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Creation of a Computer Self-Efficacy Measure: Analysis of Internal Consistency, Psychometric Properties, and Validity

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Abstract

Computer self-efficacy is an often studied construct that has been shown to be related to an array of important individual outcomes. Unfortunately, existing measures of computer self-efficacy suffer from several deficiencies, including criterion contamination, outdated wording, and/or inadequate psychometric properties. For this reason, the current article presents the creation of a new computer self-efficacy measure. In Study 1, an over-representative item list is created and subsequently reduced through exploratory factor analysis to create an initial measure, and the discriminant validity of this initial measure is tested. In Study 2, the unidimensional factor structure of the initial measure is supported through confirmatory factor analysis and further reduced into a final, 12-item measure. In Study 3, the convergent and criterion validity of the 12-item measure is tested. Overall, this three study process demonstrates that the new computer self-efficacy measure has superb psychometric properties and internal reliability, and demonstrates excellent evidence for several aspects of validity. It is hoped that the 12-item computer self-efficacy measure will be utilized in future research on computer self-efficacy, which is discussed in the current article.

Introduction

Within the study of humans and their interactions with the environment, one of the most commonly studied constructs is self-efficacy. Coined by Bandura,[1–4] self-efficacy is described as ''people's judgments of their capabilities to organize and execute courses of action required to attain designated types of performances.''[1] Initially, Bandura[1–4] postulated that the study of individuals' self-efficacy beliefs should be directed toward specific activities, but researchers in subsequent years strayed from this specific focus.[5–7] Today, authors have returned to specific forms of self-efficacy, noting that some have higher predictive ability.[8–10] Unsurprisingly, research into self-efficacy has spread to the study of human–computer interactions, with a popular construct being computer self-efficacy.

Most authors consider computer self-efficacy to be an individual's feelings toward their capabilities in working with a desktop or laptop personal computer.[11–13] In research, computer self-efficacy has been shown to predict or moderate several noteworthy relationships, which include variables such as computer phobia,[14] computer anxiety,[15,16] computer-based training transfer,[17–19] and several other computer-related attitudes.[20,21] Despite these noteworthy findings, some concerns exist in the study of computer self-efficacy, notably the measures used.

Likely the most popular measure of computer self-efficacy was created by Compeau and Higgins.[12] This measure asks participants about their capability beliefs to use a novel, work-related program. For each question, the participant is asked whether they could ''complete the job using a software package'' after an action had been taken, such as ''if I had only the software manual for reference.''[12p211] While this measure is regularly used, it has certain concerns. Several factors could be involved in individuals' computer self-efficacy beliefs that are unrelated to individuals' required necessities to learn and utilize a hypothetical work-related computer program. In fact, some authors have noted that the scale may actually measure learning self-efficacy rather than computer self-efficacy.[11] Also, various extraneous factors may bias participant responses based upon the nature of the Compeau and Higgins's[12] items. For example, a participant may have high computer self-efficacy, but indicate that they would not be able to ''complete the job using a software package if [they] had only the software manual for reference'' due to concerns over reading ability and/or the complexity of their work.

An additional computer self-efficacy scale was created by Murphy et al.[13] However, this scale has its shortcomings,

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too. To create their measure, the authors created 32 items that ask about individuals' confidence performing certain computer-related tasks. While this measure was previously effective, it is currently outdated. Questions such as ''I feel confident logging onto a mainframe computer system'' and ''I feel confident handling a floppy disk correctly'' do not apply to most modern computer users. Current studies still attempt to use this measure and remove several of the items prior to administration. Unfortunately, there is little consensus to exactly which items should be removed,[22–24] causing authors to administer various versions of the original set of items. Further, Murphy et al.'s[13] measure asks about individuals' proficiency to perform certain computer-related tasks, which seems more akin to measuring actual computer skills rather than computer self-efficacy. Finally, in repeated analyses, the scale's factor structure has demonstrated varying numbers of dimensions.[13,25]

Lastly, Cassidy and Eachus[11] also created a computer self-efficacy scale. Although their created measure was an improvement on previous efforts, three notable problems exist. First, when reporting the psychometric properties, the authors did not report the numerical results of their factor analysis, and only mentioned ''Factor and item analysis conducted on data collected in part of this study suggested that the scale was unidimensional.''[11p140] Without knowing the method that suggested a unidimensional factor structure or the numerical value of resultant eigenvalues, little support can be given for these results. Second, several of Cassidy and Eachus's[11] items may suffer from criterion contamination. For example, the item ''Computers frighten me'' may measure computer phobia, which has been shown to be an entirely separate construct from computer self-efficacy.[14,26] Third, similar to concerns with Murphy et al.'s[13] measure, some of Cassidy and Eachus's[11] items may not be relevant to modern computer users, such as ''DOS-based computer packages don't cause many problems for me.''

Other computer self-efficacy measures exist, but their deficiencies were adequately addressed in previous articles and will not be noted here.[11,27] Because of shortcomings in common computer self-efficacy scales, the current study reports the development of a new computer self-efficacy scale. In creating this scale, the limitations of the scales noted above are specifically addressed, and evidence of the scale's psychometric properties and validity is provided.

Study 1

The purpose of Study 1 was to create and subsequently reduce an over-representative item list to create a computer self-efficacy scale. To create this over-representative item list, previous self-efficacy scales were adapted to measure computer self-efficacy,[6,28] and some self-created items were added. This process ensures adequate content validity, while avoiding criterion contamination.[29,30] Specific references to computer hardware or software were avoided, due to concerns over the scale becoming outdated.

Measures

Computer self-efficacy. Twenty-five self-created items measuring computer self-efficacy were administered.

Big Five. The Big Five personality constructs were measured through Saucier's[31] minimarkers scale as indicators of divergent validity. This measure includes eight items for each of the five personality constructs. In the current study, the measure demonstrated adequate Cronbach's alphas for each construct: Openness to Experience (0.78), Contentiousness (0.83), Extraversion (0.84), Agreeableness (0.87), and Neuroticism (0.77).

Sample 1

In Sample 1, 298 participants recruited from a college student subject pool participated in return for extra course credit. Two items were included within the survey to gauge for insufficient motivation, and these items directly instructed participants to provide certain responses. If participants did not successfully answer both items, their data were removed from analyses. After removing all participants that failed attention checks, 262 participants remained. These participants were mainly female (72% female), Caucasian (76%), and young ($M_{\text{Age}} = 19.36$ years; $SD = 2.16$ years).

Results

To reduce the over-representative item list, an exploratory factor analysis (EFA) using principal axis factoring with direct oblimin rotation was performed using the results obtained from Sample 1. The initial EFA indicated that three factors were present within the over-representative item list, based upon the Kaiser criterion and a visual scree plot analysis (eigenvalues = 14.995, 1.558, 1.270). Although the Kaiser criterion is often criticized for its conservative nature,[32,33] the goal of Study 1 was to reduce the number of items within the over-representative item list, and removing rather than retaining excessive items was preferred. Item loadings within the second and third factors were largely based upon the original measure from which the item was adapted, and did not represent substantial theoretical differences within the items themselves. For this reason, items that loaded onto alternative factors were removed in a stepwise manner until a unidimensional solution was obtained. The item removal process resulted in a single factor measure (eigenvalues = 10.752, 0.902, 0.877) consisting of 17 items. The Cronbach's alpha of these seventeen items was 0.96.

Additionally, the scale had small correlations with each of the Big Five personality constructs (all below $|0.10|$), and these results are listed in Table 1.

Discussion

From the results of Study 1, the created computer self-efficacy scale demonstrated a satisfactory factor structure, superb internal consistency, and expected divergent validity. These aspects indicate that the created computer self-efficacy scale is suitable for further investigation. A second study was conducted to confirm the discovered unidimensional factor structure.

Study 2

Measures

Computer self-efficacy. The 17 self-created items retained from Study 1 were administered.

Sample 2

In Sample 2, 352 participants were recruited from Amazon's Mechanical Turk (MTurk) in exchange for a small amount of

TABLE 1. CORRELATION MATRIX OF THE INITIAL 17-ITEM MEASURE OF COMPUTER SELF-EFFICACY AND THE BIG FIVE FROM STUDY 1

	1	*2*	*3*	*4*	*5*	*6*
1. Computer self-efficacy	0.96					
2. Openness to experiences	0.07	0.78				
3. Conscientiousness	0.08	0.24**	0.83			
4. Extraversion	0.00	0.26**	0.20**	0.84		
5. Agreeableness	−0.03	0.40**	0.49**	0.28**	0.87	
6. Neuroticism	−0.05	−0.05	−0.31**	−0.13*	−0.39**	0.77

$^{*}p<0.05$; $^{**}p<0.01$.
Cronbach's alphas listed on diagonal.

payment (US$0.05 or US$0.10). Several previous studies have shown results using MTurk users are valid.[34] This sample was chosen to ensure that the psychometric properties of the created computer self-efficacy scale were replicable in a nonstudent sample. Within the survey, one item was included to gauge for insufficient motivation akin to Study 1. After removing all participants that failed the attention check, 309 participants remained. These participants were mainly male (61%), racially diverse (51% Caucasian, 29% Asian, 14% Indian, 6% other), and young ($M_{\text{Age}}=33.05$; $SD=10.94$).

Results

To test the unidimensional factor structure of the reduced computer self-efficacy measure, a confirmatory factor analysis (CFA) was performed using a listwise deletion method. All items were specified to load onto a single factor, and the loading of the first item was constrained to one for identification purposes. Initial results were acceptable, but slightly below preferred cutoffs for fit indices. For this reason, items were removed in a stepwise manner based upon the summated modification indices of their error terms. Five items were removed, resulting in a 12-item measure. The results indicated that the unidimensional model fit these items well, as the relevant fit indices were all above their respective cutoffs (Table 2). The Cronbach's alpha of this reduced measure was 0.94.

Discussion

The results of Study 2 indicate that the reduced item list has a unidimensional factor structure confirmed through CFA. With the superb psychometric properties replicated, an additional study was needed to gauge aspects of the scale's criterion and convergent validity.

Study 3

Measures

Computer self-efficacy. The 12-item measure refined in Study 2 was administered, and is provided in Appendix A. The Cronbach's alpha in this sample was 0.95.

Alternative computer self-efficacy scale. To gauge criterion validity, Compeau and Higgins's[12] 10-item measure was administered, detailed in the current article's introduction. The scale demonstrated a Cronbach's alpha of 0.93.

General self-efficacy. Chen et al.'s[5] eight-item measure of general self-efficacy was administered to gauge convergent validity, and an example item is "I will be able to achieve most of the goals that I have set for myself." For the current study, the scale's Cronbach's alpha was 0.95.

Sample 3

In Sample 3, 234 participants recruited from a college student subject pool participated in return for extra course credit. Seven items were included within the survey to gauge for insufficient motivation akin to Studies 1 and 2. This extreme number of attention checks was chosen because the survey was administered near the end of the university semester, and participants were likely those who procrastinated on participating in research studies. These individuals may be low on conscientiousness and more likely to give random responses. After removing all participants that failed attention checks, 189 participants remained. These participants were mainly female (66%), Caucasian (79%), and young ($M_{\text{Age}}=19.76$; $SD=1.70$).

Results

The results from Sample 3 demonstrated that the new computer self-efficacy scale had excellent criterion validity with another measure of computer self-efficacy ($r=0.43$). The measures are highly related, but not strongly enough to indicate that they are identical. Also, the new computer self-efficacy scale had a strong correlation with general self-efficacy ($r=0.38$), indicating excellent convergent validity. These results are listed in Table 3.

Overall Discussion

Within the current article, concerns over several existing computer self-efficacy scales were addressed, and a new

TABLE 2. CONFIRMATORY FACTOR ANALYSIS FIT INDICES FOR THE 12-ITEM COMPUTER SELF-EFFICACY MEASURE FROM STUDY 2

	CFI	*NFI*	*GFI*	*SRMR*	*RMSEA*	*AIC*	χ^2	*df*
Computer self-efficacy	0.98	0.96	0.95	0.02	0.05	143.094	95.094	54

Table 3. Correlation Matrix of Study 3 Variables

	1	2	3
1. 12-item computer self-efficacy measure	0.95		
2. Compeau and Higgins's (1995) computer self-efficacy measure	0.43**	0.93	
3. General self-efficacy	0.38**	0.29**	0.95

$^{**}p < 0.01$.
Cronbach's alphas listed on diagonal.

12-item computer self-efficacy measure was created. This measure was shown to have superb psychometric properties, as demonstrated within an EFA and a CFA, across a student and nonstudent sample. Also, the scale demonstrated excellent internal consistency, and several aspects of its validity were supported. Overall, the new computer self-efficacy measure seems to be a satisfactory tool for future research.

Several avenues for future research seem promising for computer self-efficacy. First, scale validation is never complete. Several further aspects of the new computer self-efficacy measure can be validated beyond those within the current study. Second, several areas of research seem relevant to computer self-efficacy, but have generally been understudied. A growing body of research has probed the relationship dynamics of online group members.[35–38] The connections between these individuals are likely impacted by members' computer self-efficacy, as this has been shown to effect individuals' computer-related behaviors.[39–41] Also, computer self-efficacy has been shown to impact individuals' success in organizational computer-based training programs.[42–44] It is important to discover moderators and mediators of this relationship, as those who experience low computer-self efficacy may suffer reduced transfer of training. Fortunately, the scale created in the current article can aid researchers studying each of these topics, and provides great benefits for future research and practice.

Author Disclosure Statement

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Appendix

Appendix A: 12-Item Computer Self-Efficacy Scale

1. I can always manage to solve difficult computer problems if I try hard enough.
2. If my computer is ''acting-up,'' I can find a way to get what I want.
3. It is easy for me to accomplish my computer goals.
4. I am confident that I could deal efficiently with unexpected computer events.
5. I can solve most computer programs if I invest the necessary effort.
6. I can remain calm when facing computer difficulties because I can rely on my abilities.
7. When I am confronted with a computer problem, I can usually find several solutions.
8. I can usually handle whatever computer problem comes my way.
9. Failing to do something on the computer makes me try harder.
10. I am a self-reliant person when it comes to doing things on a computer.
11. There are few things that I cannot do on a computer.
12. I can persist and complete most any computer-related task.