connected to intrinsic enjoyment (Csikszentmihalyi 1990; Hamilton et al. 1984) than to stimulation, as Csikszenmihalyi (1990) has shown that some persons can experience flow while partaking in the most mundane of activities.

Ghani's (1995) experiment used the construct of cognitive spontaneity to measure individual playfulness. He refined the Adult Cognitive Spontaneity scale used by Webster (1989) and originally developed by Lieberman (1977). It is ironic that in two of the few studies that incorporate individual differences, they both use playfulness to represent this trait, yet one study considers playfulness as the personality-driven independent variable and the other considers playfulness as the dependent variable, with OSL serving as the independent variable. More research is needed within the area of individual differences and 'autotelic personality' to help flow and HCI researchers clarify which individual measures influence the flow experience and where they occur in the process.

Reducing Ambiguity Through Tasks and Artifacts

Flow is situated in a particular time and task (Chen et al. 1999). In addition to individual characteristics, the characteristics of the particular task and the tool being used impact the potential for flow. Historically flow studies have focused on the tasks, for example, reading (Larson 1988; McQuillan & Conde 1996) and writing (Larson 1988). However, online tasks present a different context. Within a computer-mediated environment, it may be much more common to multi-task, thus it may be difficult to pinpoint exactly which task one was doing during a particular time period.

Artifacts, or tools, are a more recent addition to the flow phenomenon. Within the computer-mediated environment, an artifact may have a substantial influence on flow, for example by increasing a user's likelihood to experience telepresence or to stay focused on the underlying task. Telepresence can be broken down into the contributing factors of vividness, comprised of breadth and depth and speed, and interactivity, comprised of range, and mapping (Steuer 1991). Using these variables, a researcher could compare different artifacts and study how they might lead to a higher degree of telepresence and thus, flow. This telepresence example shows how artifacts and their impact on flow could be studied. Telepresence is just one possibility in comparing different media. Hoffman & Novak (1996) develop a typology of communication media on two poles: static/dynamic and impersonal/personal. Guru and Nah (2001) apply the media richness theory (Daft & Lengel 1986) to study flow within a learning environment.

We can disambiguate flow constructs by considering the task and the artifact used to complete the task as separate entities. For example, the construct of immediate feedback is confusing in the context of an online activity. When composing e-mail, would the feedback be from the e-mail software package or from the receiver of the e-mail? We can label the former as machine interactivity and the latter as person interactivity (Hoffman & Novak 1996). Steuer (1991) defines machine interactivity as, "the extent to which users can participate in modifying the form and content of a mediated environment in real time." The distinction between person-interactivity and machine-interactivity clarifies the feedback construct within the online environment. By differentiating between the artifact (i.e., e-mail software) and the task (i.e., correspondence with a person), we can consider the flow dimensions that occur with both of these aspects.

Methodological Challenges of Studying Flow

Studying flow has been methodologically challenging, yet these challenges are even greater when studying flow in the online environment. Over the last decade or so, empirical studies have been investigating how flow is experienced within a computer-mediated environment. Researchers have studied flow with computer-mediated communication (Ghani et al. 1991; Trevino & Webster 1992), office productivity software on desktop computers (Ghani 1995; Ghani & Deshpande 1994; Webster et al. 1993), and general Web activity (Chen 2000; Chen et al. 1999; Novak et al. 2000). In this section, we will investigate the challenges that these and other studies have faced in the data collection and operationalization phases of the research project.

Data Collection Methods

Prior to the interest of flow and computer activity, most of the flow studies were naturalistic. The popular Experience Sampling Method (ESM), a signal-contingent approach, was developed to examine flow experiences in everyday life (Csikszentmihalyi et al. 1977). For one or two weeks, the subjects wear a device that signals periodically, at which time the subjects record their activity and self-report their state (Clarke & Haworth 1994; Csikszentmihalyi & Csikszentmihalyi 1988; Haworth & Evans 1995). The ESM enables researchers to examine the dynamic nature of flow within an individual and is an appropriate method when studying flow experience in daily life. However, the ESM is not conducive to studying a particular activity. As a subject may only partake in the activity for limited times throughout a day or week, the chance of the signal occurring at the time when a subject is participating in the activity is small. Furthermore, collecting data points from the other times when the subject is not involved in the activity wastes the subjects' and researchers' time and effort.

Wheeler and Reis (1991) recommend using event-contingent methods rather than signal-contingent methods when studying a "limited number of human activities, when these events can be defined clearly for subjects, and when it is important to obtain a large number of events." Similar to the ESM, for one to two weeks subjects will self-report after they have participated in a particular activity. Event-contingent methods enable a researcher to collect many data points for the same activity but depend on the subjects to consistently report when they participate in the activity.

Chen & Nilan (1998) adapted the ESM to be more event-contingent for studying Web browsing. On computer lab terminals with Web browsers, they installed a signaling device that would pop-up every 5 to 7 minutes with a questionnaire for the subject to complete. This method remains somewhat naturalistic in that subjects are able to use the Web browser however they want for the designated time period.

Other studies (Ghani 1995; Ghani et al. 1991; Nel et al. 1999; Webster et al. 1993) have used experiments to study flow. Experiments provide a controlled environment in which the researcher can compare how different skill levels or Web site types influence the degree of flow experienced. However, experiments raise questions about the external validity of the study, especially given that flow is a context-specific experience. For example, the Nel et al (1999) study had naïve Web users evaluate specific Web sites and then complete a questionnaire on their feelings of control, attention, curiosity, and intrinsic interest. The authors find that Web sites that focused on information communication, as opposed to transactions, yield a higher degree of flow. The experiment itself may hinder the applicability of the findings. When persons are merely evaluating a Web site, information communication may be more enticing than transactions. However, when a user actually intends to complete the transaction, the transaction-based site will surpass the general information site as being more exciting. Thus, it is the task and the context that create the flow experience, not merely the Web site type.

When studying flow across media, it is even more difficult to do controlled experiments and retain external validity. Griffith et al. (2001) compare retail catalogs in print and online with a controlled experiment. They normalized the information in both of the catalogs, primarily removing additional information from the online catalog. The findings indicate that subjects experienced more involvement with the print catalogs. However, the limitations of the controlled experiment limit the real-world implications of this study. In natural settings, online catalogs may encourage involvement because they enable drilling down to deeper levels of information due to less space limitations. The fact that different media have different characteristics (Hoffman & Novak 1996) and potentially different uses cannot be ignored when studying involvement or flow experiences.

Naturalistic studies are strong in their ecological validity yet take a considerable amount of time and number of subjects to do well. Several flow researchers instead have resorted to using surveys to study flow (Ghani & Deshpande 1994; Novak et al. 2000; Trevino & Webster 1992). Whether Web or print based, these surveys use questionnaires with Likert-type scales and measure general experiences. They are limited in that they typically use closed-ended questions, and more importantly, in that respondents are asked to rate factors according to the general case, not regarding a specific experience. Surveying non-situated, generalized factors does not account for the dynamism of each factor and how its fluctuation influences flow. These surveys only pose questions about general usage. For example, a respondent's rating of *I am extremely skilled at using the Web* (Novak et al. 2000) simplifies the delicate balance of challenges and skills that contribute to flow at a given time. Flow experiences on the Web are situated (Chen et al. 1999). The challenges and skills required are not necessarily limited to the hardware and software. When users experience flow while communicating with a discussion group, it is often not the medium of the Web but the content of the discussion that causes the flow. Thus, the challenges an individual experiences and the skills s/he uses are different depending on the Web activity.

Further, the one-time surveys are limited in that they are static for each individual. The surveys do not account for the dynamic nature of flow within each individual. One respondent may be biased toward ranking flow factors high; only by viewing multiple points of an individual can we understand the dynamism and complexity of the flow experience. Methods, like ESM, that collect multiple data points for each individual provide a richer data set and enable the researcher to study the flow experience in different contexts. These contexts enhance the researcher's understanding of the flow experience.

Even when surveys are situated with a particular flow experience, such as Chen et al. (1999), the reliability is problematic because the respondent must recall the situation and distortion may occur. Real time elicitation with multiple surveying of each of the respondents will enable researchers to understand the actual experience of flow (not a memory of it) and how an individual's state changes.

Hoffman & Novak (1996) indicate that in addition to survey techniques, qualitative research techniques like protocol analyses would be useful for developing reliable and valid measures of flow within a computer-mediated environment like the Web. A forthcoming article comparing goal-directed and experiential behavior on the Web uses qualitative techniques (Novak et al. in press, 2002). We think qualitative techniques will enhance our understanding of flow by enabling us to investigate the "why," for example why users prefer e-mail over voice mail (Trevino & Webster 1992). Examples of qualitative research for studying flow and the Web are rather sparse. Chen et al. (1999) conduct open-ended questionnaires and used content analysis to explore the factors associated with flow while using the Web, perceived challenges and controls, and feelings associated with the experience. Enabling respondents to use their own words to describe their experiences can ensure validity and uncover deeper aspects of the flow model within the Internet context.

Operationalization

Though Csikszentmihalyi (1990) cites the balance of skills to challenges as the most important factor to a flow experience, operationalizing the skills/challenge ratio is troublesome. Ellis et al. (1994) note that the skill and challenge constructs are complex and unidimensional scales may not serve as valid measures. They note that these constructs could be measuring emotional, mental, or physical challenges and skills. An interesting research question is must all of these aspects be focused on the same activity to achieve an optimal experience. It would seem that Csikszentmihalyi's criterion of merging action and awareness would dictate so. To date, empirical research has primarily measured unidimensional skills and challenges. For example, Novak et al.'s (2000) measure of skills and challenges focuses on the medium (e.g., using the Web), ignoring the underlying activity (e.g., composing persuasive e-mail).

In addition to the ambiguity of what types of challenges and skills should be measured, many respondents do not fare well when asked directly to measure such constructs. Chen et al.'s (1999) respondents of the 1st sample were asked, *Have you ever experienced the feeling of "positive challenge" during your Web navigation?* Many of them (14%) wrote comments stating they did not understand the question. The researchers then added the option *I don't understand what positive challenge means* and

38% of the 2nd sample respondents selected this option. Likewise, many users were unfamiliar with the idea of control, another important factor in the flow model. When asked the question, *Have you ever experienced the feeling of "being in control" during your Web navigation?* , 25% of the 1st sample commented they did not know what it meant, and when an *I don't know* option was added, 18% or the 2nd sample selected it.

Because of the flow definition's conceptual vagueness, operationalizing the flow construct has been inconsistent in the empirical work. Some studies have estimated flow by measuring the subject's sense of control, focused attention, curiosity, and intrinsic interest (Nel et al. 1999; Trevino & Webster 1992; Webster et al. 1993). Other studies have estimated flow by measuring enjoyment and concentration (Ghani 1995; Ghani & Deshpande 1994; Ghani et al. 1991). In Novak et al.'s (2000) empirical work, they avoid the morass of operationalizing flow by substituting the construct playfulness for flow. Though this substitution lends itself to a cleaner study, its validity is left untested. Playfulness has been deemed an antecedent to flow (Ghani 1995; Guru & Nah 2001) and has not been considered one of the core aspects of flow as described by Csikszentmihalyi (1990).

To maintain the holism of the flow construct, Chen (2000) operationalizes flow by having the subjects read three actual quotations from persons experiencing flow and rate how accurately each of the quotations represents their experience. Novak and Hoffman's more recent survey instrument (Project 2000) measures flow in a similar vein, by describing the flow experience holistically and directly asking the respondent if they believe they have experienced flow.

Heretofore, the flow studies have aggregated Web activity as one activity. Chen et al. (1999) discovered that subjects experienced flow in different types of Web activities: 61% from information seeking and 18% from correspondence via e-mail and newsgroups. We suspect that the percentage of flow experiences from correspondence is actually larger than measured in this study. Recent data show that both new and experienced Web users spend about 22% of their the time on the Web using e-mail (UCLA 2001), thus e-mail activity is a substantial part of Web activity. Secondly, the early flow literature found that reading was the most common activity associated with flow (Massimini et al. 1988) and reading provides much of the underlying activity of e-mail. Chen et al. (1999) propose studying the Web, not just as hypertext navigation, but as a multi-activity medium.

We believe that studying flow within the context of e-mail, considering a recent communication model proposed by Te'eni (2001) that considers the affective component, will result in a more robust understanding of flow and communication within computer-mediated environments.

The Person-Artifact-Task (PAT) Model

As evidenced by the existing studies on flow within the IS/HCI field, one of the challenges for us as IS/HCI researchers is to extend the seemingly very useful flow model to appropriately fit the rather complex computer-mediated environment. One primary difference between the flow phenomenon in original psychology studies and the flow phenomenon in the computer-mediated environment is the introduction of a third component, which is neither the task, nor the person experiencing the flow. This third component, typically a computer application, accompanies the task a person is completing. By clearly distinguishing this third component from the task and being aware of the complexity it adds, we may gain a better understanding of the flow phenomenon within the computer-mediated environment. Thus, we introduce a conceptual model that would account for the holistic nature of flow while adapting to the unique environment of computer-mediated interactions. We believe this model gives an overarching view that will ensure that important constructs will not be overlooked or confused.

Our model has three distinct components: Person, Artifact, and Task. They create a situated experience that may or may not induce flow (Figure 1). Though flow is experienced by a person, it is experienced in the context of the task and the artifact used. A person's traits remain static and permanently bias flow in a particular direction. However, a person's state dynamically changes and can be influenced by the task and the artifact. For a particular task, a person may feel confident that s/he has adequate skills. A person's perceived ease of use (Davis 1989; Davis 1993) with regard to the artifact will also influence their sense of control and challenge. By separating the task from the artifact, researchers can study factors that influence flow from different aspects. For example, when studying the flow experience in using emails, researchers may want to investigate a user's skills with regard to writing a persuasive message along with the user's skill at the e-mail software. Does a flow experience depend upon the balance of challenges and skills with both the writing task and the software artifact?

The PAT model can be theoretically supported by existing IS literature. We can apply established concepts in the MIS literature to the task-artifact relationship in the PAT model. Vessey's (1991) cognitive fit paradigm shows that a match between the representation of the information and the designated task will improve speed and accuracy of performance. Similarly, the task-

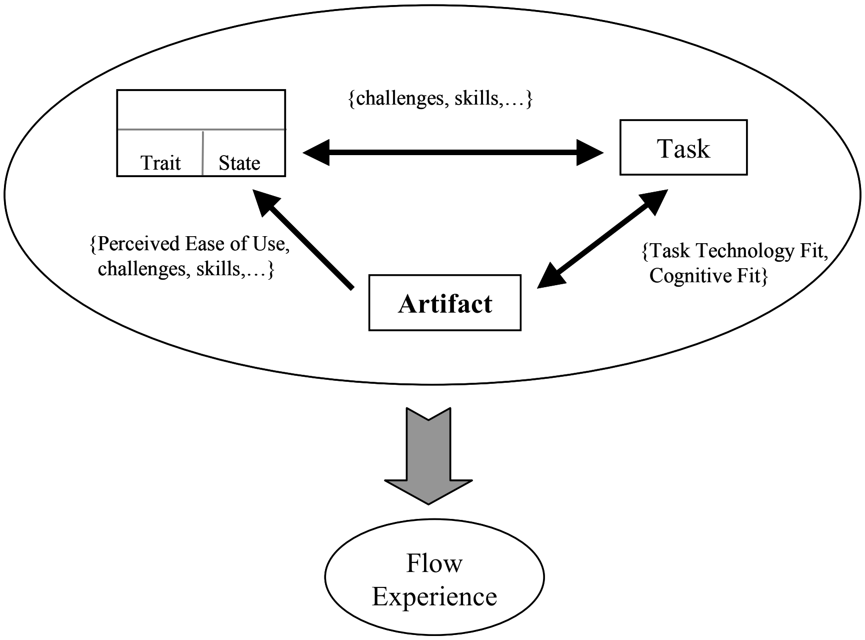

Figure 1. Person-Artifact-Task Model for Studying Flow Within a Computer-Mediated Context

technology fit (Goodhue & Thompson 1995) work discusses the positive impact of fitting technology to the task on users' performance. The artifact in the PAT model serves as the technology that represents particular information. If the link between the artifact and the task correspond well with each other, increased speed and accuracy will occur, and then, we believe flow is more likely to ensue. As shown in Figure 1, a person needs to have a balance between the challenge level and skill level with a task in order to experience flow. A balance is also needed for the artifact for the same person. In addition, the bi-directional arrow between Person and Task also indicate that a person may have an impact on task. A person's attitude about the specific task, in addition to his/her general attitude, will influence if s/he is able to find meaning in the task and how s/he will proceed with the task. A person may decide to complete the task in a more time-consuming but less cognitively taxing way or to use a less time-consuming but more cognitively taxing method. Which approach is selected will inevitably have an influence on flow.

By separating the person, artifact, and task, we can clarify ambiguous flow constructs, such as the balance of skills and challenges. By showing the interactions between these components, we retain the situated environment that provides the venue for flow. We believe the PAT model is a first step toward helping researchers study flow unambiguously within a computer-mediated environment.

Conclusion

Several researchers had the foresight to use flow theory as a way to understand human interaction with computers. Their studies have shown that flow can, among other things, lead to increased learning, improved attitudes, and positive experiences within a computer-mediated environment. The benefits of flow experiences are clear. Now the challenge for IS/HCI researchers is to develop robust models that explain how the person, artifact, and task influence each other within a situated online environment so as to create a flow experience.

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