Task Context and Computer Self Efficacy in the Era of Web 2.0 Tools

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Abstract

Many past studies of computer self efficacy (CSE) have emphasized the impact of psychogenic factors on the users' CSE, but few have examined the effects of task complexity and novel technologies. This study looks at the impact on CSE of the complexity of emerging Web 2.0 technologies and the task context in which they are applied. Students in a capstone course applied simple and complex Web 2.0 interaction tools for course assignments and were evaluated on the strength of their CSE for use of the technologies in a complex task context. Findings show significant differences in CSE between users of simple and complex Web 2.0 technologies in general and for the complex task context, suggesting that in complex task conditions, CSE is highly influenced by the complexity of new technologies. Implications for the design of technology-based learning experiences for complex tasks are discussed.

Keywords: Collaboration technologies, Collaborative learning, task complexity, task challenge

Introduction

Compeau and Higgins (1995, p. 192) define computer self efficacy (CSE) as "judgments of one's capability to use a computer." The authors go on to refine this definition by stating that CSE "incorporates judgments of one's ability to apply [computing skills] to broader tasks (preparing written reports or analyzing financial data)" (p. 192). Few studies have looked at the impact of such broader tasks on CSE, and few have examined the effects of current Web 2.0 technologies that vary greatly in complexity. This paper seeks to increase our understanding of this impact by manipulating technology complexity in a situation of high task complexity and determining the impact on CSE. To this end, we tested hypotheses regarding the impact on CSE of emerging technologies and task context.

The concept of computer self efficacy (CSE) has been shown across a large number of studies to be strongly related to subsequent technology-specific performance (e.g., Bolt, Killough and Koh 2001; Brosnan 1998; Gist and Mitchell 1992; Igbaria and Iivari 1995; Marakas, Yi and Johnson 1998; Strong, Dishaw and Bandy 2006). Hence it is an early indicator of a technology implementation's success with encouraging information technology use in academic and professional environments. CSE allows researchers to predict with some confidence the future use of a given technology using a measure that can be administered quite soon after a technology implementation. The measurement of CSE is especially valuable to educators hoping to continuously improve their implementations of technology-enabled learning, allowing for data-driven changes to such applications from term to term.

The next section will review the research on CSE and discuss our hypotheses regarding the relationship among technology complexity, task context, and CSE. The authors then describe the study we conducted to test these hypotheses. We conclude with a discussion of the implications of our findings for the design and implementation of technology-enabled education.

Background

Throughout the history of research into how people use and apply computing systems and technologies, the concept of self-efficacy, a general construct developed in psychology that broadly describes the individual's self-perceived abilities to perform, has been extended to the realm of computing. Leading self-efficacy theorist Albert Bandura defines four main sources of self-efficacy beliefs: mastery experiences, seeing others succeed, verbal persuasion toward success, and emotional and stress reactions (Bandura 1994). Mastery experiences involve successes with a given task and are most effective when successes result after difficulties are encountered. Self-efficacy beliefs may also be strengthened when one sees others' successes, particularly when they are deemed similar to oneself. Verbal persuasion refers to verbal confidence boosts from others that help one believe in one's capabilities to succeed and hence encourages one to put in sufficient effort to succeed. Lastly, people assess their capabilities based on the emotional and stress reactions associated with a given task. When people perceive that negative emotional and stress reactions are associated with a task, they tend to lower their belief in their capabilities, and hence their self efficacy.

In essence, self-efficacy refers to what people believe they are capable of accomplishing (Hasan 2006) and involves development of an "orchestration capacity" for successful accomplishment (Gist and Mitchell 1992). Early research in computer self-efficacy (CSE) focused on the concept of computer literacy, and various theoretical constructs that define computer literacy are closely related to self-efficacy (Beckers and Schmidt 2001). Since that time, CSE has been carefully defined and elaborated.

In a systematic review of the extensive body of research on CSE spanning more than a decade, Marakas and colleagues (Marakas, Yi and Johnson 1998) identified eleven main categories by the principal antecedents to CSE studied by the authors. An review of papers through 2006 confirms the continuing validity of these categories. We identified an additional category in this latter review, the influence of training on CSE. The combined results are summarized in Table 1. A striking finding from this review is that there are fewer studies of the influence of task characteristics than of other categories.

Table 1. *Primary foci of a body of CSE papers, 1987 through 2006*

Number of papers	*Major antecedent to CSE*
24	Gender
11	Anxiety and emotions
9	Initial performance characteristics
8	Verbal persuasion, vicarious experience, feedback
8	Age
6	Task characteristics
2	Time
2	Professional orientation
2	Training
1	Goal setting
1	Direction following

Gender has Faded in Significance

As Table 1 shows, the role of gender has been explored in a large proportion of studies on CSE. Early, pre-Internet studies of computer use tended to show that men had higher initial levels of computer self-efficacy in university settings, but this may have been a result of historical preferences by male students for business curricula, which have long required some degree of computer use, versus the early preference for social and applied sciences by female students (Miura 1987). In recent research, the effect of gender on self-efficacy has receded in importance, and has become secondary to the more salient influence of individual Internet usage (Durndell and Haag 2002). The recent studies that indicate that internet training improves self-efficacy for both genders (Torkzadeh and Van Dyke 2002) tends to reinforce this observation. Although some research has shown a clear relationship between gender and several measures – specifically, that females spent less time on the Internet and hold less positive attitudes about the Internet than their male counterparts (Durndell and Haag 2002) – gender as an antecedent to CSE has faded in significance relative to other factors.

Affect-based Effects are Seen at all Levels

Self efficacy is considered to be at considerable distance on an affective scale from “aversion, fear or apprehension” about the use of information systems (Beckers and Schmidt 2001, p. 35). Beckers and Scmidt hypothesized that high confidence with computers, a low level of negative affective response to computers, low negative arousal about computers, and positive overall beliefs about computers, is associated with self efficacy. Interestingly, the authors’ confirmatory factor analysis showed that self efficacy may influence anxiety-based arousal only through the impact it has on computer literacy. (Beckers and Schmidt 2001). Another study shows that lower anxiety can lead to higher performance levels in subjects in terms of quantity and quality of work outcomes (Brosnan 1998).

The relationship between computer self-efficacy and affect in industry and professional environments has been clearly demonstrated in a variety of contexts. Most studies report that high exposure to technology is associated with decreased anxiety. Other studies identify mediating variables including job characteristics and perceptions of level of exposure. Those with high CSE may be much less likely to experience cynicism and work burnout, are able to better assimilate and apply the results of computer training, and are more likely to transform these elements into increases in work productivity (Salanova, Grau, Cifre and Llorens 2000).

Goal Orientation may Contribute to Task Competency

A strong intrinsic goal orientation tends to reinforce other influences on the development of self-efficacy (Hwang and Yi 2002). Individual expectations play a large role in overall success with computer-based tasks. Such expectations exist in a reinforcing relationship with the development of self-efficacy, both on an individual level and in overall performance (Brosnan 1998). Some studies have also shown that the level of information system self-efficacy developed by faculty themselves is an essential prerequisite to successful integration of new technologies into the classroom. The faculty’s self-efficacy transfers to students in varying degrees (Kagima and Hausafus 2000). Other research has shown that Business majors, in particular, may be more highly predisposed to the demonstration of computer self-efficacy than other student majors, possibly resulting from the fact that computer use may be more consistently required in business courses than in some other programs (Karsten and Roth 1998).

The Role of Training Contributes to Task Competency

Self-efficacy has been shown to evolve over the course of skill development (Mitchell, Hopper, Daniels, George-Falvy and James 1994), and experience with a computer application has consistently shown a strong role in developing computer self efficacy (Eastin and LaRose 2000). Training has consistently been shown to have a strong relationship to performance, which may be expected to contribute to self-efficacy (Compeau, Olfman, Sein and Webster 1995). Educational training exercises have consistently shown a positive relationship with the development of computer and Internet self-efficacy (Karsten and Roth 1998). Although some studies have found that pre-formed attitudes about computers may be of equal or greater importance to the development of computer self-efficacy than actual computer-based training and skills development (Torkzadeh and Van Dyke 2002), more recent research has shown a strong potential contribution to CSE by training experiences (Torkzadeh, Chang and Demirhan 2006).

The Importance of Task, Task Challenge, and Task Context

As noted earlier, a relatively small proportion of studies have focused on task. Yet, the theoretical role of task is explicit or implicit in many models of self efficacy. Individuals "who think they will do well on a task do better" have higher levels of self-efficacy than those who don't (Gist and Mitchell 1992). The importance of the development of self-efficacy in computer tasks has been clearly demonstrated in a large number of academic and professional environments. Self-efficacy can affect the intention to use computerized systems at a number of levels, particularly when it is considered in the context of related mediating variables such as computer experience, computer anxiety, external support, and general perceptions of utility (Igbaria and Iivari 1995). Self-efficacy and confidence may not simply result from the amount of time expended in computer-based tasks. Rather, a successful computer-based task experience is more likely to provide the reinforcement necessary to develop self-efficacy (Ertmer, Evenbeck, Cennamo and Lehman 1994).

Other recent research has shown that the more challenging the computer application used in a task, the more likely a user is to develop higher levels of self-efficacy. It is clear that more challenging computing tasks, such as programming, lead to higher self-efficacy than less demanding computing tasks, such as spreadsheet calculation (Hasan 2003). But computing tasks are not the only source of task complexity. The task context – e.g. the specific task that a program is being coded for or a spreadsheet calculation is being done on – also contributes to the complexity of the situation that a user faces.

A few studies have shown that task context may be more important in reducing anxiety than other predisposing factors (Brosnan 1998). While some research has shown that CSE's contribution to technology utilization is significantly stronger that the contribution of the characteristics of the task itself (Strong, Dishaw and Bandy 2006), and that task may be better considered in parallel to SE than as its antecedent (Bolt, Killough and Koh 2001), there is evidence that task factors may contribute to CSE and subsequent performance on the use of the technology. Campbell (1986) defines task complexity as an interaction between self efficacy and the user's perception of the task itself. A confident user is more likely to perceive a task as less complex, than a user with low confidence in his/her ability to perform the task. Hasan (2007) posited that to minimize users' perceptions of system complexity, trainers should seek to introduce a technology using simple tasks before moving on to more complex applications.

This study combines the elements of complex tasks with the widely varying complexity of current Web 2.0 technologies that are also increasingly used by students and organizational professionals. The term Web 2.0, attributed to O'Reilly (2005), includes a range of second generation applications of World Wide Web technologies. Web 2.0 technologies and applications are unique in their ability to enable social interaction and the development of content by online communities. Two examples of Web 2.0 applications, wikis and blogs, were used in this study to exemplify complex and simple Web 2.0 technologies, respectively. How they exemplify these levels of complexity will be discussed in the Method section of this paper.

To explore the relationship between these Web 2.0 technologies of differing complexity, as well as tasks of differing task complexity (task challenge levels), the following hypotheses were developed.

Consistent with the findings of Hasan (2003) that more challenging computing technologies correlate with higher CSE, the first hypothesis evaluates baseline assumptions about CSE for simple and complex technologies, using new wave Web 2.0 tools that vary distinctly in complexity, using the simple task context.

> H1: In the context of a low challenge task, CSE for users of a complex technology will be higher than for users of a simple technology.

However, the relationship between technology complexity and CSE may be impacted by task context itself (Hasan, 2007). Brosnan (1998) reports that task context may play a part in reducing anxiety which in turn leads to higher performance. Building on H1, we propose two additional hypotheses to thoroughly test the effect of task complexity, or challenge, on the relationship between technology complexity and CSE.

> H2: In the context of a high challenge task, CSE for users of a complex technology will be higher than for users of a simple technology.

H3: Users of complex technology will have higher CSE for a low challenge task than for a high challenge task.

Thus, we are proposing that the relationship between CSE and technology complexity as in Hasan's 2003 findings, will continue to hold when the technologies are applied to a relatively complex and challenging task situation. In conditions of relatively complex and challenging task, we expect that the confidence developed through prior use of a complex technology will reduce their assessments of their CSE. These conditions are summarized in Table 2

Table 2. Proposed relationships between technology complexity and task complexity

	Simple technology	*Complex technology*
Simple task (low challenge)	Condition A	Condition B
Complex task (high challenge)	Condition C	Condition D
	H1: CSE B > CSE A	
	H2: CSE D > CSE C	
	H2: CSE B > CSE D	

Method

Subjects were students in two sections of an advanced, upper-division, capstone business course (total n = 62, 45 + 17) taught in Fall 2007 in a large university in the Western United States. Each section was assigned to use one of two Web 2.0 technologies, wikis or blogs, during the course of the term. Specific requirements for course performance for each subject were based on extensive use of the Web 2.0 technology over the course period, which assured a high level of subject familiarity with the assigned application. A survey was administered at the end of the term to complete the two-group, post-test only field experiment.

Operationalization

In this section we describe the operationalization of the key variables in this study: technology complexity at two levels, task complexity at two levels, and CSE.

Technology Complexity

The two groups in the study were either users of a simple or complex Web 2.0 technology. Blogs were designated as simple technologies because they are relatively easy to set up and conformed most closely to documents commonly posted to the web. This designation was supported by student comments of surprise regarding the ease with which they could set up their accounts and begin writing their blogs. Wikis were designated as complex technologies because of the substantially greater number of advanced functions, including extensive editing and linking features, as well as multiple content and history views. Significant effort was required by each participant to set up wiki platform and learn the theory of wiki interaction. The designation of the wiki as the more complex technology is supported by students, who had many questions about the functionality and application of the wiki.

Task Complexity

Students in the both the blog and wiki groups were presented with questions about two categories of tasks using Web 2.0 technologies. The first of these involved the creation of an information technology strategy based on research on relevant technologies, industries, and companies. This task was designed as the relatively simple task, because it was independent of specific technologies, and was hands-off with respect to actually using the technologies. The task was focused on business analysis, a topic familiar to participants. The second task was significantly more challenging and complex, in that it would require use of specific technologies in a hands-on sense, producing results from the technologies (as opposed to discussing their potential), as well as applying the technologies for group use and developing working prototypes.

CSE Measurement

Scales for the measurement of computer self-efficacy have been developed by a number of researchers, including Torkzadeh et al., Durndell et al., and Karsten, et al. and Compeau et al. (Compeau and Higgins 1995; Durndell and Haag 2002; Karsten and Roth 1998; Torkzadeh and Koufteros 1994). While early scales addressed some of the difficulties of logging on, using disks, and mastering the particular skills needed to put early systems to a minimal level of productive use (Murphy, Coover and Owen 1989), most current scales focus on variants of self-declared self-confidence with information system applications. The tested scales developed by Compeau and Higgins (1995) served as the basis of scales used in this study. We adapted the scales to focus only on the strength dimension of CSE, that is, "the confidence and individual has regarding his or her ability to perform (p. 192)" a broader task that involves the application of computing skills.

A set of thirteen survey questions were developed to evaluate specific dimensions of CSE with Web 2.0 technologies, using a semantic differential scale (not at all confident, totally confident, results coded to 6-point unbalanced scale). Items were adapted from Compeau and Higgins (1995). Each item was further designed to address either the high complexity (high technology challenge) task, or the relatively low complexity (low technology challenge) task. Items one through twelve are reported in Table 3:

Results

Significant differences were found in self-efficacy between the groups, as well as for several specific items, as shown in Table 3.

The significant results show:

1) Contrary to H1, a highly significant opposite relationship was found for technology complexity, such that simple Web 2.0 technologies were associated with higher CSE than for complex technologies, in the context of a low challenge task.
2) In the context of the high challenge task, the users of the simple technology showed significantly higher CSE than users of the complex technology, supporting a reverse relationship than that proposed in H2.

Table 4 presents these results, and Table 5 presents the means of the response items.

Discussion

Self efficacy of students with new technologies can be considered an important indicator of the self-efficacy trends both of student populations and of the organizational employees that they will soon become. In spite of the fact that many varieties of user-friendly Web 2.0 technologies, such as social networking applications, are widely used by students, comparatively little has been known about the self-efficacy of students using simple versus complex versions of these technologies. Little is known as well regarding the effects of applying these technologies to highly complex tasks.

In contrast to prior research (Hasan 2003), our study found that more challenging technologies did not lead to higher CSE. In fact, an opposing finding was confirmed, in spite of the fact that the students were at the completion of an information systems concentration, and hence presumably had above average familiarity and comfort with computing technologies. Secondly, our study found that simple technologies did lead to higher CSE in a complex task context, also contradicting the second hypothesized relationship. Our findings suggest that complex task contexts change the relationship between technology complexity and CSE. A complex task context leads to heightened anxiety and undermines users' efforts at building CSE for a given technology. In such contexts, users are more able to build their CSE for a simpler technology rather than a complex one. Paying attention to task

Table 3. Scaled survey questions

Task complexity (tech challenge of task)	*Self-efficacy item text (I am confident that I can . . .)*
Simple (technology independent, hands-off)	. . . assess materials for research on emerging tech, industries, companies
	. . . assess emerging tech's future and prospects
	. . . work with a team to analyze the potential of emerging tech app
	. . . work with a team to assess the costs and benefits of emerging tech app
	. . . work with a team to develop a strategy to deploy Web 2.0 in a business setting
	. . . analyze the application of an emerging tech's application in a specific bus or NPO
Complex technology specific, dependent,and hands-on)	. . . learn and integrate (wikis, blogs) in and out of classes
	. . . learn and integrate (wikis, blogs) to coordinate meetings and activities with teammates
	. . . work with a team to develop a strategy to deploy (wikis, blogs) in a business setting
	. . . learn and integrate Web 2.0 tools to coordinate meetings with my teammates
	. . . learn and integrate Web 2.0 tools into my daily activities, in and out of classes
	. . . develop a Web 2.0 prototype and business case

Table 4. Analysis of scaled items

Hypothesis	*Quantitative data*	*Summary*
H1: For low challenge task, CSE for users of complex tech higher than for users of simple tech	Opposite relationship strongly supported. ($t = 2.79$, $p = 0.003$)	Significant support for opposite relationship
H2: For high challenge task, CSE for users of complex tech higher than for users of simple tech	Opposite relationship strongly supported. ($t = 2.28$, $p = 0.013$)	Significant support for opposite relationship
H3: Users of complex technology will have higher CSE for a low challenge task than for a high challenge task	Results not significant at standard alpha level (0.05)	Not supported

complexity is important particularly when training users on the use of novel, emerging, complex technologies. Our finding support Hasan's (2007) more recent suggestion that simpler tasks are best used in the introduction of new technologies – leading up to the use of complex tasks as users develop higher CSE.

Table 5: *Means of response items*

Self-efficacy item text (I am confident that I can . . .)	*Means, simple tech*	*Means, complex tech*
… assess materials for research on emerging tech, industries, companies	5.118	4.600
… assess emerging tech's future and prospects	5.353	4.600
…. work with a team to analyze the potential of emerging tech app	5.235	5.180
… work with a team to assess the costs and benefits of emerging tech app	5.188	4.780
… work with a team to develop a strategy to deploy Web 2.0 in a business setting	5.118	4.670
… analyze the application of an emerging tech's application in a specific bus or NPO	5.059	4.500
… learn and integrate (wikis, blogs) in and out of classes	5.412	4.960
… learn and integrate (wikis, blogs) to coordinate meetings and activities with teammates	5.410	4.890
… work with a team to develop a strategy to deploy (wikis, blogs) in a business setting	5.059	5.020
… learn and integrate Web 2.0 tools to coordinate meetings with my teammates	5.412	4.640
. . . learn and integrate Web 2.0 tools into my daily activities, in and out of classes	5.471	4.800
… develop a Web 2.0 prototype and business case	5.059	4.470

This study presents interesting implications for education of students in the new, more challenging technologies that will inevitably arise, as well as for the opportunities to train students in applying complex technologies in realistic contexts, generally more complex than the one's found in the classroom. In the context of highly challenging tasks, users of new, complex technologies may experience an overload of complexity. To help users in such contexts, it may be best to reduce complexity by giving users experience with applying the complex technologies to simple tasks first, thereby building their CSE. Only when this has occurred would it be advisable to introduce applications of the technology to more complex tasks. In this way student engagement is encouraged by exposing students to a mix of task and technology complexity that provides an optimal level of challenge without overwhelming them (Nakamura and Csikszentmihali, 2005; Shernoff, Csikszenmihalyi, Scheider, and Shernoff, 2003).

The findings of this study are especially pertinent for continuing education students. Often, continuing education students rely on online learning platforms to participate in their courses and/or do their assignments. They also generally do not benefit from easy access to the information technology support structure of a university. Hence, providers of online continuing education need to pay special attention to the relationship between their online technology platform and the course tasks assigned to their students. To enhance learning by their students, it may be necessary to coordinate the level of course complexity with the level of complexity of the technology platform used in their online courses. Providing a gradual build-up of technology complexity in synch with the increasing complexity of course tasks will ensure that students do not get overwhelmed. It will also be useful to provide a separate online orientation that can help students build confidence with the technology platform before participating in online courses.

The authors see the need to continually adjust our understanding of CSE to adapt to new categories of technologies – exemplified here by Web 2.0 tools -- with a view to preparing for the challenges of the increasing frequency of their introduction in increasingly complex environments and pervasiveness across all types of organizations. By providing students with instruction and experience in applying these new technologies in the complex organizations they are about to join, educators help students successfully apply the technologies in these organizations. Furthermore, students gain the knowledge to see the Web 2.0's potential beyond the personal-level applications (e.g. myspace profiles) most familiar to their generation.

Limitations

While this study did obtain statistically significant results, the sample size was relatively small and was focused within information systems majors in a business school, and thus its generalizability to external user communities may be limited. As a field study, it was impossible to have full control over all independent variables identified as antecedents of CSE. Further research is needed to investigate these findings in other student contexts and in the workplace.

Conclusion

Few prior studies of factors impacting computer self efficacy (CSE) focused on the effect of complex technologies and tasks. This study looked at the impact on CSE of complex technologies and tasks by studying the application of current Web 2.0 technologies in courses involving complex tasks. .This study is useful in updating our understanding of student self efficacy for cutting-edge technologies and complex task contexts, both of which are expect to appear at an increasing rate in academic and organizational environments.

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