DOCUMENT RESUME

ED 408 318 TM 026 571

AUTHOR	Nash, John B.; Moroz, Pauline A.
TITLE	An Examination of the Factor Structures of the Computer Attitude Scale.
PUB DATE	Mar 97
NOTE	21p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL, March 24-28, 1997).
PUB TYPE	Reports - Research (143) -- Speeches/Meeting Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	Computer Anxiety; Computer Attitudes; *Factor Analysis; *Factor Structure; Teacher Attitudes; *Teachers; Test Construction; *Test Reliability; Test Use; Test Validity; *Training
IDENTIFIERS	*Computer Attitude Scale

ABSTRACT

The first study described in this paper estimates the reliability of the four subscale versions of the 40-item Computer Attitude Scale (CAS), an instrument designed to measure attitudes toward learning about and using computers. It provides detailed information about the factor patterns of CAS subscales and evidence of the differential validity of the CAS among four groups with differing intensity of computer usage. A second study addresses the ambiguity of the computer confidence and computer anxiety CAS subscales. In the first study, 208 subjects (mostly certified teachers) completed the CAS. Correlations and exploratory and confirmatory factor analysis were used to analyze the data. The results confirm that the confidence and anxiety subscales measure along the same continuum. A new, smaller, subscale was created to reflect this relationship. In addition, a new factor, attitudes toward academic endeavors associated with computer training, was named. In the second study, 104 subjects completed the revised computer confidence/anxiety and computer liking subscales of the CAS. Exploratory and confirmatory factor analyses support the stability of the newly formed factor for confidence/anxiety. The CAS may now be interpreted as a 34-item scale covering computer liking, perceived usefulness of computers, computer confidence and anxiety, and attitudes toward academic endeavors associated with computer training. (Contains 5 tables and 29 references.) (Author/SLD)

An Examination of the Factor Structures of the Computer Attitude Scale

John B. Nash
The University of Texas at El Paso
501 EDUC
El Paso, TX 79968
(915) 747 7614
john@utep.edu

Pauline A. Moroz
The University of Texas at El Paso
504 EDUC
El Paso, TX 79968
(915) 747 5783
pmoroz@utep.edu

Paper presented at the Annual Meeting of the American Educational Research Association, Chicago, IL, March 24-28th, 1997

Abstract

The first study in this paper obtains estimates of the reliability of the four subscale version of the forty item Computer Attitude Scale (CAS); provides detailed information regarding the factor patterns of the CAS subscales; and provides evidence about the differential validity of the CAS among four groups with differing intensity of computer usage. A second study addresses the ambiguity of the computer confidence and computer anxiety subscales of the CAS. In study one, 208 subjects completed the CAS. Correlations and exploratory and confirmatory factor analysis were used to analyze the data. The results confirm that the confidence and anxiety subscales measure along the same continuum. A new, smaller, subscale was created reflect this relationship. Further, a new factor, attitudes toward academic endeavors associated with computer training, was named. In study two, 104 subjects completed the revised computer confidence/anxiety and the computer liking subscale of the Computer Attitude Scale. Exploratory and confirmatory factor analysis support the stability of the newly formed factor for confidence/anxiety. The CAS may now be interpreted as a 35 item scale covering computer liking, perceived usefulness of computers, computer confidence/anxiety and attitudes toward academic endeavors associated with computer training.

As the number of microcomputers in schools continues to increase, it becomes increasingly important for school staffs to provide opportunities for students to utilize them properly. When viewed as an innovation, computers in schools are susceptible to the same implementation pitfalls as are any other innovation. It has been suggested that the attitudes of individuals proximate to the implementation of an innovation can influence the innovation's success (Rice and Aydin, 1991). Further, attitudes are thought to influence behavior. As such, there is great interest in understanding the attitudes of educators toward computers. The purpose of this study is to re-visit the factor structure of a well-known computer attitude inventory, the Computer Attitude Scale (Loyd and Gressard, 1984a; Loyd and Loyd, 1985). Fast becoming the measure of choice in research on attitudes toward computers, the CAS has been used with a variety of adult populations. For example, the CAS has been used with professional educators (Nash and Moroz, 1997; Christensen and Knezek, 1996; Bennett, 1995; Mertens and Wang, 1988: Roszkowski, Devlin, Snelbecker, Aiken, and Jacobsohn, 1988; Loyd and Gressard, 1986), high school counselors (Stone, Thompson, and Lacount, 1989), college students (Busch, 1995; Francis and Evans, 1995; Szajna, 1994; Carlson and Wright, 1993; Gardner, Discenza, and Dukes, 1993; Pope-Davis and Vispoel, 1993; Pope-Davis and Twing, 1991), adult basic education students (Massoud, 1991), and in the health and banking sectors of industry (Henderson, Deane, Barrelle, and Mahar, 1995).

Computer Attitude Survey

Loyd and Gressard (1984a) reported that the Computer Attitude Scale (CAS) is an effective and reliable measure of attitudes toward learning about and using computers. In its original form, the CAS is a Likert-type instrument consisting of 30 items which present statements of attitudes toward computers and the use of computers. Loyd and Gressard (1984a) sampled $\underline{n} = 155$ high school students and concluded in a confirmatory factor analysis that the CAS consisted of three stable subscales: (a) anxiety or fear of computers; (b) liking of computers; and (c) confidence in computers. This solution accounted for 55% of the variance. Alpha reliability coefficients were reported as .86, .91, and .91 for each subscale, respectively. In the same year, Loyd and Gressard sought to determine the effects of age, gender, and computer experience on attitudes toward computers (Loyd and Gressard, 1984b). Using the CAS and a sample of n = 186 high school students and n = 168 college students, Loyd and Gressard found that computer experience (as measured by amount of experience in terms of less than one week/ one week to 6 months and more than 6 months) had a significant effect on scores on the three subscale version of the CAS. Those subjects with more computer experience had significantly higher scores in the measured areas of computer confidence, computer liking, and lack of computer anxiety. Later, Gressard and Loyd (1986) examined the validity of the CAS by (1) exploring the factor structure, and (2) determining whether intervention affected test performance. Once again, Gressard and Loyd conducted a confirmatory factor analysis with a three-factor solution, this time with a sample of n = 192 teachers. They report a similar structure to that reported by Loyd and Gressard (1984a), with 54% of the variance accounted for. The second study involved administering the CAS as a pre and posttest to seventy teachers enrolled in a staff development program addressing the introduction of technology into the curriculum. Dependent t tests revealed that the CAS was indeed sensitive to attitudinal changes resulting from computer instruction (the sample were significantly less anxious and more confident about using computers on completion of their training).

In addition to the original authors of the CAS, other researchers have conducted validation studies of the three subscale version of the CAS. Bandalos and Benson (1990), for example, examined the factor structure of the CAS on 375 graduate and undergraduate students enrolled in educational measurement and statistics courses. Their results differed somewhat from Loyd and Gressard (1984a). Whilst three factors were extracted (with an oblique rotation), it resulted in a 23 item scale, differing on two of the three factors. Bandalos and Benson labeled them (a) computer confidence; (b) computer liking; and (c) computer achievement. Bandalos and Benson report that the computer liking subscale was similar to that found by Loyd and Gressard, however, Bandalos and Benson's computer confidence scale appeared to be a composite of the anxiety and confidence factors reported by Loyd and Gressard (1984a). The last factor, computer achievement, related to ones ability to do well in computer courses. In examining the revised 23-item CAS across groups, Bandalos and Benson conclude that the instrument was measuring the same construct for males, females, graduate, and undergraduate students. It must be noted, however, that Bandalos and Benson's report displayed factor pattern structure coefficient tables which referred to the CAS items only as item numbers (rather than the items themselves), making any comparisons to the current investigation somewhat laborious.

Another factor analytic study by Woodrow (1991) of the CAS provided additional evidence that the three scale version of the CAS was two dimensional, not three. Further, Woodrow questions whether the subscale scores are stable enough to be used as separate scores aside from the total CAS score. Such conclusions, however, are drawn from analyses of a relatively small data set ($\underline{n}$ = 98 graduate students).

In 1985, a forth subscale, labeled computer usefulness, was added to the CAS by Loyd and Loyd (1985). In a validation study with $\underline{n}$ = 114 K-12 teachers, Loyd and Loyd found that the computer anxiety and computer confidence subscales were highly correlated ($\underline{r}$ = .83) and subsequently specified a three-factor solution with a varimax rotation. This solution accounted for 48 percent of the variance. The coefficient alpha reliabilities for the computer anxiety, computer confidence, computer liking, and perceived computer usefulness subscales were reported as .90, .89, .89, and .82, respectively. Nine items from the computer anxiety subscale and seven from the computer confidence subscale had factor pattern/structure coefficients of .40 or higher on Factor I. With this result in mind, Loyd and Loyd concluded that computer anxiety and computer confidence were measuring the same trait; inspite of this Loyd and Loyd did not suggest a reduction in the number if items. Loyd and Loyd also investigated whether the CAS differentiated among teachers with different amounts of computer experience. The results of four one-way analysis of variance procedures (ANOVA) found that the CAS subscales did indeed differentiate between respondents who indicated computer experience in terms of less than six months, six months to one year, and more than one year.

More recently, Kluever, Lam, Hoffman, Green, and Swearingen (1994) collected data from 265 teachers volunteering to participate in computer training. A principal components analysis with varimax rotation revealed a four-factor solution that was quite similar to that found by

Loyd and Loyd (1985). Kluever et al. label the derived interrelated factors as computer anxiety, efficiency, liking, and usefulness in instruction (again, numeric labels and not items descriptions are provided). These four factors explained 54 percent of the variance. Analysis of post-test data from the sample some 9 months later produced the same interrelated factors (this time accounting for 49.5 percent of the variance). Analyses of the data by Kluever et al. using an item response theory rating scale, however, revealed several items which did not fit a unidimensional model. Three of these items were from the computer confidence subscale and one from the computer anxiety subscale. Such a result lends support to the need for further investigation and revision of the CAS computer confidence and computer anxiety subscales which research has shown to be measuring the same construct.

Rationale

As urged by Kerlinger (1986), in factor analytic research it is important to replicate studies; "the 'reality' of factors is much more compelling if found in two or three different and large samples" (p. 593). Thus, as with the Loyd and Loyd (1985) study, the primary purposes of this research was to (1) obtain estimates of the reliability of the four subscale version of the CAS; (2) to gain detailed information regarding the factor pattern of the subscales; and (3) provide evidence about the differential validity of the CAS among four groups with differing intensity of computer usage. A second study sought to address the ambiguity of the computer confidence and computer anxiety subscales; confirmation that these two subscales are in fact measuring the same construct in professional educators would perhaps allow for a streamlined version of the CAS to be administered in future research studies.

Study One

Method

Sample data were collected from 208 educators (mostly certified teachers) enrolled in graduate education courses at a large southwestern university. Thirty-one percent (n = 65) were male and n = 142 (68%) indicated that they were female (with 1 unknown). The age breakdown for the sample was as follows: n = 65 were in their twenties, n = 71 in their thirties, n = 51 in their forties, and n = 19 were fifty or older.

Instrumentation. Data was collected using the four subscale version of the Computer Attitude Scale, as presented by Loyd and Loyd (1985). The order of the forty items was randomly arranged and a 5-point Likert-style response format was used: 1 = Strongly Disagree, 2 = Disagree, 3 = Not Sure, 4 = Agree, and 5 = Strongly Agree. Consistent with previous studies involving the CAS, scores from negatively worded items were reversed, thus making a higher score indicative of higher levels of computer confidence, computer liking, perceived computer usefulness, and lower levels of computer anxiety.

Information regarding computer usage was gathered by a seven item scale covering such home computer-related activities as computer programming, accessing the internet, word-processing, retrieving and composing electronic mail, painting/drawing/or other graphical activities, and spreadsheet/numerical/statistical analyses. Respondents indicated the frequency of such activities in terms of never, occasionally in a year, monthly, once a week, and daily. Such a scale assessed the intensity of computer usage, rather than the typical 'resume' interpretation of computer experience (for example, see Loyd and Gressard, 1984b). Cronbach alpha of this type of computer frequency/intensity scale has been reported as r = .86 (Nash and Moroz, 1997). Computer activity frequency scores for respondents were calculated by summing the responses for each of the seven items; the minimum score of which was 7, and the maximum, 35. Scores which fell in the 7 to 13 range were deemed as overall occasional users, 14 to 20 were noted as more than occasional, but less than monthly, users; scores between 21 and 27 were deemed to be monthly users, while scores of 28 to 35 were determined to be weekly/daily users of computer at home.

General Procedures. Subjects in the present study were administered the CAS during regular class time within the first week of the semester. SPSS (1995) was used to form a 40 X 40 data set. A principal-component analysis of this matrix of data was computed, followed by a factor analysis with an orthogonal-varimax rotation; the criteria for determining the number of factors to rotate was eigenvalues of one or above. Like the Loyd and Loyd (1985) and Kluever et al. (1994)

study, items with factor pattern/structure coefficients of .4 or higher were considered significant. Means, standard deviations, intercorrelations of the CAS subscales, and estimates of internal consistency (Cronbach's Alpha) were also computed. In order to assess the two-factor model of computer confidence and computer anxiety, a principal components analysis with a varimax rotation (two-factor solution specified) was also generated. Finally, four one-way analysis of variance (ANOVA) were calculated for computer usage with each CAS subscale as the dependent variable. The null hypothesis in each case was that the population means of each subscale would be equal across the four levels of computer usage. The Alpha level was set to $p = .05$ and was adjusted to $p < .0125$ using the Bonferroni technique to control for Type I error. The strength of association, omega-squared, was used to assess the extent to which variability in the data was attributable to variable interaction.

Results

The mean scores for the subjects of this study on the CAS was 162.9, with a standard deviation 23.2. Table 1 presents the means and standard deviations for each of the four subscales. In general the results suggest that the sample as a whole held positive attitudes toward computers (a score of 120 would have indicated a neutral attitude toward computers). The internal consistency (coefficient alpha) was calculated as $r = .90$, $r = .91$, $r = .92$, and $r = .84$ for the subscales of computer confidence, liking, anxiety, and perceived computer usefulness, respectively. Cronbach's alpha for entire scale was $r = .97$. Intercorrelations between the subscales revealed a strong association between computer anxiety and computer confidence ($r = .91$).

Table 1
Means, Standard Deviations, and Intercorrelation of the Computer Attitude Subscales and Total Score.

Subscale	Mean	SD	1	2	3	4
1. Computer Confidence	40.4	6.4				
2. Computer Liking	38.9	7.3	.81			
3. Computer Anxiety	40.6	7.1	.91	.82		
4. Computer Usefulness	43.0	4.6	.67	.68	.65	

The principal components analysis with varimax rotation produced a six factor solution that explained 63% of the variance. Factor pattern/structure coefficients for each of these six factors are presented in Table 2. Factor I accounted for most of the covariance (44.5%) and consisted of 17 items with pattern/structure coefficients of .40 or higher (three of these items also had coefficients of .40 or higher on other factors). Two of these items were from the computer liking subscale, six from the computer confidence subscale, and nine were from the computer anxiety subscale. All but one item from the computer liking subscale had pattern/structure coefficients of .40 or higher on Factor II; this factor also yielded high coefficients from items "I don't think I would do advanced computer work" (computer confidence) and "I feel aggressive and hostile toward computers (computer anxiety). The third factor consisted of seven items from the computer usefulness subscale, plus a shared item from computer liking ("I will do as little work with computers as possible"). Factor IV appeared to be a composite of items again from the computer confidence and computer anxiety subscales: three items with pattern/structure coefficients of .40 or higher were from computer confidence, two from computer anxiety, and one from computer

Table 2
Six factor Varimax-Rotated Solution and Item-Total Correlations for the Computer Attitude Scale (N = 208).

Subscale Item	Factor Pattern/Structure Coefficients						Item-Total Correlation
	I	II	III	IV	V	VI	
Computer Confidence							
I am sure I could learn a computer language	.35	.23	-.01	.49	.39	.01	.59
Generally, I would feel OK about trying a new problem on the computer	.61	.28	.17	.24	.39	.15	.77
I'm not the type to do well with computers	.66	.14	.24	.38	.07	.26	.75
I do not think I could handle a computer course	.31	.21	.22	.61	.02	.24	.64
I think using a computer would be very hard for me	.66	.08	.12	.14	.18	.30	.61
I could get good grades in computer courses	.34	.15	-.04	.67	.28	.14	.61
I don't think I would do advanced computer work	.43	.41	.27	.39	.14	-.08	.71
I'm no good with computers	.61	.23	.35	.22	-.04	.04	.66
I am sure I could do work with computers	.35	.20	.24	.17	.66	.15	.66
I have a lot of self-confidence when it comes to working with computers	.68	.29	.06	.26	.26	-.06	.72

Table 2, continued.

Subscale Item	I	II	III	IV	V	VI	Item-Total Correlation
	Factor Pattern/Structure Coefficients						
Computer Liking							
When there is a problem with a computer run that I can't immediately solve, I would stick with it until I have the answer	.29	.52	.04	.37	.09	.31	.65
I would like working with computers	.48	.34	.29	.21	.35	.23	.76
I do not enjoy talking with others about computers	.29	.63	.08	.14	.09	.05	.58
The challenge of solving problems with computers does not appeal to me	.38	.54	.22	.30	.06	.29	.74
Figuring out computer problems does not appeal to me	.27	.68	.19	.29	.07	.04	.69
Once I start to work with a computer, I would find it hard to stop	.29	.62	.12	.25	.33	.08	.71
I don't understand how some people can spend so much time working with computers and seem to enjoy it	.23	.68	.29	.15	.13	.08	.66
I think working with computers would be enjoyable and stimulating	.37	.65	.26	.22	.26	-.05	.78
I will do as little work with computers as possible	.46	.43	.55	.17	-.04	.02	.73
If a problem is left unresolved in a computer case, I would continue to think about it afterward.	.14	.55	-.03	.24	.26	.21	.52
Computer Anxiety							
I would feel comfortable working with a computer	.60	.23	.20	.25	.47	.18	.79
Working with a computer would make me very nervous	.62	.15	.32	.30	.04	.21	.70
It wouldn't bother me at all to take computer courses.	.27	.36	.08	.67	.01	-.02	.61
I feel aggressive and hostile toward computers	.58	.49	.35	.12	-.05	.12	.76
I do not feel threatened when others talk about computers.	.59	.19	.01	-.06	.35	-.08	.49
I would feel at ease in a computer class.	.55	.29	.16	.53	.14	-.07	.75
Computers make me feel uneasy and confused	.64	.32	.37	.26	.08	.01	.79
Computers make me feel uncomfortable.	.78	.34	.17	.11	.14	.02	.76
Computers do not scare me at all.	.64	.31	.05	.19	.27	.01	.69
I get a sinking feeling when I think of trying to use a computer	.67	.25	.37	.13	.03	.29	.75
Computer Usefulness							
Learning about computers is a waste of time	.16	.20	.29	.09	.13	.74	.47
I'll need a firm mastery of computers for my future work	-.06	.15	.44	.34	.37	-.23	.38
It is important to me to do well in computer class	.07	.34	.27	.64	.21	-.02	.59
Learning about computers is worthwhile	.01	.30	.42	.36	.33	.26	.57
I expect to have little use for computers in my daily life	.19	.27	.58	-.01	.16	.18	.51
Working with computers will not be important in my life's work	.19	-.09	.57	.07	.13	.03	.33
Anything a computer can be used for, I can do just as well some other way	.14	.22	.49	-.10	.13	.29	.39
I can't think of any way that I will use computers in my career	.15	.12	.71	.17	-.02	.13	.47
Knowing how to work with computers will increase my job possibilities.	.20	.14	.55	.13	.32	-.05	.50
I will use computers many ways in my life	.23	.16	.34	.16	.67	.11	.59

usefulness. These items are all related to academic endeavors associated with computers. Factor V was also comprised of items from the computer confidence, anxiety, and usefulness subscales. This time, however, the three items were associated with 'work'. The final factor had just one item with a coefficient above .40: "learning about computers is a waste of time" (computer usefulness subscale). With so few factor pattern/structure coefficients of .40 or higher on Factor V and Factor VI, it is apparent that the factor analysis of this data set resulted in four meaningful factors.

In light of the finding that the computer confidence and computer anxiety subscales were indeed measuring the same trait, an additional principal components analysis was generated; this time with a two-factor model was specified. The purpose of such analysis was to determine which items correlated with which factor, and in so doing, produce a more parsimonious subscale. As a result, ten items were selected for inclusion in a computer confidence/anxiety subscale. Seven of these items satisfied the criteria for the development of computer attitude scales discussed by Abdel-Gaid, Trueblood, and Shrigley (1986) (coefficients of .45 or higher on one factor; and coefficients of .35 or lower on the remaining factors). An additional three items were selected, based on their item-total correlation coefficients. These items are identified in Table 3. The possible range for scores on the newly derived computer confidence/anxiety subscale is 10 through 50; a score below the median indicates degree of computer anxiety, while a score above the median is indicative of computer confidence. The mean, SD and internal consistency generated by the sample in Study One for the new computer confidence/anxiety subscale were 41.28, 6.97, and r = .93, respectively.

Those coefficients that the Abdel-Gaid, et. al criteria for Factor II were those identified in the in the exploratory factor analysis as Factor IV: academic endeavors associated with computer training. This suggests that the current CAS subscales of computer confidence and computer anxiety rely on items associated with one's attitude towards computer-related studies.

Differential validity of the Computer Attitude Scale was assessed by comparing mean scores across four subsets of the sample with differing intensity of computer usage. The mean score of the computer activity frequency scale was 18.8, SD = 7 (n = 172), thus indicating that the sample were mid-range computer users. A Levene's test for homogeneity of variance confirmed the equal variance assumption. Subsequently, one-way analysis of variance procedures were performed for the CAS subscales across the four computer usage groups to determine whether mean group differences existed. To control for Type I error, the Bonferroni correction procedure was used; that is, the alpha level (.05) was divided by 4, and only p values less than .0125 were

Table 3
Two-Factor Solution for the Computer Confidence and Computer Anxiety Subscales (Varimax-Rotated, N = 208).

Subscale Item	Factor Pattern/ Structure Coefficients I	II	Item-Total Correlation
Computer Confidence			
I am sure I could learn a computer language	.29	*.68*	.60
Generally, I would feel OK about trying a new problem on the computer*	.71	.41	.78
I'm not the type to do well with computers*	.72	.40	.78
I do not think I could handle a computer course	.30	*.69*	.62
I think using a computer would be very hard for me*	*.68*	.25	.65
I could get good grades in computer courses	.24	*.77*	.62
I don't think I would do advanced computer work	.47	.57	.69
I'm no good with computers*	*.71*	.24	.67
I am sure I could do work with computers	.48	.46	.62
I have a lot of self-confidence when it comes to working with computers	.63	.48	.77
Computer Anxiety			
I would feel comfortable working with a computer	.71	.44	.79
Working with a computer would make me very nervous*	*.71*	.30	.71
It wouldn't bother me at all to take computer courses	.20	*.78*	.59
I feel aggressive and hostile toward computers*	*.76*	.26	.73
I do not feel threatened when others talk about computers*	*.55*	.21	.52
I would feel at ease in a computer class	.50	.67	.78
Computers make me feel uneasy and confused*	.74	.39	.79
Computers make me feel uncomfortable*	*.81*	.29	.80
Computers do not scare me at all	.61	.45	.73
I get a sinking feeling when I think of trying to use a computer*	*.80*	.25	.76

Notes. Items with coefficients meeting the Abdel-Gaid, Trueblood, and Shrigley (1986) standards presented in italics.
* denotes items selected for inclusion in the revised CAS subscale of computer confidence/anxiety.

considered statistically significant. As Table 4 shows, statistically significant differences were found according to intensity of computer usage for all four of the CAS subscales. The omega-squared statistic indicated that 32% of the variance in the computer confidence subscale scores was accounted for by the different frequencies of computer usage. Similarly, the amount of variance for the computer liking, anxiety, and usefulness subscales was 24%, 27%, and 17%, respectively. With respect to the newly formed 10 item computer confidence/anxiety subscale, a statistically significant difference according to intensity of computer usage [$F(3,168) = 26.72$, $p = .001$, $\omega^2 = .31$.] The amount of variance accounted for was 31%.

Table 4
Analysis of Variance of the Computer Attitude Subscales by Frequency of Computer Usage (N = 172).

Source	df	Sum of squares	Mean squares	F ratio	p	ω^2
Computer Confidence						
Between Groups	3	2386.18	795.39	28.12	.001	.32
Within groups	168	4751.99	28.29			
Total	171	7138.16				
Computer Liking						
Between Groups	3	2429.94	809.98	18.57	.001	.24
Within groups	168	7327.74	43.62			
Total	171	9757.67				
Computer Anxiety						
Between Groups	3	2614.56	871.52	22.45	.001	.27
Within groups	168	6522.42	38.82			
Total	171	9136.98				
Computer Usefulness						
Between Groups	3	718.49	239.50	12.46	.001	.17
Within groups	168	3228.93	19.22			
Total	171	3947.42				
Computer Confidence/Anxiety						
Between Groups	3	2871.98	957.32	26.72	.001	.31
Within groups	168	6020.17	35.83			
Total	171	8892.16				

Study Two

The purpose of the second study was to confirm the factor pattern structure of the newly derived confidence/anxiety scale, created by collapsing the previous stand-alone Computer Attitude

Scale factors of computer confidence and computer anxiety.

Method

For the second study, the sample comprised of n = 104 professional educators; n = 57 of whom were principals and assistant principals from a large urban school district in the southwest. Thirty-one percent (n = 35) were male, and n = 66 (58%) indicated that they were female (with 11 unknown).

Instrumentation. Data was collected using the revised computer confidence/anxiety and the computer liking subscale of the Computer Attitude Scale. As with Study One, a 5-point Likert-style response format was used for the 20 items. Scores from negatively worded items were reversed, thus making a higher score indicative of higher levels of computer confidence and computer liking.

General Procedures. N = 47 of the subjects were administered the CAS subscales during regular class time within the first week of the semester. The remainder of the sample (n = 57) completed the subscales by mail using methods outlined by Dilman (1979) (46% response rate). Again, SPSS (1995) was used to analyze the data. A principal-component analysis was computed, followed by a factor analysis with (1) an exploratory orthogonal-varimax rotation (eigenvalues over one), and (2) a two-factor solution. Means, standard deviations, intercorrelations of the two CAS subscales, and estimates of internal consistency (Cronbach's Alpha) were also computed.

Results

The mean scores for the subjects of this study on the newly derived CAS confidence/anxiety subscale and computer liking subscale was 43.6 (SD = 6.34), and 41.8 (SD = 6.12) respectively. The internal consistency (coefficient alpha) was calculated as r = .91 and r = .60 for the computer confidence/anxiety subscale and computer liking. The Pearson product moment correlation coefficient between these two subscales was calculated as r = .76.

The exploratory factor analysis (principal components analysis, with a varimax rotation) produced a five factor solution that explained 67.4% of the variance. Factor pattern/structure coefficients for this factor are presented in Table 5. Six items from the newly derived computer

Table 5
Exploratory Five factor Varimax-Rotated Solution, Specified Two-Factor Solution, and Item-Total Correlations for the Computer Attitude Scale (N = 105).

Subscale Item	Exploratory Factor Analysis Factor Pattern/Structure Coefficients						Specified 2-Factor Solution Factor Pattern/Structure Coefficients	
	I	II	III	IV	V	Item-Total Correlation	I	II
Computer Confidence/Anxiety								
Generally, I would feel OK about trying a new problem on the computer	.12	.42	*.60*	.27	.09	.63	.44	*.57*
I'm not the type to do well with computers	.38	*.74*	.32	.06	.04	.69	*.81*	.27
I think using a computer would be very hard for me	*.61*	.41	.10	-.07	.04	.49	*.62*	.18
I'm no good with computers	*.69*	.29	.17	.18	.01	.60	*.59*	.38
Working with a computer would make me very nervous	.15	*.81*	.17	.18	.04	.56	*.80*	.10
I feel aggressive and hostile toward computers	*.41*	.37	.35	.40	-.22	.64	*.60*	.47
I do not feel threatened when others talk about computers	*.51*	.15	.35	.15	.14	.54	.36	*.51*
Computers make me feel uneasy and confused	*.68*	.34	.20	.20	-.05	.64	*.64*	.39
Computers make me feel uncomfortable	*.64*	.48	.30	.27	.01	.79	*.75*	.47
I get a sinking feeling when I think of trying to use a computer	.35	*.79*	.13	.11	-.01	.60	*.86*	.10
Computer Liking								
When there is a problem with a computer run that I can't immediately solve, I would stick with it until I have the answer	.23	.26	*.72*	.06	.16	.61	.30	*.67*
I would like working with computers	.37	.20	*.54*	.33	-.23	.60	.41	*.61*
I do not enjoy talking with others about computers	.33	.02	.04	*.75*	.11	.45	.30	*.44*
The challenge of solving problems with computers does not appeal to me	.06	.27	.32	*.71*	.12	.56	.37	*.51*
Figuring out computer problems does not appeal to me	.06	.02	.07	.08	*.92*	.15	-.02	*.25*
Once I start to work with a computer, I would find it hard to stop	.29	.06	*.71*	.23	.05	.59	.20	*.76*
I don't understand how some people can spend so much time working with computers and seem to enjoy it	*.69*	-.02	.32	.25	.04	.58	.33	*.61*
I think working with computers would be enjoyable and stimulating	.41	.19	*.50*	.44	-.07	.68	.43	*.67*
I will do as little work with computers as possible	.11	*.57*	.10	.54	-.15	.50	*.66*	.20
If a problem is left unresolved in a computer case, I would continue to think about it afterward	.14	.09	*.78*	.01	-.03	.46	.19	*.67*

Note. The strongest associations between items and factors are italicized.

confidence/anxiety subscale yielded the highest factor pattern/structure coefficients on Factor I; three items fell on Factor II; and one item on Factor III (along with five items from the computer liking subscale). Item total correlation coefficients for the computer confidence/anxiety subscale were high, except one item from the computer liking subscale ("figuring out computer problems does not appeal to me"), which yielded an item-total correlation coefficient of $\underline{r} = .15$. Interestingly, this item also yielded a poor factor pattern/structure coefficient when a two-factor solution was specified with the same data set. Table 5 also provides the information regarding the dispersment of factor pattern/structure coefficients after such a solution was generated. As shown, eight of the computer confidence/anxiety items had strong associations with Factor I; and neither of the two remaining items met the criteria laid down by Abdel-Gaid, Trueblood, and Shrigley (1986) for Factor II. Nine of the computer liking items had the strongest association with Factor II. These two factors accounted for 51.5% of the variance in scores.

Conclusion

The purpose of this study was to re-visit the factor structure of the popular Computer Attitude Scale (CAS) (Loyd and Gressard, 1984a; Loyd and Loyd, 1985). Previous research has given rise to a hypothesis that the subscales of computer confidence and computer anxiety may in fact be measuring the same trait. Thus the primary purpose of Study One of this research was to gain detailed information regarding the factor pattern of the CAS subscales and produce a ten item subscale that addressed computer confidence and computer anxiety; additional analyses addressed the reliability of the CAS, and provided evidence about the differential validity of the CAS among four groups with differing intensity of computer usage. A secondary study sought to provide construct validation evidence for the newly formed computer confidence/anxiety subscale.

The results of the four one-way ANOVA procedures found that the original four scale version of the CAS does indeed differentiate between varying levels of computer usage. Such a conclusion supports other research with the CAS (Nash and Moroz, 1997; Busch, 1995; Bear, Richard's, and Lancaster, 1987; Loyd and Gressard, 1986; Loyd and Loyd, 1985; Loyd and Gressard, 1984b). Moreover, the newly derived computer confidence/anxiety also differentiated computer use.

As with previous studies (Christensen and Knezek, 1996; Gardner, Discenza, and Dukes, 1993; Roszkowski, Devlin, Snelbecker, Aiken, and Jacobsohn, 1988; Loyd and Loyd, 1985) this research has shown that the CAS subscales of computer confidence and computer anxiety are highly correlated. Few studies, however, have addressed the possibility of reducing the number of items on the CAS due to this high intercorrelation. Results of the factor analysis from Study One confirm that these two subscales are indeed measuring the same trait. With the orthogonal-varimax rotation, four meaningful structures were identified. Factor I is a composite of both the computer confidence and computer anxiety subscales. The second factor was interpreted as computer liking, which was found by both Bandalos and Benson (1990) and Loyd and Gressard (1984a). Factor III confirmed the presence of a computer usefulness scale as identified by Loyd and Loyd (1985), while Factor IV reflected attitudes toward academic endeavors associated with computer training. This is a similar conclusion to that of Bandalos and Benson (1990).

Having confirmed that computer confidence and computer anxiety are part of the same continuum, items were selected from both subscales to create a collapsed subscale relating to one's comfort with computers. Further, a separate factor was identified which was consistent with Factor IV in the initial exploratory factor analysis (academic endeavors associated with computer training). Thus, the CAS may now be interpreted as a 35 item scale covering computer liking, perceived usefulness of computers, computer confidence/anxiety and attitudes toward academic endeavors associated with computer training.

As to this newly derived factor of one's ability to do well in computer courses, this may hold implications for assessing attitudes of school personnel as many return to coursework at the graduate level, where the integration of technology is ever increasing. It may assist in the assessment of attitude and subsequent behavior of those attending district level staff development programs.

In sum, this study contributes to the knowledge base on computer attitude by providing detailed information regarding factor pattern structure coefficients of CAS items. Further research using various populations and sample sizes will give further insight as to the appropriateness of the factors and the items necessary to assess attitudes toward computers. The present results suggest a need to examine the newly reported scales with different populations and sample sizes.

References

Abdel-Gaid, S., Trueblood, C. R., & Shrigley, R. L. (1986). A systematic procedure for constructing a valid microcomputer attitude scale. Journal of Research in Science Teaching, 23 (9), 823-839.

Bandalos, D., & Benson, J. (1990). Testing the factor structure invariance of a computer attitude scale over two grouping conditions. Educational and Psychological Measurement, 50, 501-505.

Bear, G. G., Richards, H. C., & Lancaster, P. (1987). Attitudes towards computers: Validation of a computer attitude scale. Journal of Educational Computing Research, 3 (2), 207-218.

Bennett, C. K. (1995). A staff development partnership for technology integration. Journal of Staff Development, 16 (3), 19-22.

Busch, T. (1995). Gender differences in self-efficacy and attitudes towards computers. Journal of Educational Computing Research, 12 (2), 147-158.

Carlson, R. E., & Wright, D. G. (1993). Computer anxiety and communication apprehension: Relationship and introductory college course effects. Journal of Educational Computing Research, 9 (3), 329-338.

Christensen, R., & Knezek, G. (1996, January). Constructing the Teachers' Attitudes Towards Computers (TAC) questionnaire. Paper presented to the Southwest Educational Research Association Annual Conference, New Orleans, LA.

Dilman, D. A. (1978). Mail and Telephone Surveys: The Total Design Method. New York: John Wiley and Sons.

Francis, L. J., & Evans, T. E. (1995). The reliability and validity of the Bath County Computer Attitude Scale. Journal of Educational Computing Research, 12 (2), 135-146.

Gardner, D. G., Discenza, R., & Dukes, R. L. (1993). The measurement of computer attitudes: An empirical comparison of available scales. Journal of Educational Computing Research, 9 (4), 487-507.

Gressard, C. P., & Loyd, B. H. (1986). Validation studies of a new computer attitude scale. Association for Educational Data Systems Journal, 18, 295-301.

Henderson, R., Deane, F., Barrelle, K., & Mahar, D. (1995). Computer anxiety: Correlates, norms and problem definition in health care and banking employees using the Computer Attitude Scale. Interacting with Computers, 7 (2), 181-193.

Kerlinger, F. N. (1986). Foundations of Behavioral Research (3rd ed.). Fortworth, TX: Holt, Rinehart and Winston, Inc.

Kluever, R. C., Lam, T. C. M., Hoffman, E. R., Green, K. E., & Swearingen, D. L. (1994). The Computer Attitude Scale: Assessing changes in teachers' attitudes toward computers. Journal of Educational Computing Research, 11 (3), 251-261.

Loyd, B. H., & Gressard, C. (1984a). Reliability and factorial validity of computer attitude scales. Educational and Psychological Measurement, 44, 501-505.

Loyd, B. H., & Gressard, C. (1984b). The effects of sex, age, gender, and computer experience on computer attitudes. Association for Educational Data Systems Journal, 18, 67-77.

Loyd, B. H., & Gressard, C. (1986). Gender and amount of computer experience of teachers in staff development programs: Effects on computer attitudes. Association for Educational Data Systems, 18 (4), 302-311.

Loyd, B. H., & Loyd, D. E. (1985). The reliability and validity of an instrument for the assessment of computer attitudes. Educational and Psychological Measurement, 45, 903-908.

Massoud, S. L. (1991). Computer attitudes and computer knowledge of adult students. Journal of Educational Computing Research, 7 (3), 269-291.

Mertens, D. M., & Wang, Z. (1988). Attitudes toward computers of preservice teachers of hearing-impaired students. American Annuals of the Deaf, 133 (1), 40-42.

Nash, J. B., & Moroz, P. A. (1997, January). Computer attitudes among professional educators: The role of gender and experience. Paper presented at the Annual Meeting of the Southwest Educational Research Association, Austin, TX.

Pope-Davis, D. B., & Twing, J. S. (1991). The effects of age, gender, and experience on measures of attitude regarding computers. Computers in Human Behavior, 7, 333-339.

Pope-Davis, D. B., & Vispoel, W. P. (1993). How instruction influences attitudes of college men and women toward computers. Computers in Human Behavior, 9 (1), 83-93.

Rice, R., & Aydin, C. (1991). Attitudes toward new organizational technology: Network proximity as a mechanism for social information processing. Administrative Science Quarterly, 36, 219-244.

Roszkowski, M. J., Devlin, S. J., Snelbecker, G. E. Aiken, R. M., & Jacobsohn, H. G. (1988). Validity and temporal stability issues regarding two measures of computer aptitudes and attitudes. Educational and Psychological Measurement, 48, 1029-1035.

SPSS (1995). SPSS-6.4. New York: McGraw-Hill.

Stone, W. H., Thompson, S. D., & Lacount, D. M. (1989). Attitudes of high school counselors toward computers. School Counselor, 36 (4), 281-285.

Szajna, B. (1994). An investigation of the predictive validity of computer anxiety and computer aptitude. Educational and Psychological Measurement, 54 (4), 926-934.

Woodrow, J. E. J. (1991). A comparison of four computer attitude scales. Journal of Educational Computing Research, 7 (2), 165-187.

AERA CONFERENCE 1997

TM026571

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

ERIC®

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: AN EXAMINATION OF THE FACTOR STRUTURES OF THE COMPUTER ATTITUDE SCALE	
Author(s): JOHN B NASH, PAULINE A. MORDZ	
Corporate Source: THE UNIV. OF TX AT EL PASO	Publication Date: 3/97

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic/optical media, and sold through the ERIC Document Reproduction Service (EDRS) or other ERIC vendors. Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce and disseminate the identified document, please CHECK ONE of the following two options and sign at the bottom of the page.

[✓] Check here
For Level 1 Release:
Permitting reproduction in microfiche (4" x 6" film) or other ERIC archival media (e.g., electronic or optical) *and* paper copy.

The sample sticker shown below will be affixed to all Level 1 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Level 1

The sample sticker shown below will be affixed to all Level 2 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN OTHER THAN PAPER COPY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

Level 2

[ ] Check here
For Level 2 Release:
Permitting reproduction in microfiche (4" x 6" film) or other ERIC archival media (e.g., electronic or optical), but *not* in paper copy.

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

"I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce and disseminate this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries."

Sign here→ please

Signature: [signature]	Printed Name/Position/Title: ASST. PROF.	
Organization/Address: 501 EDUC UTEP, EL PASO TX 79968	Telephone: 915 747 7614	FAX: 915 747 5355
	E-Mail Address: john@utep.edu	Date: 3/25/97

(over)