Determinants of University Students' Motivation to Use Educational Technology: A Path Analytic Study

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Abstract*: The objective of the present study was to model and test the extent to which previous success, educational technology (ET) anxiety, and instructor-provided training influenced ET efficacy beliefs, and subsequent motivation to use ET in the university classroom. Social Learning Theory (Bandura, 1982) was used as the theoretical framework to develop hypotheses and to test relationships. The results, based on a sample of 282 students, supported the hypothesized causal model. Previous success had a positive direct effect on self-efficacy (β = 0.10) and negative effect on anxiety (β = -0.23). Training had a negative direct effect on anxiety (β = -0.41) and positive effect on self-efficacy (β = 0.43). Anxiety had a negative direct effect on self-efficacy (β = -0.20). Finally, self-efficacy had a positive direct effect on motivation (β = .17). This study provides some evidence that this model is helpful in determining students' motivation to use ET. (****Keywords****: Social Learning Theory, Self-Efficacy, University Students, Motivation, Educational Technology, and Path Analysis).*

العوامل التحفيزية المحددة لاستخدامات طلبة الجامعات لتكنولوجيا التربية: دراسة تحليل المسار

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ملخص: هدفت الدراسة الحالية إلى استقصاء أثر النجاح السابق، وقلق استخدام التكنولوجيا التربوية، والتدريب المقدم من المدرس على اعتقادات الثقة بالنفس في استخدام التكنولوجيا التربوية وعواقب ذلك على دافعية المدرس الجامعي لاستخدام التكنولوجيا التربوية في الغرفة الصفية. ولبناء إطار نظري للدراسة وتطوير فرضياتها واختبار العلاقات تم اعتماد نظرية باندورا (1982) أساساً لهذه الدراسة. وقد أظهرت نتائج الدراسة المستندة إلى عينة قوامها 280 طالباً وطالبة دعماً للنموذج المقترح. كما بينت النتائج أن هناك علاقة مسار إيجابية بين النجاح السابق والثقة بالنفس بنسبة 0.10، وعلاقة مسار سلبية بين النجاح السابق والقلق بنسبة - 0.23 ، وعلاقة مسار سلبية بين التدريب والقلق بنسبة -0.41، وعلاقة مسار إيجابية بين التدريب والثقة بالنفس بنسبة 0.43. أما مسار العلاقة بين القلق والثقة بالنفس فكانت سلبية وبنسبة – 0.20، فيما كان مسار العلاقة بين الثقة بالنفس والدافعية إيجابية وبنسبة بلغت0.17، وقد قدمت هذه الدراسة بعض الشواهد التي تثبت فائدة النموذج المتبنى في تحديد دافعية الطلبة نحو استنخدام التكنولوجيا التربوية.(**الكلمات المفتاحية:** نظرية التعلم الاجتماعية، الثقة بالنفس، تكنولوجيا التعليم، الدافعية، التكنولوجيا التربوية).

Introduction: The advancements in computer technology have significantly changed the way education is delivered and implemented in the classroom. Computer-based technologies are widely used as an instructional tool in almost every teaching-learning setting and their use is continuing to expand across university campuses (Hogarty, Lang, & Kromrey, 2003; Shuell & Farber, 2001). For example, nearly 30% of instructors in colleges and universities utilize some form of instructional technology for course delivery (Goggin, Finkenberg, & Morrow, 1997). This suggests that colleges and universities make considerable investments in computer technology to enhance students' learning. However, if students are not motivated to use these technologies, successful implementation can be difficult to accomplish.

At the university level, teachers often require students to complete coursework utilizing some form of educational technology (ET). In these situations, students may need to use a mixture of computer software (e.g., PowerPoint, Macromedia), university-based technology (e.g., digital drop box, discussion board), library technology (e.g., indexes, databases) and the Internet in order to succeed in their university classes. It is widely believed by administrators and education leaders that technology integration in the curriculum will provide students with the needed skills to survive and compete in the 21st century (Fabry & Higgs, 1997) as well as increase their learning (Fletcher-Flinn & Gravett, 1995; Kulik & Kulik, 1991; Mills & Ragan, 2000; Shuell & Farber, 2001) and achievement (Schacter & Fagnano, 1999). Evidence for this can be seen on many campuses worldwide in the development of computer literacy requirements for their students, and an increasing emphasis on the recruitment and retention of technology-competent students as a key

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for advancing the reputation of the institution as a whole (Chisholm, Carey, & Hernandez, 2002).

Although there is great potential in the use of computer technology in university instruction, there remains 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 computer-based instructional technologies which require students to be capable of using a variety of 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, & Keisler, 1986). Such reactions could 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 ET in university and college classrooms is generally non-volitional. That is, when course activities and requirements are built around ET, students have little choice about whether or not to use the technology. Under these conditions the influence of individual attitudes, perceptions, and beliefs on students' use of the technology, learning, or other important outcomes may be substantially amplified (Gutek, Winter, & Chudoba, 1992, Henry & Stone, 1994).

These kinds of considerations underscore the critical importance of understanding how students react to and use ET in college and university classrooms. Researchers have generally been less concerned with the comparative value of ET than they have with learner characteristics and reactions to ET. 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) (for example, Gutek, Winter, & Chudoba, 1992). However, there are at least two flaws in the previous research concerning this issue. First, to a large degree, the research has focused on teachers' integration of technology in the classroom and teachers' attitudes toward computer technology. Only a handful of studies (e.g., (Liaw, 2002; Richards & Ridley, 1997) have examined the factors that encourage students to mobilize their efforts in the use of ET. Technology may be present in the classroom environment but unless students effectively utilize it, the full learning advantages to be gained from ET may not be realized (Shuell & Farber, 2001). Despite demands to use ET to complete assignments, factors such as anxiety associated with computer use, previous success with computers, instructor-provided training, and confidence in one's ability to use computers may play an important role in determining students' motivation and the extent to which ET is actually used.

These concerns have led to calls for researchers to begin to examine not if students achieve certain outcomes using ET but factors that facilitate achievement of desired outcomes (Congressional Web-based Education Commission, 2000; Institute for Higher Education Policy, 2000). Second, research related to computer-based instruction and information technology has tended to focus solely on user attitudes and anxiety and how these constructs are associated with individual differences variables (e.g., gender). However, many of these studies lack an adequate theoretical base that would allow for the development of more concrete insights into the causes of individual reactions (Henry & Stone, 1994) and how those reactions might influence motivation and achievement. In contrast, this study draws upon the field of social psychology, in particular social learning theory (Bandura, 1982), as the theoretical framework which has focused on self-efficacy as an antecedent to students' motivation to use ET. Using this theoretical foundation, the study seeks to develop and test a path model describing a number of antecedent variables that influence the efficacy beliefs of university students about using ET as well as their subsequent motivation to do so.

Purpose of the Study: The purpose of the present study was to develop a model of the psychological predictors of ET efficacy beliefs and subsequesnt motivation to use ET in the Hashemite University classrooms.

Importance of the Study: The advances in technology especially those related to education have presented challenges to both researchers and professionals at the university level to integrate technology in the teaching/learning process. In the past, teachers were bundeled with demands to integrate technology into the curriculum and were primarily held accountable for any unsuccessful process. However, students' role was not fully considered. The importance of the present study lies essentially in reaching the following outcomes: (a) to gain a deeper understanding of the factors which influence students' motivation to use educational technology as a learning tool, (b) to help administrators in higher education settings recognize the importance of instructor-provided training and feedback in fostering positive self-efficacy beliefs and subsequent motivation to use educational technology, and (c) to help instructors and administrators consider the importance of students' anxiety, self-efficacy, and motivation when designing classes employing some form of educational technology in the teaching and learning process.

Theoretical Framework: The literature has explored various social and cognitive constructs that can impact the effective use of computer technology (Compeau & Higgins, 1995; Hill, Smith, & Mann, 1987). One such construct is that of self-efficacy (Bandura, 1986), defined as a person's belief in his or her ability to execute specific courses of action required to effectively deal with prospective situations in a given domain of activity.

Efficacy beliefs can influence the choice and direction of an individual's course of action and the levels of effort and persistence (motivation) put forth to achieve a certain task (e.g., use of computer technology) (Bandura, 1986). This suggests that self-efficacy plays a key role in individual motivation especially when a person is faced with novel situations (Bandura, 1982). The link between self-efficacy and motivation is clearly established in the literature. Self-efficacy has been related to students' motivation to work harder (Linnenbrink & Pintrich, 2002), and is predictive of people's tendency and motivation to engage in a task (Bandura, 1986; Bandura, Adams, & Beyer, 1977; Betz & Hackett, 1981; Murphy, Coover, & Owen, 1989; Schunk, 1989; Zhang & Espinoza, 1998).

In general, the research examining self-efficacy's role in individual perceptions and use of ET confirms these expectations and has shown that individuals continually make decisions about accepting and using ET and that efficacy beliefs play an important role in these decisions (Venkatesh & Davis, 1996).

A good deal of research over the past two decades has demonstrated that efficacy beliefs influence behavior and performance through effects on direction, intensity, and persistence of effort, three core elements of motivation (Pajares, 1997). Because motivation is primarily concerned with how behavior is activated and maintained, the motivation to use ET is clearly essential to students' learning and success in technology supported courses (Geiger & Cooper, 1996; Graham & Weiner, 1996; Liaw, 2002; Linnenbrink & Pintrich, 2002; Pintrich & Schunk, 2002). In fact, some argue that motivation is more important than knowledge acquisition especially when individuals have to deal with new computer applications (Sein, Bostrom, & Olfman, 1987). From a self efficacy perspective, this suggests that the optimal effective use of ET will occur in classrooms in which students come with or build positive beliefs about what they are able to do with that technology, set goals for themselves, and plan courses of action for using the technology. In short, they must approach ET as their problem solving tool of choice for carrying out course-related learning activities (Holzinger, 1992).

The information on which efficacy beliefs are built can come from a variety of sources such as prior mastery experiences and anxiety reactions (Agarwal & Stair, 2000; Bandura, 1982; Compeau & Higgins, 1995). Social learning theory suggests that previous performance successes, particularly in novel, challenging or difficult situations, help reduce anxiety levels which in turn build and reinforce positive efficacy beliefs. Ineffective performance or failures, on the other hand, tend to create doubt (higher levels of anxiety) and undermine self-beliefs of capabilities (Kernan & Howard, 1990; Loyd & Loyd, 1985; Rosen & Maguire, 1990; Wood & Bandura, 1989). Thus, it is reasonable to expect that university students approach course-related ET learning situations with various prior experiences related to the technology being used. Their earlier success in those experiences will be attended to and closely evaluated. The resulting information will be used to make judgments about their anxiety levels and present capabilities, and these judgments will likely affect their motivation to use the technology (Shiue, 2003; Torkzadeh & Koufteros, 1994).

Along these same lines, the successful use of ET often requires that students understand and apply highly sequenced strategies to complete assignments and meet learning demands. Training can help students learn these strategies and provide opportunities for early successes. Both of these outcomes can lead to the development of positive efficacy beliefs (Torkzadeh & Dwyer, 1994). It is therefore likely that those students who receive in a course some type of training from their instructor about how to use relevant dimensions of ET may develop and report more positive efficacy beliefs than students who do not receive such training.

Individual psychological states represent another potentially important source of efficacy information. Strong emotional reactions to a task such as that associated with computer use are believed to provide cues about the level of success or failure that can be anticipated in completing that task (Pajares, 1997). For example, Rosen and Weil (1990) have defined computer anxiety as the fear of current and/or future interaction with computer related technology which forms global negative attitudes about computers and their associated use. Thus, when task demands associated with the computer technologies utilized in education produce such reactions, students may interpret these reactions to indicate that they do not have adequate skills or capabilities to complete the required learning tasks successfully. On the other hand, when anxiety reactions are no longer present (e.g., after the student develops some expertise) the recognition that he or she is no longer reacting negatively could lead to heightened efficacy beliefs (Kernan & Howard, 1990; Loyd & Loyd, 1985; Rosen & Maguire, 1990).

Overview of the Model: The objective of the present study was to model and test the extent to which previous success, ET anxiety, and instructor-provided training influenced ET efficacy beliefs, and subsequent motivation to use ET in the university classroom. The research model hypothesized a positive link from previous success to self-efficacy and a positive link from training to self-efficacy. Anxiety is hypothesized to be a function of two constructs: previous success with ET and instructor-provided training, both of which will presumably reduce anxiety reactions. Anxiety is likely to be negatively associated with ET efficacy beliefs. Figure 1 presents the hypothesized relationships.

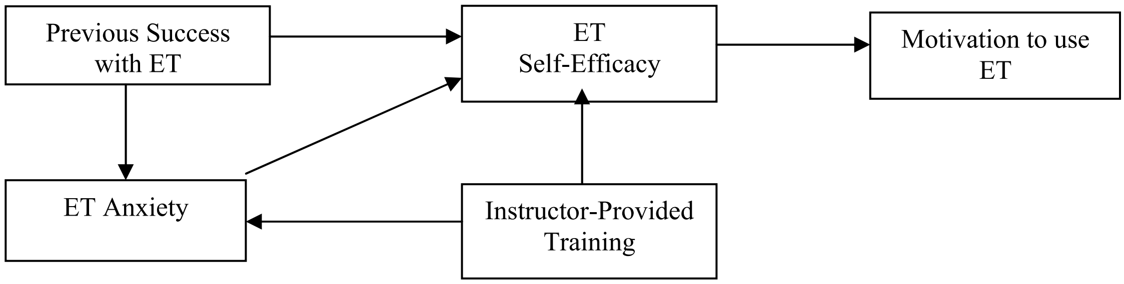


Figure 1: A model of university students' motivation to use ET

Metholdology

Research Design: To assess the adequacy of the model and fit to the data, the path analysis using LISREL 8.51 (Joreskog & Sorbom, 1993) was used in this study. The application of the path analysis provides a way to a) model and estimate multiple and interrelated causal relationships, b) represent unobserved variables or concepts in these relationships and account for measurement error in the estimation process; and c) test a set of relationships concurrently (as a unit) instead of only focusing on bivariate relationships (Hair, Anderson, Tatham, & Black, 1998). One advantage of LISREL is that it provides tests of relationships between constructs that are not attenuated by measurement error (Loehlin, 1987). In addition, statistics representing the goodness of fit between the model and the data can, given a supporting theory, provide guidance to model modification and improvement.

Subjects: Subjects in this study were 282 undergraduate students enrolled in a variety of courses at the Hashemite University. In terms of student status, the sample composed of 12% freshman, 19% sophomores, 34% juniors, and 35% seniors. Ninety-seven percent of the students were under 21 years of age. Gender distribution was 42% male and 58% female.

Procedure: Data reported here were collected from students attending 15 courses that were using some form of educational technology (e.g., microsoft office tools, Blackboard, and the Internet) as a part of instruction. These undergraduate courses represented various fields of study including Vocational Education, English, Arabic, Mathematics, Physics, Chemistry, Nursing, Engineering, and Economics & Business. 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, the researcher visited the class, explained the nature and goal of the study, and distributed the instruments. Students were asked to return the instruments to the class instructor and were then collected by the researcher.

Instrumentation: A 29-item (writen in Arabic) survey was used in this study. The instrument was developed from several sources. The first part of the instrument, the ET self-efficacy measure, was adapted from a computer self-efficacy measure developed and tested by Compeau and Higgins (1995); Compeau, Higgins, and Huff, (1999). The Compeau and Higgins' scale was modified in the present study to more specifically reflect efficacy beliefs related to the use of educational technologies. Items in this measure consisted of a stem ("I could complete the requirements of a university course using educational technology . . .") and a series of eight phrases that completed the stem (e.g., ". . . if I had never used technology like it before"). Respondents were asked to rate each completing phrase along a ten-point scale that used three anchors (1 = not at all confident; 5 = moderately confident; 10 = totally confident).

The researcher developed the other scales used in the study (previous success, anxiety, instructor-provided training, and motivation) with the assistance of several content judges who had expertise in the use of educational technology in the classroom. Scale items were drafted by the researcher 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 28 students and instructors. Feedback from this pilot test led to minor modifications in the wording of several items.

Exploratory factor analysis was conducted to provide some evidence of construct validity for the measures. Factor analysis has been recognized as "the heart of the measurement of psychological constructs" (Nunally & Bernstein, 1994, p. 111). Factor analysis is a data reduction technique that examines the intercorrelations among variables to identify underlying (latent) variables, or factors, that explain the pattern of correlations within a set of observed variables. In short, it is used to identify a small number of factors that explain most of the variance observed in a much larger number of variables.

A central question when we use factor analysis for construct validation concerns which method to use, exploratory factor analysis (EFA) or confirmatory factor analysis (CFA). Although there are no generally accepted decision rules, most researchers agree that the use of CFA requires the presence of a strong theoretical framework underlying the hypothesized latent variables and indicators. EFA, on the other hand, has no such requirement even though the latent variables may be drawn from a theoretical framework, as were the variables examined in this study. In addition, EFA makes no assumptions about the number of factors (hence its exploratory nature), but can be used in a confirmatory manner when we test for a loosely constructed model believed to underly data. Some researchers believe the two methods should be used as progressively more rigorous tests suggesting that the measurement models tested in CFA should be based on prior EFA (Bentler & Chou, 1987).

In the present study, exploratory common factor analysis was used to identify the underlying latent structure of the data. The results of the factor analysis closely paralleled the hypothesized variables and the following scales and items emerged: ET self-efficacy (8 items), motivation to use ET (4 items), previous success with ET (8 items), ET anxiety (5 items), and instructor-led training (4 items). All of these scales (except for ET self-efficacy) used a five-point Likert-type scale with values ranging from 1 (strongly disagree) to 5 (strongly agree). Estimates of reliability using Cronbach's alpha were acceptable for all scales (see Table 1).

Data Analysis: The Pearson product moment correlation coefficient was the statistical measure used to determine the strength of the associations among the hypothesized variables (Table 1). An alpha level of .05 was used to determine the significance of relationships. All variables were tested using covariance matrices generated by PRELIS and utilized a maximum likelihood method to estimate parameters in the path model.

In the present data analysis, rigorous constraints were not placed on the data because it is considered inappropriate (Bentler & Chou, 1987). For example, factors were allowed to correlate with one another. Moreover, the value of 1.0 was set to the factor loading parameter of one randomly selected item from each latent factor based on the recommendations of researchers such as Byrne (1998). This type of constraint allows the LISREL program to create a scale for the latent constructs. Finally, error terms were not permitted to correlate. We usually need a strong theoretical justification to allow the correlation of errors.

In path analysis, the null hypothesis states that data fits the hypothesized model accurately. The researcher will want to fail to reject the null hypothesis. Perhaps the most essential measure of overall fit is the chi-square statistic (Joreskog & Sorbom, 1989). However, because the chi-square fit indicator index is sensitive to sample size and violations of the assumption of multivariate normality, alternative fit indexes were used to complement the chi-square index (Tabachnick & Fidell, 1996).

Alternative fit indices generally provide an insight into the degree to which the overall path model predicted the observed covariance matrix accurately while minimizing error. There are two general types of fit indices (Hair et al., 1998). The first type is the covariance matrix reproduction indices (e.g., RMSEA, GFI, and AGFI) that describe the extent to which the proposed model regenerates the sample covariances. The second one is called the incremental fit indices (CFI and NNFI), which indicate the comparative fit of a model to the fit of a null model.

Six fit indices were examined in this study including the chi-square test. These indices were the goodness of fit index (GFI), the adjusted goodness of fit index (AGFI), the comparative fit index (CFI), the nonnormed fit index (NNFI), and the root mean square error of approximation (RMSEA) (Byrne, 1998).

In general, obtaining a non-significant chi-square value suggests model adequacy and fitness to the data. Large chi-square values indicate a poor fit while small chi-square values indicate a good fit. A value of .90 or above for the GFI and AGFI is usually recommended for an acceptable level of fit (Hair et al., 1998). Finally, RMSEA values below .05 indicate very good fit while an RMSEA values between .05 and .08 indicate a moderate fit. Any values above .08 indicate poor fit (Joreskog & Sorbom, 1993). The last two fit indices (CFI and NNFI) are considered incremental fit indices because they measure the proportionate improvement in the fit of the proposed model relative to a baseline represented by the null model. These measures have the advantage of being less influenced by sample size when compared to other indices such as GFI. Generally, values above .90 are considered sufficient (Byrne, 1998).

Results

Correlations: The correlation matrix shown in table 1 indicated that previous success was associated with ET self-efficacy ($r = .54, p < .01$); anxiety was negatively associated with training ($r = -.02, p < .01$), previous success ($r = -.62, p < .01$), and ET self-efficacy ($r = -.57, p < .01$); and ET self-efficacy was positively associated with motivation to use ET ($r = .36, p < .01$). Training and self-efficacy showed no meaningful correlation.

Table 1: Cronbach's Alpha, Means, Standard Deviations, and Correlation Coefficients for the Latent Variables

	α	Mean	SD	1	2	3	4	5
1. ET self-efficacy	.95	7.28	1.82	--				
2. Previous Success with ET	.91	3.63	.78	.54**	--			
3. ET Anxiety	.93	2.19	.97	-.57**	-.62**	--		
4. Motivation to use ET	.88	3.33	.85	.36**	.68**	-.52**	--	
5. Instructor-led training	.71	3.11	.84	-.01	.18**	-.02	.18**	--

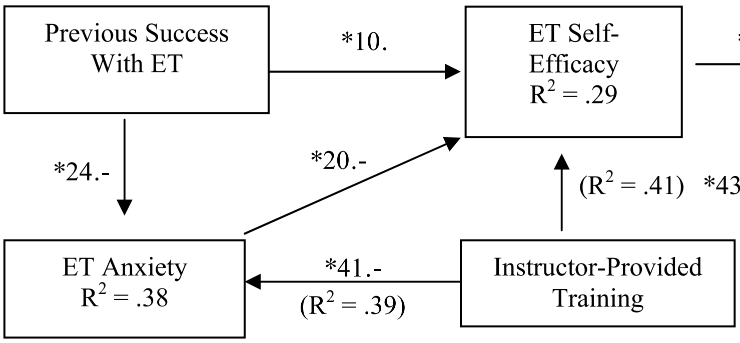
* p < .05 **p < .01

Path Analysis: The initial model was moderately consistent with the data (X^2 (3) = 8.78, p = .03). In this model, the chi-square value was significant. A significant chi-square value indicates that the proposed path model does not completely fit the observed covariances and correlations (Hair et al., 1998).

However, the chi-square by itself should not be used as the sole indicator of model fit due to its sensitivity to sample size and violations of multivariate normality. Therefore, consideration of other fit indices is considered essential. For example, the values for GFI (.99), AGFI (.94), CFI (.99), and NNFI (.97) indicated that the model fit the data sufficiently (Byrne, 1998). The RMSEA (.08) value indicated that there was a minimal amount of error associated with the tested path model (Byrne, 1998). The standard errors of all the estimates were small enough to say that the estimates are relatively precise. The t-values for the paths were above the absolute value of 1.96 indicating that paths were significant at the .05 level (Joreskog & Sorbom, 1989).

Finally, the modification indices provided by LISREL did not suggest any significant changes to improve the model, implying that this model fits the data relatively well. The intercorrelations of the measures presented in Table 1 indicated none which exceeded .80, a level commonly regarded as indicative of problems in these kinds of analyses (Hair et al., 1998).

Six separate paths were tested in this model. The results of the path analysis are summarized in Figure 2 which displays the standardized path coefficients (beta weights), as well as the explained variance (R^2) for the dependent variables (ET anxiety, ET self-efficacy, and motivation to use ET). As can be seen, all six of the hypothesized paths were supported ($p < .05$).



Note: $p < .05$ The path from ET anxiety to ET self-efficacy had an R^2 value of .33.

Figure 2: A model of University Students' Motivation to use Educational Technology/Tested

The model shows that previous success has a direct positive effect on self-efficacy (beta = .10) and a negative direct effect on anxiety (beta = -.24). Training has a negative direct effect on anxiety (beta = -.41) and a positive direct effect on self-efficacy (beta = .43). Anxiety has a negative direct effect on self-efficacy (beta = -.20). Finally, self-efficacy has a positive direct effect on motivation (beta = .17) (see Figure 2). Overall, this model had an adequate predictive power as shown by the R^2 statistic. From this model, 13% of the variance in motivation was explained by self-efficacy. Furthermore, 29% of the variance in self-efficacy was explained by previous success. Previous success explained 38% of the variance in anxiety, while 33% of the variance in self-efficacy was explained by anxiety. Morover, instructor-provided training explained 41% of the variance in self-efficacy and 39% of the variance in anxiety.

Discussion: This study represents one of the few efforts to evaluate more precisely the antecedents and causal role of self-efficacy in university students' motivation to use ET to complete course-related learning activities. According to social cognitive theory, antecedent variables such as students' previous success with ET, anxiety, and pre-course training are important because they provide cues used in making self-efficacy judgments that, in turn, can influence student motivation levels.

The results are consistent with the conceptualization of self-efficacy as a mediator between previous success with ET, ET anxiety, and instructor-provided training and motivation to use ET. Specifically, previous success with ET was associated with higher levels of self-efficacy and lower levels of ET anxiety; instructor-provided training contributed positively to efficacy beliefs and negatively to ET anxiety; and ET anxiety was negatively associated with efficacy beliefs. ET self-efficacy, in turn, was positively associated with motivation to use ET. These findings are congruent with a social learning perspective on the development and role of self-efficacy as a contributor to the direction, intensity, and persistence of effort related to the use of ET in the university classroom.

How this Research Contributes to New Knowledge

A major criticism in the design and implementation of educational technology is that such efforts are often done with little reference to theories of behavior or the principles of learning. For example, Salas and Cannon-Bowers (2001) have suggested that a science of e-learning has yet to evolve and that, until it does, many issues about how to best support and use these systems to enhance learning will remain unanswered. In short, we are only beginning to understand how these systems can best be designed and what factors influence the ability of learners to use these technologies as learning tools.

This study represents a theory-based effort to evaluate several fundamental antecedents to the development of ET self-efficacy beliefs among university students, to examine the role that those beliefs play in student motivation to use educational technology systems. The results are consistent with the notion that one of the strongest sources of self-efficacy beliefs is an individual's direct experience with the same or a similar phenomenon. This suggests that, for instructors in higher education settings, attention must be paid early to setting conditions that enhance the development of positive efficacy beliefs. This includes both efforts to reduce ET-related anxiety and the development of ET-related expertise through positive prior experiences or training. Unfortunately, it is tempting for instructors, when they develop instruction with these technologies, to focus on the instructional 'bells and whistles' the technology provides and, as a consequence, to overlook the need to develop students' confidence and capacity to effectively use the technology for learning.

This research suggests at least two ways in which this could represent a fatal flaw in the use of educational technology. First, the value of facilitating student success with ET is seen in the causal linkage from previous success with ET to self-efficacy and subsequent motivation, and in the ability of previous success to minimize anxiety reactions to ET. Secondly, pre-course training was examined in this study to more directly test the role of instructor support activities in fostering self-efficacy beliefs and subsequent motivation to use ET systems. Pre-course training showed a significant relationship with self-efficacy and a negative relationship with anxiety. Thus, students who reported receiving some type of instructor-provided training in the application of ET to learning activities at the beginning of their courses reported more positive efficacy beliefs about their capacity to use ET to meet learning demands and significantly less anxiety about doing so than did students who did not receive such training.

Although little research has addressed instructor support activities in a technology learning contexts, these findings suggest that even minimal activities aimed at preparing students to use ET to meet course learning demands may pay substantial dividends in terms of reducing anxiety, a potential block to the development of positive efficacy beliefs. Thus, preparatory activities such as familiarizing students with the technology, discussing how it will be used to meet learning objectives, and providing opportunities to experience some early successes with the technology appear to be important strategies contributing to the formation of positive attitudes, building strong efficacy beliefs, and motivating students to use ET.

The findings of this study extend previous research by demonstrating the importance of self-efficacy in enhancing learning-related motivation in environments characterized by the use of educational technology. Findings suggest that instructors should consider the importance of students' anxiety, self-efficacy and motivation when designing classes employing some form of educational technology in the teaching and learning process. Moreover, instructors should consider how to prepare students to use instruction-related technologies prior to class, and how preparatory activities can best be designed to enhance efficacy beliefs and reduce anxiety**.**

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