Available online at www.sciencedirect.com
ScienceDirect
Computers in Human Behavior 23 (2007) 175–191
Computers in Human Behavior
www.elsevier.com/locate/comphumbeh

Self-efficacy and college students' perceptions and use of online learning systems

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Available online 10 May 2004

Abstract

This research hypothesized a mediated model in which a set of antecedent variables influenced students' online learning self-efficacy which, in turn, affected student outcome expectations, mastery perceptions, and the hours spent per week using online learning technology to complete learning assignments for university courses. The results are consistent with the inference of a partially mediated model in which the block of antecedents had a direct effect on self-efficacy, a direct influence on the outcome measures, and an indirect effect on the outcomes through their influence on self-efficacy. In general, the findings suggest that the relationships between self-efficacy, its antecedents, and several online learning outcomes are more complex than has typically been recognized in the research.

1. Introduction

Technology is increasingly shaping how learning experiences are delivered. A variety of computer-based technologies such as authoring tools, multimedia servers, learning catalogs, e-mail, and various software platforms are becoming an essential part of college classrooms. Online learning systems such as BlackBoard, Semester Book, or WebBoard have become increasingly popular because they make available a range of components

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0747-5632/$ - see front matter
doi:10.1016/j.chb.2004.04.004

that are seen as capable of enhancing learning and instruction. These components often include:

- Authoring and assembly tools (e.g., multimedia, HTML) that can be used to create learning content.
- Storage and distribution components such as test and resource banks.
- Synchronous and asynchronous interactive components (e.g., email, chat rooms, discussion boards) that allow learners and instructors to build 'real-time collaborative learning environments.
- Learning management elements that instructors can use to direct and administer the learning process (Robson, 2002).

The incorporation of these technological elements into online learning systems is believed to provide a number of significant instructional advantages. For example, these systems are seen as having the ability to:

- Overcome the time and place constraints on instruction found in traditional classrooms.
- Make available to students a greater breadth of information about course topics.
- Provide a means to more closely monitor and facilitate student progress.
- Encourage more 'chair-time' and 'time-on-task'.
- Facilitate more active participation and interaction.
- Provide instructors with an increased range of instructional techniques and options.

Although advocates of online learning systems see great potential, critics have outlined a number of potentially troubling issues. There have been suggestions, for example, that the design and implementation of these systems are often done with little reference to the body of laws or principles of learning (Salas & Cannon-Bowers, 2001). These authors suggest that a science of e-learning has yet to evolve and that, until it does, many issues about how to best design these systems to enhance learning will remain unanswered.

There are also a number of critical issues related to students' reactions to these technologies. There are indications that as many as one-third of college students suffer from technophobia (DeLoughery, 1993), or a fear of computer and information technology. This may be compounded by the instructional demands of online learning technology which requires students to be capable of using a variety of computer-related technologies such as e-mail, internet search engines, chat rooms, databases and so on (Kinzie & Delcourt, 1991). Multiple demands of this kind can leave students feeling shocked, confused, at a loss for personal control, angry and withdrawn (Sproull, Zubrow, & Kiesler, 1986). Such reactions could certainly impair students' belief in their capacity to use and learn from the technology and undermine their motivation to use them in the future.

It is also important to note that students' use of online learning technology in university and college classrooms is generally non-volitional. That is, when course activities and requirements are built around online learning technology, students have little choice about whether or not to use the technology. Under these conditions the influence of individual attitudes, perceptions, and beliefs on student use of the technology, learning, or other important outcomes may be substantially amplified (Gutek, Winter, & Chudoba, 1992 cited in Henry & Stone, 1994).

These kinds of considerations underscore the critical importance of understanding how students react to and use e-learning technology in college and university classrooms. A good deal of research has been done in the last decade examining individual attitudes, beliefs, and perceptions of computer-based instruction and information technology (IT). However, this research has tended to focus on user attitudes and anxiety constructs and how these are associated with individual difference variables (e.g., gender) and system design features. Much of it has also been criticized because it has not been grounded in theoretical models that would provide more concrete insights into the causes of individual reactions (Henry & Stone, 1994).

On the other hand, one promising area of research, grounded in social cognitive theory (SCT) (Bandura, 1982), has focused on self-efficacy as a predictor of individual perceptions and use of computing technology (e.g., Decker, 1998; Gist, Schwoerer, & Rosen, 1989; Hill, Smith, & Mann, 1986, 1987). In general, this research has shown that individuals "are constantly making decisions about accepting and using computer technology" and that self-efficacy plays an important role in these decisions (Venkatesh & Davis, 1996, p. 452).

The present study seeks to extend current research on the role of self-efficacy in reactions to and use of computer technology in three key areas. First, with few exceptions (e.g., studies by Compeau, Higgins, & Huff, 1999; Henry & Stone, 1994) the previous research in this area has focused on the role of self-efficacy as a correlate or predictor of various outcomes related to computer acceptance and use. For example, studies have shown self-efficacy to be a significant predictor of computer technology use among college students (Kinzie & Delcourt, 1991; Kinzie, Delcourt, & Powers, 1994; Prieto & Altmaier, 1994), student attitude towards computer technologies (Kinzie & Delcourt, 1991), intentions to learn about computers (Hill, Smith, & Mann, 1987), and desirability of learning computer skills (Zhang & Espinoza, 1998). Consistent with SCT, findings such as these suggest that self-efficacy beliefs play a mediating role between prior experiences and present outcomes (Bandura, 1997). In general, however, past research has interpreted self-efficacy as a mediator without statistically testing for such a relationship. Evaluating the mediating role of self-efficacy in the context of online learning technology would provide a better understanding of the functional properties of self-efficacy and further clarify what factors may account for differences in individual reactions and behavior when using online learning technology.

A second limitation of previous research has been that it has not fully examined the factors that may contribute to the development of individual self-efficacy in computer-mediated learning settings. Most of the research appears to be concerned with outcomes of self-efficacy beliefs rather than the factors that foster those beliefs. Without a more complete understanding of the antecedents of self-efficacy our capacity to design instruction or other interventions to build efficacy beliefs and facilitate acceptance and use of online learning technology is limited. The present research seeks to identify and test a number of theoretically based factors believed to contribute to the development of efficacy beliefs.

Finally, little self-efficacy research has been extended to some of the newer computer-based learning technologies such as CD-ROM databases, e-mail (Kinzie et al., 1994), and, most importantly, the online learning systems popular today on college campuses.

The objective of the present research was to empirically examine several key antecedents of self-efficacy and test the role of online learning self-efficacy as a mediator between these antecedents and perceptions and use of online learning technology in university

classrooms. The variables examined in this study are shown in Fig. 1 and are described in more detail below. This research hypothesized a mediated model in which a set of antecedent variables influence students' online learning self-efficacy that, in turn, affects student outcome expectations, mastery perceptions, and the hours spent per week using online learning technology to complete learning assignments.

2. Self-efficacy and its antecedents

Self-efficacy refers to one's personal judgments about his or her performance capabilities in a given domain of activity (Schunk, 1985). Efficacy beliefs are self-regulatory mechanisms that can influence choice of behavior (e.g., to use or avoid online learning systems), motivation (e.g., effort and persistence in using online learning technology), level of performance, and the level of stress experienced under demanding circumstances (Bandura, 1991).

Individual efficacy appraisals occur most often when people encounter novel, unpredictable or demanding tasks (Bandura, 1982). Thus, students encountering online learning systems for the first time or applying these systems to new learning tasks will likely generate and process efficacy information relative to this technology. Whether accurate or faulty, efficacy beliefs can, over extended periods of time, influence "choices about what technologies to adopt, how much to use them, and how much to persist in the face of obstacles to successful use of such technologies" (Compeau et al., 1999, p. 155).

Self-efficacy beliefs are the product of multiple sources of efficacy information (Bandura, 1991). Key sources of this information include enactive mastery (e.g., past performance accomplishments resulting from previous experiences or training), verbal persuasion such as that resulting from collaboration and performance-related corrective feedback, and physiological arousal including changes in emotional states such as anxiety, fear, or positive anticipation (Bandura, 1982).

2.1. Enactive mastery: Past performance and training

Students approach learning situations with various prior experiences. Those experiences are closely evaluated producing information that is used to make judgments about present capabilities (Bandura, 1991). As SCT suggests, performance successes, particularly in the face of adversity, reinforce efficacy beliefs but failures create doubt and undermine self-beliefs of capability (Wood & Bandura, 1989b). In general, therefore, past success with online learning technology would be expected to lead to higher self-efficacy whereas poor past performance would tend to lower self-efficacy.

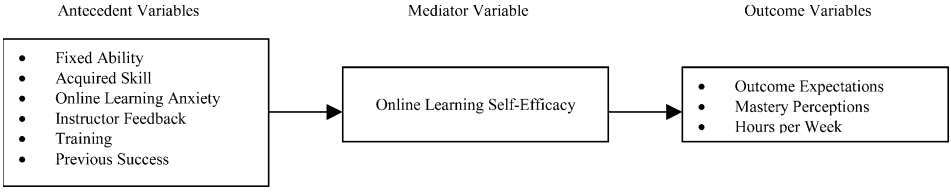

Fig. 1. Research model.

The successful use of online learning technology requires the application of strategies or a set of sequenced operations that students apply to meet learning demands. Training can help students learn these strategies and it can build efficacy beliefs that will foster their use. This suggests that students using online learning technology who receive training early in the course from their instructors about how to use various elements of online learning systems, and have opportunities to practice those behaviors may exhibit higher levels of self-efficacy than students who do not receive such training.

2.2. Performance feedback

The development of efficacy beliefs requires that individuals get clear information about their mastery and acquisition of knowledge or skills being pursued. Instructor feedback about performance supports this process by clarifying the outcomes and pattern of progress being made and by providing data upon which efficacy judgements can be made. Thus supportive feedback from a university instructor or professor about a student's performance in completing course assignments using online learning technology could be an important source of efficacy information. Efficacy beliefs would be expected to mediate the relationship between this feedback and subsequent perceptual and behavioral outcomes.

2.3. Physiological states

Social cognitive theory also suggests that physiological states such as anxiety, stress, and fatigue can provide efficacy information. Strong emotional reactions to a task are believed to provide cues about the level of success or failure that can be anticipated in completing that task (Pajares, 1997). Thus when task demands associated with using an e-learning system produce symptoms of stress (sweating, anxiety) or negative affect (apprehension), students may interpret these to indicate they don't have the capability to complete the task(s) successfully. By the same token, when these reactions are no longer present (e.g., after the student develops some expertise) recognition that they are no longer reacting negatively could lead to a heightened sense of self-efficacy (Schunk, 1985).

2.4. Nature of online learning ability

One other potentially important influence on efficacy judgments that has not been examined in the context of computer or information technology relates to how individuals perceive the nature of online learning ability. Wood and Bandura (1989b) suggest that, in complex decision-making environments, whether an individual perceives ability as an alterable and acquirable skill or a relatively fixed capacity can influence efficacy beliefs and subsequent performance. Thus, it is possible that students who perceive the ability to use this technology as a relatively fixed aptitude would be less apt to report high efficacy levels or positive expectations about the learning outcomes of using online learning technology. Consequently, they are also likely to feel they had acquired relatively more modest levels of mastery as a result of using these systems. Students who view this ability as an alterable and acquirable skill would be more likely to see these systems as a way to expand their learning and would be more apt to report higher self-efficacy levels, have more positive expectations about online learning outcomes, and consequently feel they had acquired relatively greater mastery.

3. Methodology

3.1. Subjects

Subjects in this study were 288 students enrolled in a variety of courses at a large public university in the Southern US. In terms of student status, the sample was 9% freshman, 8% sophomores, 16% juniors, 33% seniors, 30% Masters students, 3% Ph.D. students, and 2% non-matriculating students. Twenty-seven percent of the students were under 21 years of age, 57% were 21 to 29, and 16% were 30 or older. Eighty-two percent were full-time students. The sample was largely female (72%).

3.2. Procedure

Data reported here were collected from students during the last two weeks of a recent Spring semester. Data were collected from 19 courses that were using a popular e-learning system (BlackBoard®) as a part of instruction. These graduate and undergraduate courses represented various fields of study including English, Speech and Communications, Business Administration, Social Work, Library Science, and Human Resource Development. Permission to include a particular class in the study was first obtained from the course instructor who was contacted in person or by telephone. Once permission was obtained, one of the authors visited the class, explained the nature and goals of the study, and asked for volunteers to participate in the study. Surveys were distributed and collected in the class at that time.

3.3. Instrumentation

A 44-item survey was used to collect the data in this study. The first part of the instrument, the online learning technology self-efficacy measure, was adapted from a computer self-efficacy measure developed and validated by Compeau and Higgins (1995) and Compeau et al., 1999. The authors developed the other scales used in this study with the assistance of several content judges who had expertise in the use of online learning systems. Drawing on a review of relevant literature, scale items were drafted by the authors and submitted to the content judges for review. Based on their feedback, items were added, dropped or reworded where necessary. A preliminary questionnaire was pilot tested with a group of 38 students and instructors. Feedback from this pilot test led to minor modifications in the wording of several items. All scales other than self-efficacy and mastery perceptions used a five-point Likert-type scale with values ranging from 1 (strongly disagree) to 5 (strongly agree). Descriptions of the latent constructs are presented in Table 1.

3.4. Online learning self-efficacy

Compeau and Higgins (1995) developed a measure of computer self-efficacy that has shown evidence of construct as well as criterion-related validity (Compeau et al., 1999). Because self-efficacy judgments have the greatest explanatory power when matched to specific tasks and situations (Bandura, 1986) the wording of Compeau & Higgin's original items were modified slightly to more specifically reflect the requirements of online learning systems in college classrooms. Items in the online learning self-efficacy measure consisted

Table 1
Scale names and definitions

Online learning system self-efficacy (adapted from Compeau and Higgins, 1995) – the extent to which people feel confident in their ability to successfully use online learning technology to complete the learning task requirements of college courses
Outcome expectations – respondents' expectation that the use of online learning technology will lead to learning-related outcomes valued by the individual
Previous online learning system success – the extent to which respondents believe they have been successful in their previous experiences with online learning system technology
Pre-course training – the extent to which respondents perceived they received training in how to use online learning technology systems to complete learning assignments at the beginning of the course
Fixed ability – the extent to which respondents felt that the ability to effectively use online learning technology was for them a relatively unchangeable skill that could not be easily improved
Acquired ability – the extent to which respondents felt that the ability to use online learning technology effectively was a skill that could with modest effort be acquired and improved
Instructor feedback – the extent to which respondents felt they received prompt and regular feedback from the course instructor about their performance using online learning technology to complete course assignments
Online learning technology anxiety – the extent to which respondents felt nervous or threatened about using online learning technology to complete course requirements

of a stem (''I could complete the online learning requirements of a college course using online learning technology...'') and a series of phrases that completed the stem (e.g., ''...if I had never used technology like it before''). Respondents were asked to rate their level of confidence in their ability to complete the tasks described in each of the items. Ratings were made on a 10-point scale that used three anchors (1, not at all confident; 5, moderately confident; 10, totally confident).

3.5. Predictor variables

Six factors believed to be antecedents to online learning self-efficacy were assessed. Previous success with online learning technology (8 items), pre-course training (4 items), instructor feedback (4 items), fixed ability (4 items), acquired ability (4 items), and online learning system anxiety (5 items).

3.6. Outcome variables

Three outcome measures were collected in this study: outcome expectations, skill mastery, and number of hours spent per week completing course-related online learning activities. Data for each of these measures were collected via self-report. Outcome expectations were assessed using a five-item scale that tapped students' perceptions of the learning outcomes they believed could accrue from the use of online learning systems. Research (e.g., Keller & Suzuki, 1988; Stone & Henry, 2003) has identified learner expectations as one of the key motivational factors affecting the use of computers for instructional purposes. Clearly, creating positive expectations both that effort devoted to using online technology will lead to effective learning and that such learning will lead to outcomes valued by the student can be critical to student commitment to and use of the success online learning systems. In addition, efficacy beliefs are likely related to learning-related expectancies to the extent that ''one cannot conjure up outcomes without giving thought to what one is doing and how well one is doing it'' (Bandura, 1997, p. 232). Thus we expected students

reporting higher levels of online learning self-efficacy would be more likely to anticipate positive, successful learning outcomes from the use of online learning systems than those reporting lower self-efficacy beliefs.

Mastery perceptions were measured with a single item that asked respondents to rate the extent to which they felt they had mastered the use of online learning technology. A 10-point scale was provided with anchors at 1 (no mastery at all), 5 (moderate mastery), and 10 (total mastery). Mastery perceptions are distinguishable from self-efficacy to the extent they reflect a narrow judgment about the level of mastery in using online learning technology that an individual has attained. Self-efficacy, on the other hand, is seen as a more inclusive construct that taps a person's confidence in his or her capacity to integrate a broad set of cognitive, social, and behavioral skills when using this technology for learning. In short, the former represents a judgement about the level of personal command achieved and the latter a judgment about an individual's confidence to use online technology for learning. We expected these constructs to be related insofar as mastery perceptions would be at least partially dependent on an individual's efficacy beliefs. A reverse path is also likely to operate between these factors but was not of interest in this study.

Hours per week spent using online learning technology to complete learning assignments was collected using a forced-choice item in which students were asked "On average, about how many hours per week did you spend completing online learning activities for this course". Response choices included 1 or less, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15 or more. Since time-on-task is a potentially important instructional advantage of online learning systems, one of our interests was to evaluate whether efficacy beliefs influenced the amount of time students spent completing online learning assignments.

3.7. Analysis

Common factor analysis was used to identify the latent construct structure of the survey items. Common factor analysis is considered more appropriate than principal component analysis when the objective is identification of latent structures (Nunally & Bernstein, 1994) and more accurate than principal component analysis when the data correspond to the assumptions of the common factor model (Fabrigar, Wegener, MacCallum, & Strahan, 1999). Oblique rotation was employed because of its suitability for latent variable investigation when latent variables may or may not be orthogonal (Hair, Anderson, Tatham, & Black, 1998). The initial criterion used to determine the number of factors to retain was an eigenvalue greater than or equal to one. In the analysis (a) factor loadings reflected interpretable simple structures; (b) only items with loading 0.40 or higher were included in the scales; and (c) average item loading values were greater than 0.50 on major factors and less than 0.05 on other factors for all scales. All of the scales exhibited acceptable levels of internal consistency as measured by Cronbach's α.

Bivariate correlations were calculated to examine the direction and magnitude of inter-variable associations. Hierarchical regression analysis was used to determine whether the mediated model provided a reasonable description of the relations among variables. A mediator has been described as a variable "that accounts for the relation between the predictor and the criterion" (Baron & Kenny, 1986, p. 1176). James and Brett (1984) describe two types of mediators, complete and partial. Complete mediation occurs when the mediating variable "transmits all of the influence of the antecedent x to a consequence y, which implies that x and y are indirectly related" (p. 310) and that the relationship between x and

y disappears when the mediator z is controlled for. Thus the independent variable significantly affects the mediator; the mediator significantly affects the dependent variable; and controlling for the mediator produces a nonsignificant relationship between the independent and dependent variables. Partial mediation occurs when the independent variable has a direct effect on the dependent variable as well as an indirect effect through the mediator (James & Brett, 1984). Partial mediation is suggested when controlling for the mediator does not attenuate the significant relationship between the independent and dependent variables.

Our model suggests an $x \rightarrow z \rightarrow y$ theory in which self-efficacy (z) mediated the relationship between a block of predictor variables (x) and three outcome measures (y_1, y_2, y_3). To infer support for a mediated model using hierarchical regression several statistical conditions must be met (Baron & Kenny, 1986; Rosenberg, 1968). Specifically, for each dependent variable three regression analyses need to be run to determine if self-efficacy functions as a mediator. A fourth regression analysis provides information about the nature of the mediated relationship (complete or partial mediation). In the first analysis, the predictor block is regressed on the outcome variable ($x \rightarrow y$). Second, the mediator variable is regressed on the outcome measure ($z \rightarrow y$). Third, the predictor block is regressed on the mediator ($x \rightarrow z$). To infer support for a mediated relationship between the variables each of these regression equations must be significant. Finally, to obtain information about the nature of the mediation a hierarchical regression analysis is performed in which self-efficacy (the mediator) is regressed on the outcome measure ($z \rightarrow y$) and the block of predictor variables (x) is added as a second step. If adding x contributes significantly to the variance explained by the regression equation and $z \rightarrow y$ remains significant this suggests the presence of partially mediated relationship (i.e., one in which there are both direct and mediated effects). If adding x does not yield a significant R^2 increment, then there is evidence of complete mediation. This four-step regression process was performed for each of the three outcome measures.

4. Results

4.1. Regression diagnostics

Diagnosis of the data did not reveal any serious violations of regression assumptions, multicolinearity, or the presence of influential observations.

4.2. Descriptive statistics

The means, standard deviations, and intercorrelations for all measures are shown in Table 2. Examination of the intercorrelations suggests several noteworthy patterns. First, the one-tailed correlations among variables were generally low to moderate suggesting the measures used in this study were assessing different constructs. Second, self-efficacy showed significant correlations with all variables except hours spent, instructor feedback, and pre-course training. All of the associations were in the expected direction. Third, the means for the instructor-related variables, pre-course training and feedback (3.11 and 3.02, respectively), were relatively neutral suggesting course instructors in this study were perceived as providing at best only modest levels of feedback and pre-course training to students. Both of these factors were significantly associated with higher outcome

Table 2
Means, standard deviations, coefficients α and intercorrelations

Scale	α	Mean	SD	N	1	2	3	4	5	6	7	8	9	10
1 Outcome expectations	0.87	3.40	0.72	287	–									
2 Mastery	–	7.21[a]	1.93	280	0.25**	–								
3 Hours/week	–	3.35	2.90	257	0.14*	0.05	–							
4 Fixed ability	0.80	2.12	0.78	286	−0.05	−0.25**	0.12	–						
5 Acquired skill	0.78	4.31	0.51	284	0.37**	0.34**	0.02	−0.26*	–					
6 Anxiety	0.93	2.19	0.97	286	−0.26**	−0.56**	0.11	0.39**	−0.31**	–				
7 Feedback	0.91	3.02	0.91	287	0.14*	0.16**	0.24**	0.05	0.14*	−0.02	–			
8 Previous success	0.91	3.49	0.75	285	0.51**	0.56**	0.06	−0.20**	0.45**	−0.62**	0.20**	–		
9 Training	0.71	3.11	0.84	287	0.12*	0.19**	0.08	0.04	0.23**	−0.02	0.45**	0.20**	–	
10 Self-efficacy	0.95	7.40[a]	1.83	285	0.26**	0.56**	−0.12	−0.32**	0.38**	−0.56**	−0.05	0.48**	−0.02	–

[a] Mean calculation based on a 10-point scale.
* $p \leqslant 0.05$ (one-tailed).
** $p \leqslant 0.01$ (one-tailed).

expectations and mastery perceptions but not with self-efficacy. Fourth, the ability-related constructs (fixed ability, acquired skill) were associated with self-efficacy (−0.32, 0.38 respectively, $p \leqslant 0.01$) and mastery perceptions (−0.25, 0.34, $p \leqslant 0.01$) in the expected directions. Neither of these factors showed a correlation with hours spent. Finally, online learning system anxiety showed negative correlations with outcome expectations (−0.26), mastery perceptions (−0.56), previous success (−0.62), and self-efficacy (−0.56) but a positive correlation (0.39) with fixed ability perceptions. It is interesting to note that this last finding suggests that students who view their ability to use online learning systems as a fixed aptitude are more likely to be anxious about using those systems as learning tools.

4.3. Mediated model evaluation

The steps for testing for mediation are shown in Table 3. Results show, first, that the block of independent variables was a significant predictor of each of dependent variables including outcome expectations ($R^2 = 0.29$, $p \leqslant 0.05$), mastery perceptions ($R^2 = 0.42$, $p \leqslant 0.05$), and hours spent per week ($R^2 = 0.09$, $p \leqslant 0.05$). Second, in each of the regression models self-efficacy was a significant predictor of the dependent variable: outcome expectations ($R^2 = 0.07$, $p \leqslant 0.05$), mastery perceptions ($R^2 = 0.32$, $p \leqslant 0.05$), and hours spent per week ($R^2 = 0.02$, $p \leqslant 0.05$). Third, the block of predictor variables was a significant predictor of e-learning system self-efficacy ($R^2 = 0.40$, $p \leqslant 0.05$). These results support the inference that online learning self-efficacy mediates the relationship between the independent variables and each of the outcome measures in this study.

To obtain information about the nature of the mediation, a fourth regression analysis was performed. The results of this analysis showed that self-efficacy was a significant predictor in each regression model; the addition of the antecedent variables significantly increased the variance explained for outcome expectations ($R^2_{\text{change}} = .23, p \leqslant 0.05$), perceived mastery ($R^2_{\text{change}} = 0.16, p \leqslant 0.05$), and hours spent ($R^2_{\text{change}} = 0.09, p \leqslant 0.05$); and self-efficacy remained a significant predictor after the addition of the antecedent variables. These results indicated that, after controlling for self-efficacy, the significant relationship between the independent and dependent variables was not removed or reduced to non-significance. This finding does not support the hypothesized fully mediated model. Rather, online learning self-efficacy appears to have partially mediated the relationship between the antecedent variables and the dependent variables in these regression models.

Examination of the beta weights provides a basis for examining the relative importance of the predictor variables in this study. Several interesting points emerge from this analysis. First, previous online learning success was the only variable with significant beta values across all dependent variables. Second, neither of the instructor-related variables (instructor feedback or pre-course training) showed consistently significant beta values across outcome measures. Third, the perception that the capacity to use online learning technology is an acquired skill emerged as an important variable relative to the other predictors in regression models when self-efficacy and outcome expectations were dependent variables. Finally, examination of the beta value and correlation coefficient for feedback showed some discrepancy with respect to self-efficacy. The simple correlation between feedback and self-efficacy was positive (as expected) yet the beta value for feedback in the regression model with self-efficacy as the dependent variable was negative. The negative beta weight indicates that *lower* levels of instructor feedback made this factor a better predictor of self-efficacy beliefs. This finding appears to be counterintuitive given the

Table 3
Regression analyses testing for mediation

Dependent variables	Models									
	$x^{a} \rightarrow y^{b}$		$z^{c} \rightarrow y$		$x \rightarrow z$		$z \rightarrow y + x$			
	R^2 Adj R^2	$F_{\text{model/df}}$	R^2 Adj R^2	$F_{\text{model/df}}$	R^2 Adj R^2	$F_{\text{model/df}}$	R^2 Adj R^2	$F_{\text{model 1/df}}$	$F_{\text{model 2/df}}$	R^2_{change}
Outcome expectations	0.29	19.23*/6276	0.07	20.62*/1282	0.40	29.99*/6273	0.30	20.37*/1278	16.57*/8272	0.23*
	0.28		0.07		0.38		0.28			
Mastery	0.42	31.71*/6268	0.32	126.73*/1275	0.40	29.99*/6273	0.48	124.26*/1270	34.38*/7264	0.16*
	0.40		0.31		0.38		0.46			
Hours/week	0.09	3.92*/6245	0.02	3.84*/1254	0.41	29.99*/6273	0.09	3.75*/1249	3.50*/7243	0.09*
	0.07		0.01		0.40		0.07			

[a] x = predictor block (fixed ability, acquired skill, instructor feedback, pre-course training, previous success, online learning technology anxiety, *gender*).
[b] y = dependent variable (outcome expectations, mastery, hours per week).
[c] z = mediator variable (online learning technology self-efficacy).
* $p \leqslant 0.05$.

expectation that performance feedback would provide information about outcomes and skill acquisition that is needed to make efficacy judgements. However, as noted earlier mean scores for instructor feedback suggested that the instructors in this study provided only modest levels of feedback about students' capacity to use online learning technology effectively. It is possible therefore that students who completed their online learning assignments with relatively minimal instructor feedback attributed their success to personal ability and consequently developed higher self-efficacy than those given greater assistance. This interpretation is consistent with speculations by Schunk (1985) about the relationship between external aid, attributions, and self-efficacy.

Determining which of these explanations is most appropriate is constrained by the inherent difficulty of interpreting situations in which the regression weight for a variable is different from its simple correlation with a criterion measure. Beta weights are highly variable and are dependent on all the intercorrelations in a regression model making it difficult to account for unexpected relationships in models with even a modest number of predictors (Bobko, 1995). Certainly more research is needed to investigate how variations in instructor feedback (e.g., type, frequency) interact with ability attributions to influence the development of self-efficacy in the context of online learning systems (see Table 4).

4.4. Limitations

There are several limitations in this study that deserve mention. First, this study relied on self-report and survey data. Although the correlation matrix indicated a relatively wide range of correlations, most generally consistent with expectations, common method variance could have inflated the correlations or affected the observed relationships in other unknown ways. On the other hand, some researchers have suggested that method bias may not be as serious a problem as has been assumed (Spector, 1987) and that the seriousness of the bias depends on the research question. For instance, when perceptions are the object of empirical interest, method bias may not be a serious issue (Clark, Dobbins, & Ladd, 1993). Although we do not suspect that method bias significantly affected the pattern of results in this study, the use of additional data collection strategies (e.g., direct observation) would have strengthened the validity of our findings. Second, the cross-sectional nature of the data as well as the analytical technique employed means that the causal relationships between variables in this study can only be inferred. Cultivating more

Table 4
Beta weights for predictor variables

Predictors	Dependent variables			
	Self-efficacy	Outcome expect	Mastery	Hours/week
Fixed ability	−0.09	0.07	−0.04	0.04
Acquired skill	0.15*	0.20*	0.02	0.01
Anxiety	−0.36*	0.10	−0.24*	0.16
Feedback	−0.11*	0.04	0.07	0.22*
Previous success	0.20*	0.47*	0.22*	0.18*
Training	−0.05	−0.03	0.10*	−0.06
Self-Efficacy	–	0.04	0.32*	−0.09

* $p \leqslant 0.05$.

valid insights about the causal antecedents and effects of online learning self-efficacy beliefs would benefit from future research employing experimental or longitudinal designs.

5. Discussion

There is a general paucity of research directly examining the antecedents to self-efficacy and its role as a mediator in the use of online learning systems among college students. The purpose of this study was to investigate the role of online learning self-efficacy as a mediator between a set of antecedent variables and three outcome measures that reflected student outcome expectations about the use of online learning systems, mastery perceptions, and hours-spent using the technology to complete learning assignments. According to social cognitive theory, antecedent variables such as students' previous success with online learning technology, instructor feedback, anxiety, pre-course training, and the perceived nature of online technology ability may be important factors because they provide cues used in making efficacy judgements.

The results were consistent with the inference of a partially mediated model. In this model, the group of antecedent factors was found to predict online learning self-efficacy beliefs. Self-efficacy beliefs, in turn, influenced predicted student outcome expectations, mastery perceptions, and hours spent using online learning technology. Regression results also indicated that the block of antecedent factors was a significant predictor of student outcome expectations, mastery perceptions, and hours spent using online learning technology. In short, results suggested a partially mediated model in which the block of antecedents had a direct effect on the dependent variables as well as an indirect effect through their influence on self-efficacy.

These results represent one of the few efforts to more precisely evaluate the nature of the mediating role of self-efficacy in student use of online learning systems. They suggest that the relationships between self-efficacy, its antecedents, and important outcomes related to the use of online learning technology are more complex that has typically be examined in the research. The science of online learning has much to gain from future research that more thoroughly investigates the complexity of these relationships using sound theoretical models and more complex analytical techniques such as structural equation modeling (SEM).

This study also pointed to several important factors that can influence both self-efficacy beliefs about online learning systems and an individual's motivation and use of these systems. For example, the findings indicated that previous success with online learning systems may be a critical factor in the development of self-efficacy and attitudes about online learning system use. This factor was a consistently strong predictor of self-efficacy, outcome expectations, and mastery perceptions. These findings are consistent with other research (Kinzie & Delcourt, 1991; Loyd & Loyd, 1988) and Bandura's (1982) premise that one of the strongest sources of self-efficacy beliefs is an individual's direct experience with the same or a similar phenomenon. The implication is that instructional strategies that provide positive learning experiences with online learning technologies may be crucial for building online learning self-efficacy beliefs, fostering positive expectations, and encouraging use of the technology.

Social cognitive theory suggests that ability attributions can be important factors in the development of self-efficacy. Little has been done, however, to examine the role of this factor in the context of online learning systems, computer-based instruction, or information

technology. The findings of this study indicate that students who viewed online learning ability as an alterable and acquirable skill reported higher self-efficacy levels, more positive expectations about e-learning outcomes, less anxiety about using the technology, and a higher mastery level with respect to those systems. On the other hand, students who tended to believe that online learning ability was a relatively fixed skill reported higher anxiety levels, less previous success, and lower efficacy levels. These findings suggest that the kind of attributions students make about online learning skills and their capacity to improve those skills may be a significant factor in their subsequent motivation and performance in online learning settings. Future research should further examine these questions as well as how attributions about the nature of online learning ability (fixed versus acquired skill) come about and how they can be modified to build efficacy beliefs, learning-related motivation, and promote mastery of this technology.

Finally, two antecedent variables (instructor feedback, pre-course training) were included in this study to directly examine the role of instructor support activities in fostering self-efficacy beliefs, outcome expectations, mastery perceptions, and use of online learning systems. Although these two factors did not emerge as significant predictors across all regression models, their correlations with other variables in this study suggest the activities associated with these factors can be important for online learning system use among college students. For example, students who received prompt and regular feedback from the course instructor about their performance using online learning technology had higher outcome expectations, reported a higher level of mastery, and spent more hours per week using the technology than students who did not get such feedback. Students who reported receiving some type of training in online learning system use at the beginning of their course also had higher outcome expectations, mastery perceptions, and reported higher efficacy beliefs than students who did not receive such training.

Little research has addressed instructor support activities in online learning contexts and consequently there are few guidelines about if, when or how such support should be provided. Technology in and of itself does not promote learning nor does it lessen the instructor's responsibility for structuring learning environments that facilitate success and promote student competence as effective learners using online learning technology. The importance of instructional support in the form of practice completing representative learning tasks and ongoing feedback about learning efforts have long been recognized as critical elements in instructional design (Tessmer, 1990) that help build necessary skills, positive attitudes, expectations and strong efficacy beliefs. Effective instructor support may also help reduce the potential for 'disorientation' (Edwards & Hardman, 1989) that occurs among students when, faced with the often daunting breadth and complexity of information available through hypermedia learning environments, they feel lost and unable to determine where they are in a lesson or what they are supposed to do to. In short, one of the key challenges for online learning system research and practice will be understanding how to match appropriate kinds of instructor support with the breadth and difficulty of the subject matter, learning tasks, learner characteristics, and the level of achievement desired.

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