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Computer Self-Efficacy: A Replication After Thirty Years

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Abstract:

This work replicates Compeau and Higgins' (1995) study of computer self-efficacy (CSE). Nearly 30 years have passed since those data were collected, and the CSE concept and measurement instrument have been widely used with very limited change. This, despite extensive changes in both the technological and user environment. The original study was conducted using a mail survey of professional workers who learned to use computers for business related tasks in organizational settings. We conduct a conceptual replication with digital natives (undergraduate business students) who were learning to use computers for business related tasks in a university lab setting. We test the original model, with the measures adapted as needed to match the context. Our results confirm some but not all the initial study's hypotheses (9 in the replication study vs. 16 in the original study). These findings suggest the need for additional investigation into the utility of the original CSE conceptualization and the implications of computer self-efficacy in computer use for contemporary IS contexts.

Keywords: Computer Self-Efficacy, CSE, Replication Research, Structural Equation Modeling.

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1 Introduction

Computer self-efficacy (CSE), defined as “a judgment of one’s capability to use a computer” (Compeau & Higgins, 1995, p. 192) has been an important construct in information systems (IS) research since those authors developed a measurement instrument and research model. Many studies have tested aspects of the original CSE model or have developed models building on the original findings. CSE has also been studied in many contexts, including virtual learning environments (Piccoli, Ahmad, & Ives, 2001), user acceptance and technology adoption (Venkatesh, Morris, G. B. Davis, & F. D. Davis, 2003), post-adoption behaviors (Jasperson, Carter, & Zmud, 2005), supply chain system integration (Rai, Patnayakuni, & Seth, 2006), dark side of technology (Beaudry & Pinsonneault, 2010; Turel, Serenko, & Giles, 2011) and information security (Boss, Galletta, Lowry, Moody, & Polak, 2015). While the dominant technology acceptance models (e.g., TAM2, UTAUT) do not directly include a measure of CSE, both models incorporate self-efficacy explanations for the influence of ease of use and effort expectancy (Venkatesh, 2000; Venkatesh & Davis, 1996; Venkatesh et al., 2003).

While the CSE concept has been used in many studies and has shown continuing good effects, there has been no formal replication of the original CSE study. Such replication is important for two reasons. First, since its introduction, critics have suggested that the influence of CSE would disappear as IT became more ubiquitous and as new generations grew up using technology. Compeau, Higgins, and Huff (1999) argued against this point but, since they only tracked data over a 1-year interval, the empirical evidence they provided was limited. Second, the extent of change in technologies and in the context of IT use raises questions about the continuing validity of the CSE measure (Compeau, Correia, & Thatcher, 2017). As the IT and use contexts change, it raises a question about the content validity of the items, particularly when they reference dated artifacts like software manuals. Each of these arguments raises questions about how well the CSE model (both the measurement and structural models) developed by Compeau and Higgins would continue to remain relevant after more than 30 years of technological and organizational change. Literature reviews (Compeau, Gravill, Haggerty, & Kelley, 2006; Marakas, Yi, & Johnson, 1998) and a meta-analysis (Karsten, Mitra, & Schmidt, 2012), along with the literature summarized above provide at least some evidence of the robustness of CSE. However, the most recent study draws on published articles that are more than a decade old, which means that the underlying data is even older. Only the most recent of studies included in the Karsten et al.'s (2012) meta-analysis, for example, would include data collected after the introduction of the smartphone and none of the data collected would have included millennials who have grown up with IT. By replicating the original study, we seek to understand which constructs and relationships still hold in the modern context. In doing so, we provide a foundation for the continued use of appropriate constructs and relationships while also providing evidence for some of these to be updated or challenged.

To answer these questions, we conceptually replicate the Compeau and Higgins (1995) study. Understanding the evolution of a theoretically well-grounded model is important. On one hand, if the original findings are replicated in the 2020 context, the enduring value of this theory of use is further supported. On the other, if the findings are not replicated (as ultimately is the case in our study), we can learn about the ways in which user behavior is changing over time and so suggest new avenues of investigation.

We chose a conceptual replication—testing the same research hypotheses but using different methods and contexts (Dennis & Valacich, 2014)—over an exact or methodological replication because changes in research method and context have made either of the other choices impractical. The original sampling frame for the Compeau and Higgins study no longer exists (the publication from which subscribers were drawn is now defunct) and most surveys today are conducted electronically to match respondent expectations and to facilitate various data quality checks. The exact context also cannot be replicated as the work environment has fundamentally changed since the early 1990s. At the time of Compeau and Higgins’ data collection, computer use at work was still emerging. As many as 20% of the original sample did not use a computer at work, enterprise systems had largely not appeared on the scene, and neither had the first internet browsers. Therefore, a conceptual replication, which carefully updates the methods and measures to faithfully reflect the intention of the original model, was determined to be the appropriate choice.

The paper is organized as follows. First, we compare the models, contexts, measures, methods and analyses in the original and replication studies. In doing so, we provide justification for decisions surrounding our study design. Then, we summarize our results and compare them with the original study.

Finally, we discuss the implications of this study, describe its limitations, and offer directions for future research.

2 Comparing the Original and Replication Studies

In this section, we compare the original and replication studies to highlight why and how the original study was adapted to a contemporary use context. These adaptations are summarized in Table 1. The model and hypotheses were left unchanged. The context was modified from business professionals to present and future business professionals (i.e., business students enrolled in a class where they were learning to use computers for business related tasks). The original measures were adapted following guidance on theory and measure contextualization by Crossler, Di Gangi, Johnston, Bélanger, and Warkentin (2018) and Hong, Chan, Thong, Chasalow, and Dhillon (2014). Differences in data collection and analysis were motivated by advancements in research methodologies since the time of the original study.

Table 1. Comparison of Compeau and Higgins (1995) and Replication Studies

	Original Study	**Replication Study**
Model	14 hypotheses reflecting 20 relationships	Same model
Context	Professionals using computers for business related tasks.	Present and future professionals learning to use computers for business related tasks.
Measures	Scales capturing the business context.	Slightly adapted measures to assure proper capturing of the school context.
Method	Mailed survey to business professionals (N=481)	Web-based survey of business students during class time (N=287)
Analysis	LVPLS	SmartPLS 3.0

2.1 Model

Compeau and Higgins' (1995) model and hypotheses are presented in Figure 1 and Table 2. The model comprises 14 hypotheses, reflecting 20 relationships[1]. The model, grounded in Bandura and National Institute of Mental Health's (1986) social cognitive theory, hypothesizes that encouragement of use by others, others' use of computers, and organizational support for computer use, affect CSE and personal and performance-related outcome expectations (OE). CSE also influences OE, and both CSE and OE influence affect, anxiety and use.

The purpose of our replication study is to test whether the CSE construct and its associated nomological network are still relevant in contemporary technological environments. Thus, the model's original hypotheses were replicated without adaptation.

[1] The hypotheses shown here reflect the final model presented by Compeau and Higgins. The model was refined based on their analyses to divide the outcome expectations construct into two dimensions: performance outcome expectations and personal outcome expectations.

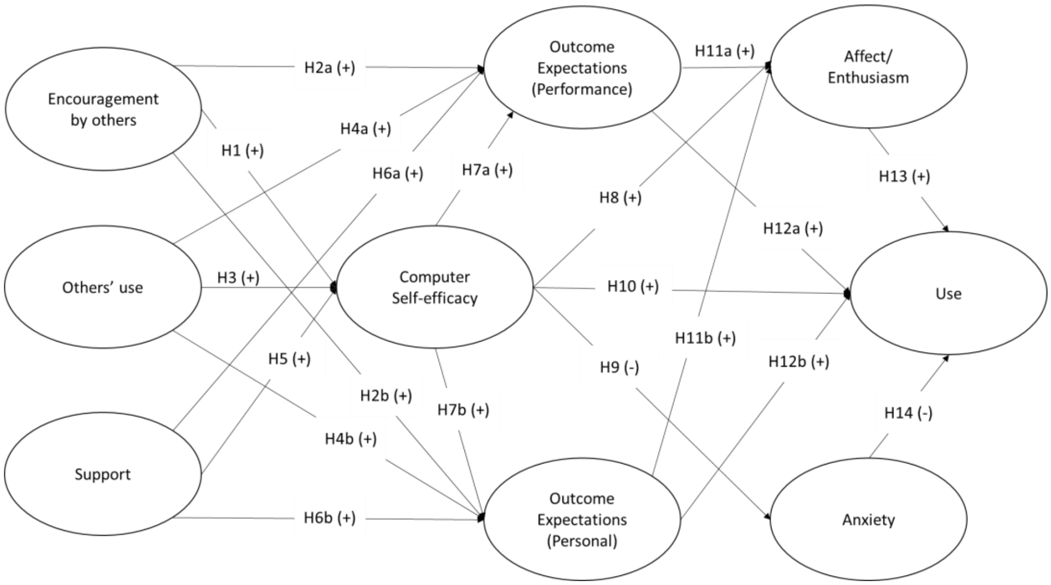

Figure 1. Research Model

Table 2. Hypotheses (Compeau & Higgins, 1995)	
H1:	The higher the encouragement of use by members of the individual's reference group, the higher the individual's computer self-efficacy.
H2a:	The higher the encouragement of use by members of the individual's reference group, the higher the individual's performance outcome expectations.
H2b:	The higher the encouragement of use by members of the individual's reference group, the higher the individual's personal outcome expectations.
H3:	The higher the use of the technology by others in the individual's reference group, the higher the individual's computer self-efficacy.
H4a:	The higher the use of the technology by others in the individual's reference group, the higher the individual's performance outcome expectations.
H4b:	The higher the use of the technology by others in the individual's reference group, the higher the individual's personal outcome expectations
H5:	The higher the support for computer users in the organization, the higher the individual's computer self-efficacy.
H6a:	The higher the support for computer users in the organization, the higher the individual's performance outcome expectations.
H6b:	The higher the support for computer users in the organization, the higher the individual's personal outcome expectations
H7a:	The higher the individual's computer self-efficacy, the higher his/her performance outcome expectations.
H7b:	The higher the individual's computer self-efficacy, the higher his/her personal outcome expectations.
H8:	The higher the individual's computer self-efficacy, the higher his/her affect (or liking) of computer use.
H9:	The higher the individual's computer self-efficacy, the lower his/her computer anxiety.
H10:	The higher the individual's computer self-efficacy, the higher his/her use of computers.
H11a:	The higher the individual's performance outcome expectations, the higher his/her affect (or liking) for the behavior.
H11b:	The higher the individual's personal outcome expectations, the higher his/her affect (or liking) for the behavior.
H12a:	The higher the individual's performance outcome expectations, the higher his/her use of computers.
H12b:	The higher the individual's personal outcome expectations, the higher his/her use of computers.
H13:	The higher the individual's affect for computer use, the higher his/her use of computers.
H14:	The higher the individual's computer anxiety, the lower his/her use of computers.

2.2 Context

It has been argued that due to rapidly changing technological environments, replication studies should be the norm and not the exception in our discipline (Niederman & March, 2015). Yet, as technology changes, it becomes increasingly difficult to replicate studies in the same context since the technological environment is always shifting. Despite this difficulty, developing well-contextualized replication studies is an important endeavor, since the context of replication impacts the ability to build conceptually and practically significant IS theories (Niederman & March, 2015).

To contextualize and replicate Compeau and Higgins' (1995) study, we followed the guidelines of Whetten (2009), Hong et al. (2014) and Crossler et al. (2018). Each of these papers addresses the challenges of adapting theory from one context to another and all identify the importance of ensuring similar meaning across contexts as critical to developing context-sensitive explanations of phenomena. Such context sensitivity does not require surface-level similarity of constructs and items—what Locke (1986) called ecological validity—but rather similarity in the essential features to produce similar underlying meanings for participants.

In the 1980's and 1990's, individuals were first exposed to information technologies in the workplace and computer use was largely confined to the workplace while today people often use computers in their personal lives before using them at work (Carter & Petter, 2015). Moreover, computer use in the workplace is so pervasive that—as we reflected on how best to replicate the original study—it became evident that in western industrialized societies (at least), the workforce is now highly familiar with using computers for work purposes. This presented a sampling frame issue. Since novelty was an important component of the original study, such familiarity meant that Compeau and Higgins' (1995) sample frame would likely be a poor fit for replication even if it had been available for use.

A student sample provided a better approximation of the original use environment. The students in our sample were learning to use a technology that was novel to them (Microsoft Excel) for business-related tasks[2]. In that sense, they were experiencing the same situation as the business users in Compeau and Higgins (1995) study—they were learning how to use IT in support of their work-related needs. As in the original study, we asked them about their use of computers broadly for school-related purposes thus maintaining the work-related focus of their behavior. Thus, the focus of the study was not on Excel-related self-efficacy and use but rather on general CSE and use.

Previous research supports our use of business students in at least two ways. First, while so-called digital natives use information technology much more than previous generations, they find it less usable than their older counterparts (Metallo & Agrifoglio, 2015). Therefore, it cannot be assumed that business students have high levels of CSE. This assertion is supported by Karsten and Schmidt (2008) who found that business students in 2008 did not show higher levels of CSE than those studied a decade earlier. Second, while digital natives have much higher competence in some areas of IT use, undergraduate information systems courses continue to provide opportunities to improve proficiency (Suša, 2014).

Our choice of sample frame does not influence our measures because our model continues to focus on beliefs and behaviors about using computers generally. In doing so, it maintains contextual similarity with the original model, which is important for understanding the relationships between constructs. The sample frame also provides a key distinction, in terms of participant age, which may help extend understanding of generational differences in computer use and speak to the continuing relevance of CSE for the IS discipline.

2.3 Measures

CSE was measured using the 10-item scale developed by Compeau and Higgins (1995). The question format was maintained, with participants first indicating whether they could complete a school-related task using a computer. Under each of the 10 conditions (YES/NO), if participants selected "YES", they were asked to provide a confidence judgment for the specific condition. This results in an 11- point scale. The only changes made to contextualize the scale were minor wording changes to the introduction. Instead of asking about a hypothetical software package that was intended to make their jobs easier, we asked about a hypothetical software *application* that participants were given to support some aspect of their *schoolwork* that was intended to make *tasks* easier.

Compeau and Higgins measured computer use with 4 items that asked about the frequency of use at work, time spent using computers at work each day, and time spent using a computer at home on

[2] We did not specifically ask about the students' familiarity with using Microsoft Excel but the faculty who teach this class reported that their students have very low levels of such familiarity. Even where students have used Excel previously, they have not generally been taught to use even basic features such as cell referencing, autofill, and copy/paste let alone more advanced features such as VLOOKUP and Pivot Tables.

weekdays and on Saturdays and on Sundays. We adapted these items to assess the frequency of computer use for schoolwork, time of use for schoolwork, and total time of computer use. These changes were necessary to avoid over-emphasizing the location of use and to emphasize the purpose of use. When data were collected in the original study, personal computers were beginning to gain popularity but working from home was a novelty; in the contemporary environment, which is characterized by networked and mobile devices, location of computer use is less important than what computers are used for (i.e. leisure, work).

Two items measuring performance outcome expectations required small modifications because they referred specifically to *the job*. For these items we substituted the words *in my studies* or *of my schoolwork* to emphasize the performance domain that was closest to the job context. One item for performance outcome expectations was dropped because it emphasized reliance on clerical support. This item had loaded poorly in the original study (λ=0.504) and did not have a parallel in the student context.

Three items measuring personal outcome expectations were modified. Instead of asking whether co-workers would perceive the individual as competent, we asked about *fellow students.* Instead of asking whether using computers would increase one's chances of obtaining a promotion, we asked about the chances of *getting a good job.* For students, getting a job is the equivalent of getting a promotion as it reflects the next step in their career development. Similarly, we substituted *getting a better grade* for getting a raise, to reflect the extrinsic reward given for work in the context of the study. From a student's perspective, grades are given by professors for high performance just as raises are given by organizations for high performance.

Compeau and Higgins measured encouragement by others and others' use with 4 items: peers in your organization, your manager, other management, and peers in other organizations. We dropped the phrase *in your organization* from the first item, substituted *your professors* for managers in the second, *school administrators* for other management, and *other students* for your peers in other organizations. The peer-related items reflect very similar relationships. The relationship between students and their professors or school administrators differs from that between employees and their managers or other management on some dimensions (e.g., professors cannot fire students), but the power relationship between students and professors is widely acknowledged and thus we argue it is sufficiently similar.

Two items measuring support were modified. In one, "co-workers" was changed to *fellow students.* In the other, the reference to the organization was changed to the *school.* Affect and anxiety were not modified in our study. In the original study, computer anxiety was found to be multidimensional and the authors retained only the four items that "best capture[d] the feelings of anxiety associated with computer use, and not the beliefs that might produce anxiety or other attitudes about computers" (Compeau & Higgins, 1995, p. 200). Accordingly, only these four items were included in our instrument. For comparison purposes, both sets of measures are provided in Appendix 1. As shown, changes in items reflect changes in the context of use, while preserving original meanings and purposes.

2.4 Method

The original study used a mail survey sent to over 2000 workers and had a response rate above 50%. The survey was mailed with a cover letter and a prepaid envelope to return the survey. A reminder was mailed three weeks after the questionnaire was sent, to those who had not responded. The authors describe the sample as follows:

> 1,020 respondents were mostly male (83 percent) and had an average age of 41 years. They represented all levels of management and were evenly split between line and staff positions. They worked in a variety of functional areas, including accounting and finance (18 percent), general management (30 percent), and marketing (16 percent). Forty-three percent had completed one college or university degree; a further 40 percent had completed post-graduate degrees. The respondents' educational backgrounds were primarily in business (61 percent), arts (10 percent), science (14 percent), and social science (5 percent). (Compeau & Higgins, 1995, p. 199).

Given the substantial changes in the IT and use contexts since the early 1990s, an exact replication would have been impossible. Conducting a methodological replication with our chosen sample frame would have created other methodological issues, particularly around response rates to a paper-based mail survey. Thus, we designed a method to capture students' computer use and perceptions in a setting that provides essential features validity (Locke, 1986)[3]. Data were collected from students in an introductory information systems course. This course is taken by all students who major or minor in business and by students majoring in related fields such as sports management. Thus, the sample represents a wide range of individuals interested in business careers and thus may be predictive of the experiences of the next generation of business professionals.

Data were collected in a required weekly lab. One of the researchers attended the labs and invited students to participate in the research. Thus, the data were collected in-person and synchronously, and the computer screen and keyboard became a replacement for a pen and paper. Klausch, Hox, and Schouten (2013) found that paper and pencil and web-based surveys do not produce systematic measurement differences, so long as they follow a unified design (Dillman, Smyth, & Christian, 2014), matching the visual stimulus as closely as possible. Thus, this difference between the original and replication studies was not considered to be a plausible alternative explanation for any observed differences.

The data were anonymous; identifiers were collected in a separate linked survey to provide extra credit for their participation.

2.5 Analysis

We analyzed the data following the same principles and using the same criteria as Compeau and Higgins (1995). We used SmartPLS 3 (Ringle, Wende, & Becker, 2015) to analyze the measurement model and the structural model while Compeau and Higgins used Lohmöller's LVPLS software (version not known). To assess the measurement model, we tested the reliability, convergent validity and discriminant validity of the measures (Lowry & Gaskin, 2014) using the same tests as the original study, as well as additional tests recommended for SmartPLS (Hair, Hult, Ringle, & Sarstedt, 2016). To assess the structural model, we used bootstrapping with 5000 samples. Compeau and Higgins used jack-knifing (parameters unknown).

3 Results

We collected a total of 425 responses. This represents 92% of the students registered for the course, and virtually all of those in attendance during the labs that week. After removing incomplete data and careless responses (as outlined in Table 3), 287 usable responses remained. According to Hair et al. (2016) it is possible to detect a 10% R^2 in use (our DV with the most IVs) with a sample size of 122 (or 169 for a significance level of 1% rather than 5%). Using GPower (version 3.1.9.4) to estimate sample size to ensure adequate power for tests of individual path coefficients also shows that our sample has adequate power to detect a small effect size of 0.02. So, while our sample size is smaller than the original study, statistical power is adequate.

Table 3. Responses

Total Responses	425
Responses Removed	
Did not finish	16
Failed attention checks	116[4]
Speeders (less than 3.2 minutes)	1
Missed questions (more than 4)	5
Usable Responses	287
% Usable responses	67.53 %
Average Duration (usable responses)	10.07 mins

[3] Locke argues that providing settings that invoke similar theoretical meaning (essential features validity) are more important to generalizability than perfectly matching all of the features of the setting (which he terms ecological validity).

[4] We attribute the relatively high number of students who failed the attention checks to the way in which extra credit was assigned. Students received extra credit for participating in the study, regardless of whether they failed the attention checks. This undoubtedly led some students, whose only motivation for participating was to earn extra credit, to respond without carefully attending to the questions. Including the three attention check questions gives us confidence that these responses have been filtered out.

Table 4 shows the demographic details of the sample. In comparison to the original research, the current sample has more women (41% vs. 17%). Participants are much younger (average age of 20.4 compared to 41 in the original study), and most (79.4%) are in their first or second year of higher education.

Table 4. Participant Age, Gender and Year in School

Age Distribution				Gender				Year in School		
	N	Percent			N	Percent			N	Percent
18	1	0.3%		Male	167	58.2%		Freshman	103	35.9%
19	67	23.3%		Female	118	41.1%		Sophomore	125	43.6%
20	110	38.3%		Other	1	0.3%		Junior	44	15.3%
21	73	25.4%		Missing	1	0.3%		Senior	13	4.5%
22	18	6.3%						Other	2	0.7%
23	6	2.1%								
24	5	1.7%								
27	3	1.0%								
28	2	0.7%								
Missing	2	0.7%								

Table 5 provides the breakdown of the sample in terms of major. Eighty-five percent of the sample are business majors, with the highest percentages in marketing, finance, general business and management. This represents a similarly varied functional profile in comparison to the original study.

Table 5. Participant Majors

Major	N	Percent
Marketing	49	17.1%
Finance	44	15.3%
General Business	35	12.2%
Management	30	10.5%
Accounting	28	9.8%
HBM	24	8.4%
IB	17	5.9%
MIS	13	4.5%
Entrepreneurship	5	1.7%
Non-business majors	40	13.9%
Undecided/Unsure	2	0.7%

Table 6 reports means (based on unweighted averages of the scale items), standard deviations and ranges for each of the constructs in our model. We are unable to present a comparison to Compeau and Higgins (1995) as the authors did not report this information. We note, however, that for all constructs except others' use, the responses cover nearly the full range of possible scores, thus providing adequate variability for our modeling.

Table 6. Construct Means and Distributions

Construct	Mean	Std Dev	Range
Encouragement of Use	4.19	0.61	1.83-5
Others' Use	4.32	0.50	3-5
Support	3.83	0.66	1.17-5
Computer self-efficacy	5.36	1.79	0-9.6
Outcome Expectations (Performance)	3.99	0.61	1.2-5
Outcome Expectations (Personal)	3.60	0.70	1.6-5
Affect	3.38	0.67	1-5
Anxiety	2.41	0.92	1-5
Use	3.11	1.04	1.33-5

As IT has become ubiquitous, and applications pervade all aspects of our lives, an important question is whether lack of computer self-efficacy remains a potential problem. Are most users now confident and is there sufficient variance in CSE to matter? In order to assess this, we compared data from our study to reports of CSE in the literature. While Compeau and Higgins (1995) did not disclose the means and standard deviations of constructs in their study, Compeau et al. (2006) report data based on a re-analysis of Compeau and Higgins (1995) and based on Marcolin, Compeau, Munro, and Huff (2000). These studies used an 8-item short form for CSE. In Table 7, we present a comparison of our data (using just the 8 items found in the Compeau et al. (2006) paper) with the data they report.

Table 7. CSE Items Means and Standard Deviations						
			Data reported in Compeau et al. (2006), based on:			
CSE Items	**Replication (2020) *n* = 287**		**Compeau & Higgins (1995) *n* = 394**		**Marcolin et al. (2000) *n* = 224**	
	Mean	***SD***	**Mean**	***SD***	**Mean**	***SD***
If there was no one around	3.01	*2.88*	5.16	*2.79*	4.34	*2.61*
If I had just the manuals	3.59	*2.93*	5.85	*2.69*	5.02	*2.71*
If I had seen someone using it	5.32	*2.56*	5.77	*2.63*	5.67	*2.30*
If I could call someone for help	6.50	*2.73*	7.42	*2.19*	7.07	*2.08*
If someone helped me get started	6.66	*2.24*	6.96	*2.30*	6.87	*2.14*
If I had a lot of time	6.05	*2.74*	7.31	*2.60*	6.78	*2.80*
If I had just the built-in help	5.72	*2.74*	5.58	*2.55*	5.52	*2.82*
If someone showed me how to do it.	7.50	*2.30*	7.71	*2.24*	7.77	*2.05*
CSE (average of 8 items)	5.54	*1.83*	6.47	*1.97*	6.13	*1.93*

The results show a slightly lower mean for CSE in the replication data than in prior studies and lower scores on all but one of the underlying questions. The standard deviation of responses has increased for some items and decreased for others with a slight reduction overall, but still adequate variability. Like the working professionals surveyed by Compeau and Higgins (1995), on average, our participants had moderate confidence in their ability to use computers in their schoolwork; however, the level of confidence varied substantially among participants.

3.1 Assessment of the Measurement Model

The first assessment of the measurement model provided mixed evidence. The composite reliabilities for all the constructs were above 0.70 (Table 8). The average variances extracted (AVE) were above 0.50 except for CSE (0.46), OE-Performance (0.48) and Affect (.44). Thirteen items had loadings below 0.70 (see Appendix 2 for loadings and cross loadings).

For discriminant validity, we examined the individual item cross-loadings which were all less than the loadings. We also compared the shared variance between constructs in comparison to the shared variance between each construct and its own measures (Fornell & Larcker, 1981). In this case, all constructs meet the conditions for discriminant validity, as shown in Table 8. OE-performance is highly correlated with OE-personal (r=0.61), but this correlation is below the diagonal elements and is unsurprising given that these are subdimensions of the same construct. Heterotrait-Monotrait Ratios (HTMT) also exceeded the 0.85 threshold (Henseler, Ringle, & Sarstedt, 2015), except for OE personal/OE performance which was 0.79.

Table 8. Reliability and Discriminant Validity (Original and Replication)										
	CR†	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Compeau and Higgins (1995)‡										
1 Encour.	0.87	0.80								
2 Other Use	0.80	0.52	0.72							
3 Support	0.91	0.24	0.18	0.79						
4 CSE	0.95	0.20	0.18	-0.10	0.81					
5 OE Perf	0.87	0.27	0.22	-0.09	0.32	0.72				
6 OE Pers	0.87	0.19	0.11	-0.12	0.17	0.49	0.76			
7 Affect	0.87	0.20	0.15	-0.13	0.49	0.48	0.32	0.75		
8Anxiety	0.87	-0.11	-0.07	-0.00	-0.50	-0.23	0.05	-0.51	0.79	
9 Use	0.82	0.17	0.24	-0.05	0.45	0.41	0.24	0.47	-0.37	0.73
‡As reported in Compeau and Higgins (1995) Table 2										

Replication Study										
1 Encour.	0.84	0.76								
2 Other Use	0.85	0.50	0.76							
3 Support	0.87	0.31	0.23	0.72						
4 CSE	0.90	0.18	0.12	0.23	0.68					
5 OE Perf	0.82	0.29	0.17	0.30	0.23	0.69				
6 OE Pers	0.83	0.21	0.05	0.19	0.19	0.61	0.71			
7 Affect	0.79	0.19	0.05	0.23	0.20	0.38	0.31	0.66		
8Anxiety	0.87	-0.02	-0.05	-0.06	-0.17	-0.14	0.07	-0.32	0.79	
9 Use	0.86	0.05	0.04	-0.01	0.05	0.04	0.08	0.29	-0.01	0.82

†CR= Composite Reliability

Note: Diagonal elements (shaded) are the square root of the average variance extracted (AVE). Off-diagonal elements are the correlations among constructs. For discriminant validity, diagonal elements should be larger than off-diagonal elements.

Overall, then, the measurement model is acceptable for most of the model but does indicate potential problems in CSE, OE-performance and affect owing to a few lower loading items. The two low affect items are the negatively worded items, which are often found to have lower loadings in constructs. For CSE and OE-performance, the problematic items reflect aspects of the construct whose relevance may have altered over time. The low loading items for CSE (CSE 2 – if I had never used an application like it before; 3 – if I had only the software manuals for reference; and 8 – if I had just the built-in help facility for reference) reflect items that are misaligned with the current technological and use context. While it was common in the early 1990s to use technologies that were unlike anything one had seen before, the evolution of software and IT platforms make this situation rare today. Software manuals are almost non-existent today and the built-in help facility is a dated concept that now extends to a wide range of online help tools. Similarly, the low outcome expectations item (OE3) relates to spending less time on routine tasks; using computers to automate routine tasks was typical in the early 1990s and users experienced the change from the old to the new way of working; today these are taken-for-granted ways of working. These differences in the measurement model provide a first answer to the question of the continuing validity of the model. It appears as though aspects of the measurement of key constructs may need to be revisited, as suggested by (Compeau et al., 2017)

The existence of these differences also poses a challenge in the assessment of the structural model. Retaining all of the items ensures that each construct represents the same content, but runs the risk that weakness in the measurement model would depress the structural model correlations and thus overstate the differences. Using the preliminary loadings to revise the measurement model creates non-equivalent constructs but improves the validity of the structural model findings. To address this challenge, we tested the model two ways. In the sections that follow we present the analysis with all items retained in our model, despite the observed weaknesses. In Appendix 3 we present the analysis with a revised measurement model where the lowest loading items were removed. The results from the two models are consistent, providing stronger evidence to support our conclusions about the differences between the original study and our replication.

3.2 Assessment of the Structural Model

As Table 9 indicates, our model explains a similar amount of variance in CSE, performance outcome expectations and personal outcomes as the original study, but substantially less variance in affect (17% vs. 37%), anxiety (3% vs. 25%) and use (10% vs. 32%).

Table 9. Comparison of R^2

	Original Study	Replication
Computer self-efficacy	7%	7%
OE-Performance	17%	16%
OE-Personal	8%	8%
Affect	37%	17%
Anxiety	25%	3%
Use	32%	10%

Nine of the twenty hypothesized relationships were supported. A review of these hypotheses reveals some areas of consistency, but important differences vis-à-vis the original study provide opportunities for future investigation.

Encouragement of use demonstrated consistent effects on both types of outcome expectations across both studies but its influence on CSE decreased (*b* = 0.11 vs. 0.18 in the original) and became non-significant in the replication.

In the original study, others' use of computers exerted a weaker effect on CSE (*b* = 0.10) and performance outcome expectations (*b* = 0.10) than encouragement. In the replication, others' use did not exert a significant effect on CSE and OE-Performance. Both studies support the conclusion that others' use plays a limited role in the formation of CSE and outcome expectations judgements.

The effects of organizational support on CSE, performance outcome expectations and personal outcome expectations were negative in the original study, running counter to the hypotheses. In our replication, organizational support exerted a positive effect on CSE and performance outcome expectations, which confirmed the initial hypothesis. The relationship between organizational support and personal outcome expectations was not significant.

The effect of CSE on four of the five predicted outcomes was significant, thus providing basic support for the model. It is noteworthy, however, that all but one of the effects decreased substantially suggesting a weaker influence than originally hypothesized.

The effect of performance outcome expectations on affect was consistent with the original; however, its relationship with use became non-significant. The relationship between personal outcome expectations and affect was also non-significant in the replication. The path from personal outcome expectations to use was very small in the original study (*b* = 0.03) despite its significance; in the replication the path coefficient changed to 0.02 and the relationship between the constructs was non-significant, as might be expected.

In the replication, affect continued to exert a significant influence on use, with the magnitude of the path increasing from 0.19 to 0.34. The relationship between anxiety and use, which was significant in the original study, was non-significant in the replication.

Of the five constructs that influenced use in the original study, only one (affect) did so in the replication. The paths from CSE, performance outcome expectations, personal outcome expectations, and anxiety were non-significant, suggesting that any influences they may exert are mediated by affect. Overall, the model explained only 10% of variance in use, compared with 32% in the original study. Table 10 summarizes and compares our findings with Compeau and Higgins (1995) study. Replication findings that differ in significance and/or direction from the original study are shown in bold.

Table 10. Comparison of Path Coefficients

	Original Study	Replication
H1. Encouragement – Computer self-efficacy	.18***	**.11**
H2a. Encouragement – Performance Outcome Expectations	.20***	.19***
H2b. Encouragement – Personal Outcome Expectations	.20***	.20***
H3. Others' Use – Computer self-efficacy	.11***	**.02**
H4a. Others' Use – Performance Outcome Expectations	.10***	**.01**
H4b. Others' Use – Personal Outcome Expectations	.02	-.09
H5. Support – Computer self-efficacy	*-.16****	**.19*** **
H6a. Support – Performance Outcome Expectations	*-.14****	**.21*** **
H6b. Support – Personal Outcome Expectations	*-.16*** *******	.12
H7a. Computer self-efficacy – Performance Outcome Expectations	.24***	.15**
H7b. Computer self-efficacy – Personal Outcome Expectations	.12***	.14**
H8. Computer self-efficacy – Affect	.37***	.12**
H9. Computer self-efficacy – Anxiety	-.50***	-.17**
H10. Computer self-efficacy – Use	.22***	**.01**

H11a. Performance Outcome Expectations – Affect	.32***	.28***
H11b. Personal Outcome Expectations – Affect	.10***	**.12**
H12a. Performance Outcome Expectations – Use	.21***	**-.09**
H12b. Personal Outcome Expectations – Use	.03***	**.02**
H13. Affect – Use	.19***	.34***
H14. Anxiety – Use	-.11***	**.08**
** p < 0.05; *** p < 0.01; *** p<0.01 in the opposite direction to initial hypothesis		

3.2.1 Common Method Bias

Compeau and Higgins provide no test of common method bias but, because the data are collected in a single survey, it is important to rule out this threat to validity. We followed the approach of Simmering, Fuller, Richardson, Ocal, and Atinc (2015) as implemented by Chin, Thatcher, Wright, and Steel (2013) for PLS, using blue attitude (Miller & Chiodo, 2008) as a marker variable. The results (Appendix 4) produced very similar results to both the unmodified and modified model, thus reducing the likelihood that common method bias is a significant issue in the replication study.

4 Discussion

Our replication provided mixed support for the model proposed and tested by Compeau and Higgins (1995). The first difference we note is in the measurement model. Changes in the loadings are not surprising between any two studies and may be a function of systematic changes in the meaning of the constructs or may reflect only sampling variation or random error. Thirty-two of the items had higher loadings in the original study while 11 were the same or lower in the original. Thus, not all of the changes favor the original study. Nonetheless, if the differences were truly random we might expect to see a more even balance of positive and negative changes. Moreover, in the original study, five of the individual item loadings were below the traditional benchmark of 0.70. In the replication, 18 loadings were below this level. The composite reliability scores for most constructs are lower than those in Compeau and Higgins, by about 0.04. Looking at the individual items, several of those that were problematic in our analysis were also low in Compeau and Higgins' study (e.g., Others' Use 3, OE 1, Affect 3). Two items that had loadings below 0.70 in Compeau and Higgins (e.g., Others' Use 4, OE 7) had adequate loadings in our model. Looking specifically at the CSE construct, the average drop in the loadings for this construct is higher than for the other constructs (average decrease in loadings = 0.13 vs. 0.9 or less for the others). While all of these differences are small, taken together they suggest some degradation in the performance of the measures over time, and particularly in the performance of the CSE items.

A comparison of the structural model results reveals interesting differences. Of the 20 paths in the models, 7 showed only small changes in the path coefficient ($\Delta < 0.10$ with no change in significance). These paths center on the constructs of encouragement of use, outcome expectations, affect and use. One path (from affect to use) showed a substantive increase, from 0.19 to 0.34. Four paths had opposite signs to those in the original study: the three paths from support to CSE, OE-Performance and OE-Personal and the path from anxiety to use though the latter also went from significant to non-significant. Eight paths either dropped by more than 0.10 or went from significant to non-significant; this included all but one of the outcomes of CSE. Looking at the model as a whole, the greatest differences across the two studies related to the construct of support (discussed earlier) and the construct of CSE.

Overall, while many of the core theoretical predictions of social cognitive theory remain supported, our replication suggests four key areas that may require reconsideration. These are: (1) the low explained variance in use; (2) the relatively poor performance of the antecedents of CSE; (3) the weak results with regards to personal outcome expectations; and, (4) the conceptualization and measurement of CSE.

4.1 Explanation of Use

First, the lack of significance of most of the predictors of use and the reduction in its explained variance may lend support to the view that cognitive factors, such as CSE and OE, play a lesser role in influencing user behavior as IT becomes more ubiquitous. Our results are also consistent with a more automatic (i.e., system 1) approach to computer use, rather than a rational calculus of their capability and the likely outcomes of their use (system 2) (Ferratt, Prasad, & Dunne, 2018). This would explain the increasing importance of affect as a predictor of use. It would also be consistent with TAM studies that found the effect of EOU to be direct early in the use experience but fully mediated by other variables (in their case PU) as experience is gained. Carter, Petter, Grover, and Thatcher (2020) show a similar phenomenon with respect to the UTAUT cognitive variables and IT identity. They show that the extent to which people identify with information technology (ITID) mediates the effect of UTAUT predictors on IT use. Thus use becomes a function of who one is, rather than what can be gained through use. CSE plays a role in identity theory wherein it results from past interactions and influences ongoing computer use through IT identity.

This change in the model, whatever its theoretical explanation, may reflect both the age of the participants (if younger users are more susceptible to such automatic processing or identity explanations) and differences in the computing environment in 2019 versus 1990 when the data for the two studies were collected. Our replication does not provide clear evidence as to which is the case; however, both have implications for future research. The former explanation suggests a need for future research to investigate whether the changes observed in the relationships between CSE, OE and use are stable across age groups. If so, this would lend support to the latter explanation, which suggests a potentially enduring change in the relationships between CSE, OE and use due to context. If these changes are not stable across age groups, then it will be important for future research to delineate and explain the contexts in which CSE, rather than other factors such as IT identity, predominates.

4.2 Antecedents of CSE and OE

Our results also suggest the need for more attention to the antecedents of CSE and OE. Others' use remained a weak influence on both CSE and OE, becoming non-significant in our replication. Encouragement of use influenced OE but not CSE. This is not entirely surprising. The hypothesis was based on Bandura's concept of verbal persuasion, which is one of the four key sources of self-efficacy information. However, in Bandura's work the persuasive messages tend to be of the form "you can do it" while in our study the items reflected the message "you should do it". Messages about what one can do would influence self-efficacy while messages about what one should do would influence outcome expectations.

In contrast to the original study, the hypotheses regarding the effects of support on OE and CSE are supported, confirming the original theorization in which support positively affect CSE as well as OE . Compeau and Higgins (1995) suggested a few reasons why the observed relationships in the original study may have been opposite to what was expected. One was that users who were less confident might make more use of support and thus be more aware of its availability and value. The second was that the way in which support was provided may have inadvertently decreased confidence by highlighting the gap in proficiency between the support provider and the user. Our replication, however, shows support to positively influence both CSE and outcome expectations, perhaps suggesting that the original result was simply an artifact of the sample. Another explanation may be that the way IT support is being offered at this time has improved, generating confidence in the user about what they can achieve with computer use. Furthermore, students are not accustomed to having corporate IT support with hot-lines available to offer advice when a computer is not working according to their expectations. For today's students having any support system is a big improvement compared to available alternatives, such as search engines or YouTube videos.

In contrast to the findings related to the prediction of use, we believe the results related to the antecedents suggest a general need for stronger theorizing of the antecedents of CSE and OE. The replication of weak effects (others' use) and the lack of replication of a counter-intuitive effect (support) collectively suggest the need for a stronger theoretical development related to the sources of information from which individuals form their CSE and OE judgments.

4.3 Role of Personal Outcome Expectations

The separation of performance and personal outcome expectations was not originally hypothesized by Compeau and Higgins (1995). The measurement model tests showed weak loadings on the 11-item scale and an exploratory factor analysis identified the two separate dimensions. The results regarding personal

OE in the original study were consistent with theorizing but the effects were quite small. In our replication, only two of the original six hypothesized paths are significant even though the effect sizes are similar.

Taken together, the two studies provide consistent evidence that performance outcome expectations, which represent the instrumental—and largely intrinsic—outcomes of using computers, are relevant. Personal outcome expectations, which focus more on extrinsic rewards such as getting a job or being perceived well by others, are less relevant to the explanation of affective and behavioral outcomes. Across different samples and different contexts, personal outcome expectations appear to exert only limited influence on these outcomes.

4.4 Conceptualization and Measurement of CSE

The replication study revealed both a weaker measurement model and structural model performance, especially in the CSE construct. Indeed, the lack of a relationship between CSE and use surprised us, especially considering that many other studies have supported such a relationship. We considered the possibility that this reflects the study context, where business students were taking a class to gain proficiency in computer use. This context decreases the realizable voluntariness of use for participants (Tsai, Compeau, & Meister, 2017) since at least some degree of use was necessary for students to complete schoolwork for the class in which they were surveyed. However, our survey questions asked students about their use of computers for all school-related work and the required use of computers for these students (a few hours a week to complete assignments) is far less than their actual reported use of several hours per day, so this explanation cannot fully account for the differences we found.

An alternative explanation relates to the conceptualization and measurement of our model's constructs. Compeau et al. (2017) highlight the risks of continuing to use measures that were developed in vastly different technical environments. Their assessment of the CSE measure shows multiple ways in which the conceptualization might have become misaligned with the current IT context. First, the measure was developed at a time when use of IT was more focused on the completion of work tasks, whereas use today supports a wide range of both work and non-work tasks. Second, the CSE measure focuses on using a "novel" piece of software because the ability to cope with novelty was a key characteristic of the environment facing the digital immigrant users of the time. In the current context, the authors argue, that emphasis on novelty seems less relevant.

Our analysis showed significant issues in this study's measurement model which lends support to their argument. Our initial model resulted in 18 items (out of 46) loading below 0.70. Perhaps the measures of our constructs are not adequate in contemporary contexts of technology use. Items for CSE and outcome expectations in particular contain references to dated technology concepts. Even the use of "computers" as a way of describing the variety of technological devices that people use is problematic as it is not clear whether the term computer was interpreted narrowly (desktop and laptop computers) or broadly (to include smartphones, tablets, and a wide range of other computing devices). Future research needs to further consider the implications of changing technology for the measurement of constructs in order to (a) separate measurement issues from substantive changes in the phenomenon as explanations for our results, and (b) provide measures that will help us understand the underlying concepts in a vastly different technological environment. CSE shows significantly weaker measurement properties than it did in the 1995 study. While this is unsurprising given some of the technical references in the items, it raises the theoretical question of how we ought to be measuring an individual's IT-related self-efficacy in a world of ubiquitous technology and technology opportunity.

4.5 Limitations

The findings of our study must be considered in light of our study's limitations. Despite our view that the context of business students learning to use computers for work purposes creates similar meaning to the context of professionals learning to use them in the early 1990s, there remain some differences between them that limit our ability to conclusively explain the results. Our subjects are younger than those studied by Compeau and Higgins and have different life experiences, being digital natives. In addition, with regards to social factors, the characteristics and demands of business school vs. business (e.g., failing to comply with social influences at school has different implications than doing so at work) may have influenced the relationships though we find less difference in these relationships than in others in the model. As noted earlier, challenges in the conceptualization and measurement of the constructs as the environment has changed may also explain some of the observed differences. Nonetheless, this was a purposeful choice. While perhaps counter-intuitive, we contend that the context of our study using business students more closely matches Compeau and Higgins' (1995) context than if we had gathered data from an online panel of business professionals. The students in our sample were enrolled in a class where they were learning to use unfamiliar software, with advanced features that they could not be expected to know beforehand. We believe this learning context is comparable to the workplace of the 1990s, where workers learned to use technology in the workplace. By varying the context, we may lose some explanatory ability to say exactly *why things have changed*, but we more accurately represent *the extent of change that has occurred*. Moreover, the subjects we studied here are the future professionals we seek to understand. Knowing how the next generation of IT users relate to the technology will help us develop forward-looking theories in a technological and work environment that continues to change. Future research will be needed to further understand the reasons and the relative importance of measurement issues versus changes in the socio-technical environment, but our study represents a call to action to further this line of work

4.6 Key Takeaways for CSE

We began this study to understand the extent to which the constructs and relationships proposed in the CSE model continue to remain relevant in the modern IT use context. Our replication provides some evidence to suggest that CSE remains relevant. It continues to predict both OE-performance and anxiety, and to indirectly influence use through OE and affect. However, the results show a weakening of the effects across time and with our younger sample of digital natives which could mean that CSE, like EOU in TAM, has lost its theoretical relevance because of the ubiquity of IT.

We believe that such a conclusion would be premature, based on theoretical and empirical grounds. Theoretically, self-efficacy has been found to be relevant across a wide range of behavioral domains, including exercise, healthy eating and parenting (Bandura, 2006). Each of these domains reflects ubiquitous activities and yet people continue to differ in the extent to which they develop confidence in the relevant abilities and how these differences influence behavior. We see no reason to believe that IT would be a unique domain where self-efficacy has no predictive ability. Empirically, we believe our findings with respect to measurement difficulties for CSE suggest an alternative explanation for the weaker effects. The lower loadings of items that clearly reflect dated IT references suggest that the CSE measure may be losing validity. Even the reference to "computer" self-efficacy seems out of touch with the modern context of IT use where smartphones and tablets dominate.

One way to further explore these ideas would be to conduct additional replication studies, using updated measures for CSE and other constructs in the model. An updated measure of CSE that better reflected the different devices currently being used and the ways in which we "organize and execute courses of action" (Bandura, 1997, p. 3) necessary to use them. By first addressing the construct validity issues, future research could explore the theoretical relationships in more detail. Continuing to study CSE without first addressing the potential measurement issues risks drawing theoretical conclusions that understate its importance and draw attention away from a potentially important driver of behavior.

Even more valuable, in our view, would be research that updates both the measure and the nomological network. The current model focuses on a particular form of behavior choice (extent of use) as the dependent variable. Given the ubiquity of IT extent of use may not be as driven by CSE, since so many activities of daily life demand its use. Innovative use (Wang, Li, & Hsieh, 2013) or exploratory use (Carter et al., 2020) are also aspects of behavior choice, but as more creative and voluntary behaviors, they might be more strongly influenced by CSE than extent of use. Moreover, behavior choice is only one outcome of self-efficacy in SCT; persistence in the face of obstacles, physiological states and performance are also theorized to be influenced by self-efficacy judgments. Perhaps future research on CSE (once updated) should focus more on understanding its influence on persistence and stress, along with performance.

4.7 Key Takeaways for Replication

This replication study reaffirms the importance of conceptual replication, even for established findings. While CSE remains an important construct in our field, and meta-analyses (e.g., Karsten et al., 2012) provide support for its influence on a range of individual cognitions and behaviors, no research had replicated the entire conceptual model. Our findings show significant differences from the original results, which may help to support further theorizing about the measurement of the constructs and about the role of contextual influences on the relationships.

One of the main challenges when replicating social research in a non-controlled environment is contextualizing the study in the closest possible way to the original study. In our case, we conducted several rounds of review in our instrument to ensure that the intent and meanings of items in the original study were preserved. We kept our measures as close as possible to the original study to enhance comparability, while understanding that this would be challenging because the studies were performed in very different contexts.

In order to have an instrument as close as possible to the original, the wording of questions that would shed light on new conceptualizations were painstakingly set aside in favor of wording that would be the same or closest to the original. For instance, after long debates, we decided to keep using the word computer, instead of information technology, to avoid confusion with newer technologies that did not exist when the original study was performed (e.g., cell phones, tablets). While it prevented us from understanding self-efficacy's role in use of newer technologies, it allowed a closer comparison of our results and measures with the original study. To that end, we advise replication researchers to thoroughly strategize their approach to how measures are modified, focusing on enhancing the ability to compare study results. The more measures and context differ between studies, the less researchers can conclude about differences in outcomes. Over time, this could have the unfortunate effect of prompting the academic community to question the importance and usefulness of replications in scientific inquiry.

5 Concluding Remarks

Our replication of Compeau and Higgins' foundational study of computer self-efficacy supports the core ideas of the model but suggest that changes in the technological and user environment have influenced the ways in which individuals relate to information technology. In doing so, we highlight opportunities to further explore the nature of these changes and their implications for our theoretical models and our construct measurement.

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Appendix A: Measurement Comparison

Table A1. Measurement Comparison

Original Study (loadings shown in parentheses)	**Replication**
Encouragement and Use by Others	
5-point Likert scale (strongly disagree to strongly agree)	
To what extent do you feel that using a computer is encouraged or discouraged by each of the following groups of people?	
1. Your peers in your organization (λ=0.83) 2. Your manager (λ=0.74) 3. Other management (λ=0.83) 4. Your peers in other organizations (λ=0.80)	1. Your peers 2. Your professors 3. School administrators 4. Other students
To what extent do each of the following groups of people use computers?	
1. Your peers in your organization (λ=0.89) 2. Your Managers (λ=0.85) 3. Other management (λ=0.54) 4. Your peers in other organizations (λ=0.49)	1. Your peers 2. Your professors 3. School administrators 4. Other students
Support	
The next few questions concern the amount of support your organization provides for computer users. Please indicate the extent to which you agree or disagree with each of the following statements. 1. Guidance is available to me in the selection of hardware, software, printers, and other equipment (λ=0.81) 2. A specific person (or group) is available for assistance with software difficulties (λ=0.77) 3. A specific person (or group) is available for assistance with hardware difficulties (λ=0.76) 4. Specialized instructions and education concerning popular software are available to me (λ=0.79) 5. My co-workers are able to provide assistance when I encounter problems using the computer (λ=0.76) 6. In general, I feel this organization has been very supportive of computer users (λ=0.82)	The next few questions concern the amount of support your school provides for computer users. Please indicate the extent to which you agree or disagree with each of the following statements. 1. Guidance is available to me in the selection of hardware, software, printers, and other equipment 2. A specific person (or group) is available for assistance with software difficulties 3. A specific person (or group) is available for assistance with hardware difficulties 4. Specialized instructions and education concerning popular software are available to me 5. My fellow students are able to provide assistance when I encounter problems using the computer 6. In general, I feel this school has been very supportive of computer users
General Computer Self-efficacy	
11-point scale from 0 – NO – to 10 YES and totally confident	
This part of the questionnaire asks you about your ability to use an unfamiliar piece of software. Often in our jobs we are told about software packages that are available to make work easier. For the following questions, imagine that you were given a new software package for some aspect of your work. It doesn't matter specifically what this software package does, only that it is intended to make your job easier and that you have never used it before. The following questions ask you to indicate whether you could use this unfamiliar software package under a variety of conditions. For each of the conditions, please indicate whether you think you would be able to complete the job using the software package. Then, for each condition that you answered "yes", please rate your confidence about your first judgement, by circling a number from 1 to 10, where 1 indicates "Not at all confident", 5 indicates "Moderately confident", and 10 indicates "Totally confident".	This part of the questionnaire asks you about your ability to use an unfamiliar piece of software. Often in our jobs we are told about software applications that are available to make tasks easier. For the following questions, imagine that you were given a new software package for some aspect of your schoolwork. It doesn't matter specifically what this software application does, only that it is intended to make your tasks easier and that you have never used it before. The following questions ask you to indicate whether you could use this unfamiliar software package under a variety of conditions. For each of the conditions, please indicate whether you think you would be able to complete the job using the software package. Then, for each condition that you answered "yes", please rate your confidence about your first judgement, by circling a number from 1 to 10, where 1 indicates "Not at all confident", 5 indicates "Moderately confident", and 10 indicates "Totally confident".

Table A1. Measurement Comparison	
Original Study (loadings shown in parentheses)	**Replication**
I could complete the job using the software package… 1. If there was no one around to tell me what to do as I go. (λ=0.83) 2. If I had never used an application like it before. (λ=0.80) 3. If I had only the software manuals for reference. (λ=0.84) 4. If I had seen someone else using it before trying it myself. (λ=0.86) 5. If I could call someone for help if I got stuck (λ=0.85) 6. If someone else had helped me get started. (λ=0.82) 7. If I had a lot of time to complete the job for which the software was provided. (λ=0.83) 8. If I had just the built-in help facility for assistance. (λ=0.71) 9. If someone showed me how to do it first. (λ=0.76) 10. If I had used similar packages before this one to do the same job. (λ=0.80)	I could complete the task using the software application… 1. If there was no one around to tell me what to do as I go. 2. If I had never used an application like it before. 3. If I had only the software manuals for reference. 4. If I had seen someone else using it before trying it myself. 5. If I could call someone for help if I got stuck 6. If someone else had helped me get started. 7. If I had a lot of time to complete the task for which the software was provided. 8. If I had just the built-in help facility for assistance. 9. If someone showed me how to do it first. 10. If I had used similar applications before this one to do the same job.
Outcome Expectations	
The following statements describe the outcomes that people might experience as a result of using a computer. For each item indicate on the scale whether you feel you would be likely to experience that outcome from your computer use. *5-point Likert scale. Very unlikely to very likely*	The following statements describe the outcomes that people might experience as a result of using a computer for schoolwork. For each item indicate on the scale whether you feel you would be likely to experience that outcome from your computer use. *5-point Likert scale (strongly disagree to strongly agree)*
Performance Outcome Expectations	
If I use a computer…	If I use a computer for my schoolwork…
1. I will be better organized (λ=0.58) 2. I will increase my effectiveness on the job (λ=0.84) 3. I will spend less time on routine tasks (λ=0.70) 4. I will increase the quality of output of my job (λ=0.85) 5. I will increase the quantity of output for the same amount of effort (λ=0.79) 6. I will be less reliant on clerical support staff. (λ=0.50)	1. I will be better organized 2. I will increase my effectiveness in my studies 3. I will spend less time on routine tasks 4. I will increase the quality of my schoolwork 5. I will get more work done for the same amount of effort 6. DROPPED
Personal Outcome Expectations	
6. My co-workers will perceive me as competent (λ=0.72) 7. I will increase my sense of accomplishment (λ=0.62) 8. I will increase my chances of getting a promotion (λ=0.84) 9. I will be seen as higher in status by my peers (λ=0.76) 10. I will increase my chances of getting a raise (λ=0.82)	1. My fellow students will perceive me as competent 2. I will increase my sense of accomplishment 3. I will increase my chances of getting good job 4. I will be seen as higher in status by my peers 5. I will increase my chances of getting a better grade
Positive Affect	
The next few statements describe feelings that some people have about computers. For each statement, please indicate the extent to which you agree or disagree with the feelings being expressed. *5-point Likert scale (strongly disagree to strongly agree)*	
1. I like working with computers. (λ=0.87) 2. I look forward to those aspects of my job that require me to use a computer (λ=0.82) 3. Once I start working in the computer, I find it hard to stop (λ=0.62) 4. Using a computer is frustrating for me (λ=70) 5. I get bored quickly when working on a computer (λ=0.73)	1. I like working with computers. 2. I look forward to those aspects of my studies that require me to use a computer 3. Once I start working in the computer, I find it hard to stop 4. Using a computer is frustrating for me 5. I get bored quickly when working on a computer

Table A1. Measurement Comparison

Original Study (loadings shown in parentheses)	**Replication**
Anxiety	
This section if the questionnaire asks about your feelings towards using computers. The following statements reflect various feelings towards using computers that you may or may not hold. For each statement, please indicate the extent to which you agree or disagree with the feelings expressed. *5-point Likert scale (strongly disagree to strongly agree)*	
1. I feel apprehensive about using computers (λ=0.81) 2. It scares me to think that I could cause the computer to destroy a large amount of information by hitting the wrong key (λ=0.74) 3. I hesitate to use a computer for fear of making mistakes that I cannot correct (λ=0.77) 4. Computers are somewhat intimidating to me (λ=0.85)	1. I feel apprehensive about using computers 2. It scares me to think that I could cause the computer to destroy a large amount of information by hitting the wrong key 3. I hesitate to use a computer for fear of making mistakes that I cannot correct 4. Computers are somewhat intimidating to me
Computer Use	
On average, how frequently do you use a computer at work? (λ=0.80) 1. Several times a day 2. About once a day 3. A few times a week 4. A few times a month 5. Once a month 6. Less than once a month	On average, how frequently do you use a computer for school-related work? 1. More than ten times a day. 2. Every day between two and ten times 3. Once a day 4. Between two and seven times a week 5. Less than once a week
On average, approximately how much time do you spend each day using a computer at your place of work? *Converted to a 5-point scale.* (λ=0.79) _______ hours and ______minutes	On average, approximately how much time do you spend each day using your computer for **school related work**? Select the number of hours from the list below. *Converted to a 5-point scale based on quintiles.* 0-20 in intervals of .5
On average, approximately how much time do you spend each day using your computer? *Converted to a 5-point scale* Weekdays: ______ hours and _____ minutes (λ=0.65) Weekends: ______ hours and _____ minutes (λ=0.67)	On average, approximately how much **total time** do you spend each day using your computer? Select the number of hours from the list below. *Converted to a 5-point scale based on quintiles.* 0-20 in intervals of .5

Appendix B: Loadings and Cross-Loading Unmodified Model

Table B1. Loadings and Cross-Loading Unmodified Model

	Enc	O Use	Support	CSE	OE Perf	OE Pers	Affect	Anx	Use
Enc_1	**0.84**	0.42	0.31	0.09	0.27	0.16	0.20	-0.05	0.10
Enc_2	**0.63**	0.38	0.17	0.20	0.15	0.12	0.07	-0.04	-0.08
Enc_3	**0.69**	0.32	0.21	0.15	0.11	0.10	-0.01	0.06	-0.06
Enc_4	**0.84**	0.39	0.23	0.13	0.29	0.22	0.23	-0.02	0.10
OUse_1	0.42	**0.80**	0.21	0.08	0.14	0.04	0.06	-0.08	0.02
OUse_2	0.38	**0.71**	0.17	0.10	0.11	0.04	0.00	0.02	0.03
OUse_3	0.33	**0.68**	0.11	0.04	0.07	0.00	-0.05	0.04	-0.03
OUse_4	0.39	**0.84**	0.18	0.11	0.17	0.05	0.08	-0.06	0.06
Sup_1	0.25	0.15	**0.73**	0.18	0.16	0.14	0.13	0.01	-0.05
Sup_2	0.11	0.13	**0.75**	0.18	0.26	0.12	0.13	-0.05	-0.04
Sup_3	0.19	0.19	**0.77**	0.10	0.23	0.13	0.15	-0.05	0.00
Sup_4	0.24	0.15	**0.70**	0.12	0.18	0.19	0.15	0.01	0.02
Sup_5	0.16	0.15	**0.61**	0.18	0.17	0.08	0.21	-0.04	0.00
Sup_6	0.35	0.20	**0.74**	0.21	0.28	0.15	0.20	-0.10	0.03
CSE_1	0.04	0.03	0.12	**0.67**	0.11	0.12	0.10	-0.20	0.03
CSE_2	0.04	0.02	0.08	**0.61**	0.13	0.13	0.13	-0.07	0.03
CSE_3	0.12	0.05	0.21	**0.59**	0.05	0.10	0.02	-0.03	0.11
CSE_4	0.15	0.10	0.12	**0.69**	0.17	0.16	0.19	-0.07	0.03
CSE_5	0.13	0.09	0.20	**0.71**	0.11	0.10	0.14	-0.11	0.06
CSE_6	0.14	0.06	0.19	**0.77**	0.16	0.12	0.11	-0.05	0.00
CSE_7	0.05	0.01	0.11	**0.71**	0.19	0.13	0.19	-0.22	0.06
CSE_8	0.19	0.14	0.17	**0.54**	0.08	0.07	0.11	0.03	0.09
CSE_9	0.26	0.17	0.18	**0.74**	0.21	0.10	0.20	-0.15	0.02
CSE_10	0.09	0.11	0.22	**0.76**	0.26	0.21	0.14	-0.18	-0.01
OE_1	0.20	0.16	0.21	0.09	**0.67**	0.41	0.31	-0.05	0.06
OE_2	0.23	0.16	0.22	0.17	**0.79**	0.49	0.36	-0.18	0.07
OE_3	0.10	0.08	0.17	0.20	**0.48**	0.38	0.10	0.03	-0.07
OE_4	0.26	0.15	0.27	0.17	**0.80**	0.44	0.27	-0.13	0.00
OE_5	0.18	0.01	0.18	0.22	**0.67**	0.39	0.20	-0.07	0.04
OE_6	0.18	0.06	0.10	0.13	0.30	**0.69**	0.07	0.14	0.03
OE_7	0.12	-0.01	0.17	0.10	0.47	**0.78**	0.33	0.06	0.14
OE_8	0.18	0.09	0.12	0.15	0.36	**0.72**	0.17	0.04	0.06
OE_9	0.12	0.00	-0.01	0.14	0.30	**0.58**	0.09	0.17	-0.02
OE_10	0.16	0.05	0.20	0.16	0.61	**0.75**	0.29	-0.04	0.02
Aff_1	0.15	0.09	0.27	0.27	0.27	0.17	**0.76**	-0.37	0.19
Aff_2	0.19	0.04	0.14	0.09	0.34	0.30	**0.82**	-0.18	0.24
Aff_3	0.12	0.03	0.12	0.13	0.26	0.30	**0.63**	0.08	0.24
Aff_4	0.07	-0.06	0.05	0.07	0.12	0.01	**0.53**	-0.56	0.14
Aff_5	0.04	-0.01	0.16	0.08	0.19	0.12	**0.54**	-0.31	0.08
Anx_1	-0.04	-0.08	-0.01	-0.14	-0.16	0.04	-0.19	**0.80**	-0.05
Anx_2	0.07	0.07	0.03	-0.07	0.01	0.13	-0.11	**0.65**	0.11
Anx_3	-0.10	-0.11	-0.09	-0.09	-0.10	0.08	-0.30	**0.80**	-0.02
Anx_4	0.01	-0.01	-0.08	-0.19	-0.13	0.05	-0.34	**0.90**	-0.01
UseSW	0.00	0.02	-0.01	0.02	0.03	0.09	0.21	0.06	**0.87**
UseTT	0.01	-0.01	-0.04	0.07	0.02	0.08	0.24	-0.03	**0.85**
UseFrq	0.11	0.09	0.03	0.03	0.05	0.02	0.25	-0.05	**0.71**

Appendix C: Model Testing with Revised Measurement Model

In order to assess the possibility that problems in the measurement model would influence the structural model results, we tested a second model after refining the original measures to achieve improved validity of constructs. We reviewed each item that loaded below 0.70 and removed those with very low loadings (below 0.60) and/or where a strong conceptual argument could be made. If an item loaded between 0.6 and 0.7 and the overall construct metrics (discussed further below) met their required thresholds, we did not remove the item.

Two items from CSE were removed due to low loadings. CSE 3 and CSE 8 referred to the use of software manuals and built-in help applications. It is not surprising that these items did not load on the construct since applications do not come with software manuals and the built-in help facility is now often integrated with a wide range of online resources. We also examined CSE for evidence of multidimensionality (Thatcher, Zimmer, Gundlach, & McKnight, 2008). Exploratory factor analysis, using both principal components and principal axis factoring produced a single factor model, with all the items loading at or above 0.49. When a two-factor solution was imposed in the EFA, the second factor included 3 items (which correspond to the items that Thatcher et al. (2008) considered to be “internal”). However, several of the items in the first factor also reflect situations where social support is not present (e.g., if I had used similar packages before, if I had a lot of time to complete the task, if I had just the built-in help facility). Thatcher et al. (2008) dropped these items in order to produce their internal and external dimensions. An alternative explanation for their result reflects task difficulty. Bandura argues that self-efficacy measures should include items reflecting various levels of task difficulty. In the context of using computers, the items that Thatcher et al. (2008) labeled as external also reflect the easier items in the scale. Thus, we believe that the original conceptualization of CSE as a single factor, using all the scale items, is more consistent with the construct definition.

Two of the items measuring affect (Aff 4 and Aff 5) were also removed. These are reverse-coded items and did not correlate well with the remaining items. This is a common problem in reverse coded items.

Two items from the outcome expectations constructs were removed because the notion of “routine tasks” embedded in OE 9 was not meaningful to students in the context of our study. Similarly, the idea of computer use as a status symbol (OE 7) is less relevant especially given that students were participating in the study as part of a required course.

The remaining items with loadings below 0.70 (Encouragement of Use 2 and 3, Others Use 3, Support 5, CSE 1 and 2, OE 1, 5 and 6, and Anxiety 1) were retained in the model to preserve content comparability with the original model. This is consistent with the process suggested by Hair et al. (2016) for dealing with weak item loadings.

With these items removed, we re-ran the model. The loadings for the retained items were generally satisfactory (see Table C1). The composite reliabilities were all above 0.80 and the average variances extracted were all above 0.50 (Table C2). Thus, the constructs demonstrated adequate reliability and convergent validity.

For discriminant validity, we examined the individual item cross-loadings which were all less than the loadings. We also compared the shared variance between constructs in relation to the shared variance between each construct and its own measures (Fornell & Larcker, 1981). In this case, all constructs meet the conditions for discriminant validity. OE-performance is highly correlated with OE-personal (r=0.59) but this correlation is well below the diagonal elements and is not surprising given that these are subdimensions of the same construct. For discriminant validity, the Heterotrait-Monotrait Ratio (HTMT) can be used as well, and none of the values should exceed the 0.85 threshold (Henseler et al. 2015). For this model, the highest HTMT value was 0.76 (OE personal / OE performance).

The results of the modified model (Figure C1) were not substantially different from the results obtained from the first model. Despite the demonstrated convergent validity and reliability, the only difference was that, despite having the same path coefficient (b = 0.12), the relationship between CSE and affect was non-significant in the modified model. We consider this a random result since bootstrapping for this model resulted in a $p = .054$ vs. a $p = .050$ in the unmodified model.

Table C1. Loadings and Cross Loadings for Modified Model

	Enc	O Use	Support	CSE	OE Perf	OE Pers	Affect	Anx	Use
Enc_1	**0.84**	0.42	0.31	0.08	0.27	0.15	0.21	-0.04	0.10
Enc_2	**0.64**	0.38	0.17	0.19	0.15	0.13	0.07	-0.04	-0.08
Enc_3	**0.69**	0.32	0.21	0.14	0.12	0.10	0.00	0.06	-0.06
Enc_4	**0.84**	0.39	0.23	0.11	0.29	0.22	0.24	-0.02	0.10
OUse_1	0.42	**0.81**	0.21	0.08	0.14	0.03	0.08	-0.08	0.02
OUse_2	0.39	**0.71**	0.17	0.09	0.11	0.04	0.02	0.02	0.03
OUse_3	0.33	**0.67**	0.11	0.03	0.07	0.01	-0.04	0.04	-0.03
OUse_4	0.39	**0.85**	0.17	0.11	0.17	0.06	0.10	-0.06	0.06
Sup_1	0.25	0.15	**0.73**	0.16	0.17	0.16	0.12	0.01	-0.05
Sup_2	0.11	0.12	**0.76**	0.18	0.25	0.13	0.11	-0.05	-0.04
Sup_3	0.18	0.19	**0.77**	0.08	0.22	0.14	0.15	-0.05	0.00
Sup_4	0.24	0.15	**0.70**	0.11	0.17	0.19	0.17	0.02	0.02
Sup_5	0.16	0.15	**0.60**	0.18	0.15	0.09	0.21	-0.04	0.00
Sup_6	0.35	0.20	**0.74**	0.20	0.28	0.17	0.21	-0.10	0.03
CSE_1	0.04	0.03	0.12	**0.67**	0.10	0.11	0.11	-0.20	0.03
CSE_2	0.04	0.02	0.07	**0.61**	0.11	0.13	0.15	-0.07	0.02
CSE_4	0.14	0.10	0.12	**0.70**	0.15	0.15	0.20	-0.07	0.03
CSE_5	0.14	0.09	0.20	**0.71**	0.11	0.10	0.12	-0.10	0.06
CSE_6	0.14	0.06	0.19	**0.78**	0.15	0.12	0.12	-0.04	0.00
CSE_7	0.05	0.01	0.11	**0.72**	0.18	0.13	0.18	-0.21	0.06
CSE_9	0.26	0.16	0.18	**0.74**	0.19	0.10	0.19	-0.15	0.02
CSE_10	0.09	0.11	0.21	**0.77**	0.25	0.20	0.14	-0.17	-0.01
OE_1	0.19	0.16	0.21	0.11	**0.67**	0.42	0.28	-0.04	0.06
OE_2	0.23	0.16	0.22	0.17	**0.81**	0.50	0.35	-0.18	0.07
OE_4	0.26	0.15	0.27	0.18	**0.81**	0.44	0.27	-0.13	0.00
OE_5	0.18	0.01	0.19	0.22	**0.67**	0.38	0.21	-0.07	0.04
OE_6	0.18	0.06	0.10	0.12	0.27	**0.67**	0.12	0.15	0.03
OE_7	0.12	-0.01	0.17	0.10	0.46	**0.79**	0.34	0.06	0.14
OE_8	0.18	0.09	0.12	0.15	0.34	**0.73**	0.19	0.04	0.06
OE_10	0.16	0.05	0.20	0.18	0.60	**0.77**	0.29	-0.03	0.02
Aff_1	0.14	0.10	0.27	0.27	0.28	0.18	**0.76**	-0.37	0.19
Aff_2	0.19	0.04	0.14	0.10	0.35	0.30	**0.84**	-0.18	0.24
Aff_3	0.12	0.03	0.12	0.13	0.24	0.30	**0.70**	0.08	0.24
Anx_1	-0.04	-0.08	-0.01	-0.15	-0.16	0.01	-0.11	**0.79**	-0.05
Anx_2	0.06	0.07	0.03	-0.09	0.00	0.12	-0.02	**0.67**	0.11
Anx_3	-0.10	-0.11	-0.09	-0.11	-0.12	0.06	-0.19	**0.81**	-0.02
Anx_4	0.01	-0.01	-0.08	-0.20	-0.14	0.04	-0.24	**0.89**	-0.01
UseSW	-0.01	0.02	-0.01	0.00	0.04	0.10	0.23	0.07	**0.88**
UseTT	0.01	-0.01	-0.04	0.06	0.03	0.09	0.23	-0.03	**0.84**
UseFrq	0.11	0.09	0.03	0.03	0.06	0.03	0.25	-0.05	**0.71**

Table C2. Reliability and Discriminant for Modified Model

	CR†	1	2	3	4	5	6	7	8	9
1 Encour.	0.84	0.76								
2 Other Use	0.85	0.50	0.76							
3 Support	0.86	0.31	0.22	0.72						
4 CSE	0.89	0.16	0.11	0.22	0.71					
5 OE Perf	0.83	0.29	0.17	0.30	0.23	0.74				
6 OE Pers	0.83	0.21	0.05	0.21	0.18	0.59	0.74			
7 Affect	0.81	0.20	0.07	0.22	0.21	0.38	0.34	0.77		
8 Anxiety	0.87	-0.02	-0.04	-0.06	-0.19	-0.15	0.06	-0.20	0.79	
9 Use	0.86	0.04	0.04	-0.01	0.04	0.06	0.09	0.29	0.00	0.82

†CR= Composite Reliability

Note: Diagonal elements (shaded) are the square root of the average variance extracted (AVE). Off-diagonal elements are the correlations among constructs. For discriminant validity, diagonal elements should be larger than off-diagonal elements.

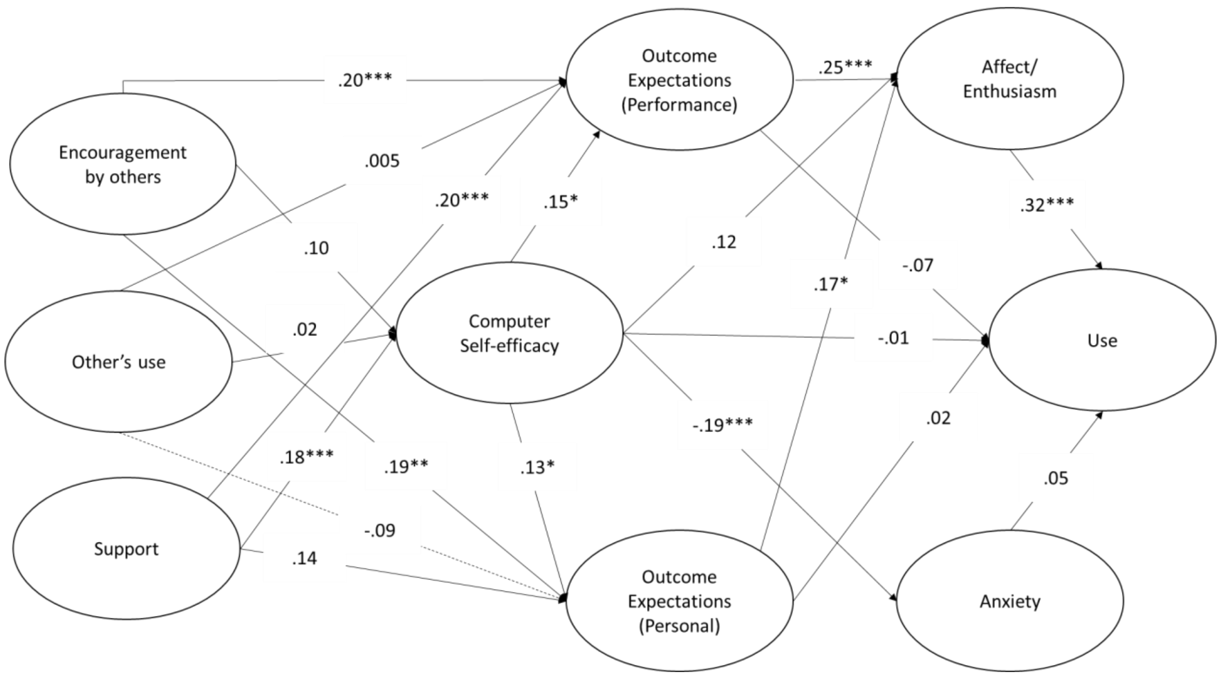

Figure C1. Replication Study Modified Model Results

Appendix D: Assessment of Common Method Bias

Table D1. Assessment of Common Method Bias		
Hypothesis	**Replication Unmodified model**	**CMB marker variable**
H1. Encouragement – Self-efficacy	.11ns	.09ns
H2a. Encouragement – Performance Outcome Expectations	.19***	.19***
H2b. Encouragement – Personal Outcome Expectations	.20***	.19**
H3. Others' Use – Self-efficacy	.02ns	.01ns
H4a. Others' Use – Performance Outcome Expectations	.01ns	.006ns
H4b. Others' Use – Personal Outcome Expectations	-.09ns	-.08ns
H5. Support – Self-efficacy	.19***	.19***
H6a. Support – Performance Outcome Expectations	.21***	.21***
H6b. Support – Personal Outcome Expectations	.12ns	.12ns
H7a. Self-efficacy – Performance Outcome Expectations	.15**	.14**
H7b. Self-efficacy – Personal Outcome Expectations	.14**	.12**
H8. Self-efficacy – Affect	.12**	.12**
H9. Self-efficacy – Anxiety	-.17**	-.16**
H10. Self-efficacy – Use	.014ns	.02ns
H11a. Performance Outcome Expectations – Affect	.28***	.29***
H11b. Personal Outcome Expectations – Affect	.12ns	.11ns
H12a. Performance Outcome Expectations – Use	-.09ns	-.09ns
H12b. Personal Outcome Expectations – Use	.02ns	.02ns
H13. Affect – Use	.34***	.34***
H14. Anxiety – Use	.08ns	.10ns
** $p < 0.05$; *** $p < 0.01$		

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