Theoretical Biophysics Group

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Evaluation of CTSE (Collaboration Technology Self-Efficacy) Scale

As set out in the original proposal, the BioCoRE evaluation program is expected to measure attitudes of BioCoRE users and when necessary develop new measures applicable to the collaboratory environment. The Collaboration Technology Self-Efficacy Scale (CTSE) is an attempt to achieve both these goals concurrently – to develop a new scale that measures an attitude that may impact evaluations of BioCoRE.

Scale Description:

The CTSE is included in the BioCoRE registration form and its focus is user self-efficacy when using BioCoRE. Self-efficacy can be defined as a person's assessment of his or her ability to carry out a set of behaviors or behavior pattern (Bandura, 1978). Context-specific measures of self-efficacy have shown a relation to work performance in numerous contexts, ranging from life insurance sales to adaptability to a new technology (Staples, Hulland, & Higgins, 1998).

It was reasoned that BioCoRE user self-efficacy in two areas would likely impact their use and evaluation of the collaboratory: (1) self-efficacy in regards to dealing with computer technology, and (2) self-efficacy in regards to how well the individual may function in an on-line collaborative group. Combined, the two measures are meant to provide a gross estimation of user self-efficacy in regards to how successfully users think they may function within the BioCoRE environment.

Two subscales comprise the total scale. The Technological Self-Efficacy (TSE) subscale measures self-efficacy in handling computer programs, while the On-line Collaboration Self-Efficacy (OCSE) subscale assesses self-efficacy in working with on-line groups.

The question stems for each subscale are below, followed by an evaluation of the validity and reliability of the scale. Conclusions are then drawn regarding the scale.

Scale Items:

Technological Self-Efficacy (TSE):

1. I can get most software programs to do what I want in a short amount of time (CTSE-TSE-1).
2. I can fix most problems with software programs without help (CTSE-TSE-2).
3. I can use programs means to assist collaborative work without difficulty (CTSE-TSE-3).

On-line Collaboration Self-Efficacy (OCSE):

1. Communicating clearly with others in a virtual group is not a problem (CTSE-OCSE-1).
2. I can follow what is happening in a virtual group without difficulty (CTSE-OCSE-2).

Responses were collected during the period March 1, 2000 to November 11, 2000 using a seven-point Likert scale ranging from 1=Strongly Disagree to 7=Strongly Agree with a midpoint of 4=Unsure. One change was made in the scale wording in late August 2000: the word 'virtual' replaced 'on-line' in the question stems

Scale Evaluation

Responses to the scale items were taken from the BioCoRE registration database on November 11, 2000, for use in evaluating the validity and reliability of the scale. The data set was cleaned of information generated by BioCoRE developers, who knew the purpose of the scale and thus could not be considered valid respondents. The resulting data set represents the responses of 179 scientists, though in practice about 100 scientists answered this specific scale items, as the scale items are optional for BioCoRE registrants. Response rates across the entire survey items varied by question.

Scale Validity

Content validity. The two subscales of the CTSE were intended to assess the respondent's level of self-efficacy in using software programs, and self-efficacy in working collaboratively. The combination of the two subscales is meant to provide a general measure of how well respondents think they will be able to handle a collaborative technology like BioCoRE. Two members of the BioCoRE evaluation team reviewed the question stems; readers can assess the face validity of the items themselves as well.

Construct validity. The CTSE is similar to various self-efficacy scales in its measurement strategy. Earlier scales assessing computer attitudes include Nickel & Pinto, 1986; Zakrajsek, Waters, Popovich, Craft, & Hampton, 1990; Davis, 1993; Hudiburg, 1995; Davis & Venkatesh, 1996; Hudiburg, 1998, as well as two scales assessing self-efficacy and attitude towards computers (Murphy, Coover, & Owen, 1989; Staples, Hulland, & Higgins, 1998). A comparison between programming experts and scientists' mean responses to the CTSE yielded no significant differences.

Criterion validity. At present there are no scales that measure the same domain as the CTSE and therefore no meaningful comparison for assessing its criterion validity is possible.

Scale Reliability

Six criteria, as described by R. F. Devellis (1991) in Scale Development: Theory and Applications were used to assess the reliability of the CTSE. The criteria include the assessment of (1) scale item intercorrelations, (2) assessing the applicability of reverse scoring, (3) item-scale correlations, (4) item variances, (5) item means, and (6) the coefficient alphas of the entire scale. Correlations and significance tests are produced using the bivariate correlations method in the SPSS-X statistical analysis program.

I. Scale item intercorrelations.

High intercorrelations among scale items are a good indication of scale reliability, and also suggest that they yield a true measurement of the underlying concept.

Table 1: Correlation Matrix for All Scale Items

		CTSE Tech SE 1	CTSE Tech SE 2	CTSE Tech SE 3	CTSE Online Coll 1	CTSE Online Coll 2
CTSE Tech SE 1	Pearson Correlation	1.000	.524**	.424**	.205*	.252**
	Sig. (1-tailed)	.	.000	.000	.020	.006
	N	104	103	101	100	100
CTSE Tech SE 2	Pearson Correlation	.524**	1.000	.510**	.190*	.248*
	Sig. (1-tailed)	.000	.	.000	.029	.006
	N	103	103	101	100	100
CTSE Tech SE 3	Pearson Correlation	.424**	.510**	1.000	.392**	.455*
	Sig. (1-tailed)	.000	.000	.	.000	.000
	N	101	101	101	99	99
CTSE Online Coll. 1	Pearson Correlation	.205*	.190*	.392**	1.000	.754*
	Sig. (1-tailed)	.020	.029	.000	.	.000
	N	100	100	99	100	99
CTSE Online Coll. 2	Pearson Correlation	.252**	.248**	.455**	.754**	1.000
	Sig. (1-tailed)	.006	.006	.000	.000	.
	N	100	100	99	99	100

** Correlation is significant at the .01 level (1-tailed).
* Correlation is significant at the .05 level (1-tailed).

As the table indicates, all scale items have a significant, positive relationship with each other, and several have values above r = .50. Thus, the CTSE scale reasonably meets the criterion of high intercorrelations.

II. Applicability of reverse scoring

Since there are no negative correlations evident in the correlation matrix, there is no call for reverse scoring.

III. Item-scale correlations

In a highly intercorrelated scale, each item of the scale should have a high correlation with the remaining items in the scale. There are two methods of assessing item-scale correlations, termed corrected and uncorrected. A corrected item-scale correlation compares an item to all the remaining items in the scale, excluding itself. In an uncorrected item-scale correlation, the item of interest is left in the scale to which it is compared.

A. Corrected item-scale correlations

The correlation matrix below (see below, Table 2: Correlation Matrix for Corrected Scale) shows the correlations between a scale item and the remaining items in the scale.

All correlations are significant and are reasonably high, indicating sufficient item-scale reliability.

B. Uncorrected item-scale correlations

As expected, the uncorrected item-scale correlation values (see below, Table 3: Correlation Matrix for Uncorrected Scale) are higher than in the corrected item-scale correlations. The correlation values indicate a high level of uncorrected item-scale reliability.

Table 2: Correlation Matrix for Corrected Scale

Corrected Item-scale Correlations With Items Remaining in Scale		
CTSE Tech SE 1	**Pearson Correlation**	**.456****
	Sig. (1-tailed)	**.000**
	N	**98**
CTSE Tech SE 2	**Pearson Correlation**	**.477****
	Sig. (1-tailed)	**.000**
	N	**98**
CTSE Tech SE 3	**Pearson Correlation**	**.598****
	Sig. (1-tailed)	**.000**
	N	**98**
CTSE Online Coll. 1	**Pearson Correlation**	**.552****
	Sig. (1-tailed)	**.000**
	N	**98**
CTSE Online Coll. 2	**Pearson Correlation**	**.607****
	Sig. (1-tailed)	**.000**
	N	**99**

** Correlation is significant at the .01 level (1-tailed).

Table 3: Correlation Matrix for Uncorrected Scale

Uncorrected Item-scale Correlations With Total Scale		
CTSE Tech SE 1	**Pearson Correlation**	**.636****
	Sig. (1-tailed)	**.000**
	N	**98**
CTSE Tech SE 2	**Pearson Correlation**	**.678****
	Sig. (1-tailed)	**.000**
	N	**98**
CTSE Tech SE 3	**Pearson Correlation**	**.760****
	Sig. (1-tailed)	**.000**
	N	**98**
CTSE Online Coll. 1	**Pearson Correlation**	**.743****
	Sig. (1-tailed)	**.000**
	N	**98**
CTSE Online Coll. 2	**Pearson Correlation**	**.775****
	Sig. (1-tailed)	**.000**
	N	**98**

1. Subscale: Technological Self-Efficacy (TSE)

Corrected and uncorrected item-scale correlations were also generated for the CTSE subscales. The results for the TSE are shown below. The results are similar to those discussed above – and are all significant.

Table 4: Correlation Matrix for TSE Subscale

		Corrected Scale	Uncorrected Scale
CTSE Tech SE 1	Pearson Correlation	.546**	.779**
	Sig. (1-tailed)	.000	.000
	N	1.1	101
CTSE Tech SE 2	Pearson Correlation	.611**	.848**
	Sig. (1-tailed)	.000	.000
	N	101	101
CTSE Tech SE 3	Pearson Correlation	.539**	.803**
	Sig. (1-tailed)	.000	.000
	N	101	101

** Correlation is significant at the .01 level (1-tailed).

2. Subscale: On-line Collaboration Self-Efficacy (OCSE)

The corrected scale results for the OCSE reflect the correlation between the two separate items of the scale, which is high at r = .75 and significant.

Table 5: Correlation Matrix for OCSE Subscale

		Corrected Scale	Uncorrected Scale
CTSE Online Coll. 1	Pearson Correlation	.754*	.938**
	Sig. (1-tailed)	.000	.000
	N	99	99
CTSE Online Coll. 2	Pearson Correlation	.754*	.935**
	Sig. (1-tailed)	.000	.000
	N	99	99

** Correlation is significant at the .01 level (1-tailed).
* Correlation is significant at the .05 level (1-tailed).

IV. Scale item variances

High variance in response to a scale item indicates the item is capturing a meaningful level of diversity in the target population. The table below provides means, standard deviations, and variances for each item in the scale.

Table 6: Means, Standard Deviations, and Variances for Scale Items

	CTSE Tech SE 1	CTSE Tech SE 2	CTSE Tech SE 3	CTSE Online Coll 1	CTSE Online Coll 2
Mean	**5.80**	**5.36**	**5.18**	**5.55**	**5.63**
Std Deviation	**1.18**	**1.45**	**1.34**	**1.45**	**1.43**
Variance	**1.39**	**2.11**	**1.79**	**2.11**	**2.03**

Most of the variance captured tends to reflect the upper half of the scale items, indicating mostly positive values from respondents.

V. Item means

The means for the scale items (see above table) range from a low of 5.18 to a high of 5.80 indicating only positive assessment of respondents' own self efficacy in regards to working with collaborative technology and online collaborative work. The item means fall within the midpoint of the range of the upper parts of the scale, rather than falling at the midpoint of the scale, making the scale mildly successful in meeting the criteria of means close to the center of the range of possible scores.

VI. Coefficient alphas of the entire scale

The Cronbach's alpha for the CTSE is moderately high, with the SPSS-X scale reliability analysis procedure producing an alpha score of $\alpha = .77$, a 'respectable' reliability score for a scale (DeVellis, 1991).

A. Subscale alpha score: Technological Self-Efficacy

Alpha scores were also generated for the component subscales of the CTSE. In the case of the technological self-efficacy subscale, the alpha produced was $\alpha = .74$.

B. Subscale alpha score: On-line Collaboration Self-Efficacy

The highest alpha score was found for the on-line collaboration self-efficacy subscale, with an alpha of $\alpha = .86$.

Conclusion

The validity of the CTSE scale could not be fully assessed due to lack of meaningful comparative criteria. The scale was found to be reasonably reliable. Future efforts in scale development could address further the validity issues of the CTSE, by soliciting expert opinion, turning up similar scales for comparison, identifying groups known to vary in the degree of the constructs measured, and so forth.

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