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Development and validation of a computer attitude measure for young students (CAMYS)

Timothy Teo [a,*], Jan Noyes [b]

[a] Learning Sciences and Technology Academic Group, National Institute of Education, Nanyang Technology University, 1 Nanyang Walk, Singapore 637616, Singapore

[b] Department of Psychology, University of Bristol, Senate House, Tyndall Avenue, Bristol BS8 1TH, United Kingdom

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ABSTRACT

An important aspect in successfully implementing instructional technology in educational settings is user acceptance, which is greatly influenced by users' attitudes towards computers. Today, computers have become an integral part of instruction at all levels of education and it is important for educators and policy makers to understand how various factors interact with the user's characteristics to influence the teaching and learning process involving the use of computers. Over the years, many scales have been developed to measure computer attitudes of secondary students and adults. Few have been develop to be used for students in the primary schools. The aim of this study is to develop and validate a computer attitude measure for young students (CAMYS). The revised 12-item CAMYS was piloted with 256 students aged 10–12 with a mean of 11.9 years (SD = 0.31). Several statistical analyses were performed to assess the reliability and validity of the measure. The measure, together with suggestions for administration and scoring are included.

1. Introduction

Computers have become an integral part of instruction at all levels of education; therefore, it is important to understand how they interact with the environment and the user's characteristics to influence the teaching and learning process that lead to desired goals. An important aspect in successfully implementing instructional technology in educational settings is user acceptance, which is

* Corresponding author. Tel.: +65 6790 3238; fax: +65 6896 8036.
E-mail addresses: timothy.teo@nie.edu.sg (T. Teo), J.Noyes@bris.ac.uk (J. Noyes).

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greatly influenced by users' attitudes towards computers (Davies & Brember, 2001; Teo, 2006). Researchers have examined computer attitudes to understand how attitudes towards computers play a critical factor in enhancing the acceptance of computers as well as understanding current and future user behavior, such as computer usage (Huang & Liaw, 2005; Teo, 2008). Computer attitudes reflect a disposition towards computers with respect to learning or using them, and has been found to be a predictor of the adoption of new technologies such as computers (Myers & Halpin, 2002) as well as being widely recognized to correlate positively with the effective use of technology in the classroom (Yildirim, 2000).

Human–computer interaction is a complex phenomenon and the attitudes and feelings involved with the relationship are difficult to identify (Willis, 1995). However, as the role of the computer expands in our global society, it is increasingly important that educators become aware of the user's reaction towards computers. Teo (2006) suggested that negative attitudes towards computers may exist, and could be a deterrent to using computers in the learning environment. Willis (1995) found that when students respond positively to computers, they tend to master the necessary skills quickly. However, for those to whom the computer represents an unpleasant and anxious experience, mastering the appropriate skills could prove to be difficult (Meelissen & Drent, 2008; Teo, 2006). This anxiety may take the form of hostility, fear, and/or resistance; these are attitudes, which may inhibit the acquisition of computer skills much as mathematics anxiety can inhibit achievement in this subject (Yildirim, 2000). If positive attitudes increase, students can master the computer skills involved, which then offers many advantages in the educational process: informal student interaction, absence of embarrassment, student-paced operation, problem solving, tutoring, immediate feedback, and absence of subjectivity. It is likely that the students' attitudes towards and acceptance of computer technology, as well as learning about computers, may be important in the integration of electronic technologies in the classroom, workplace, and home (Teo, Chai, & Lee, 2008).

Over the last few years a considerable body of literature has been devoted to describe the relationship between computer attitudes and its associated variables. Computer experience positively correlated with attitudes towards using computers (Kumar & Kumar, 2003; Potosky & Bobko, 1998; Seyal, Rahim, & Rahman, 2000). Computer training or computer instruction significantly decreased anxiety about computers while confidence and computer liking were increased (Chau, 2001; Rovai & Childress, 2002; Tsitouridou & Vryzas, 2003). Factors that might affect computer attitudes such as age and gender were also tested by many research studies (Bovee, Voogt, & Meelisen, 2007). This broad array of research is multi-disciplinary and incorporates a wide variety of perspectives and topics. However, at its foundation this research is directed at influencing a person's ability to use a computer efficiently.

1.1. Scales for measuring computer attitudes

Among the methods employed by researchers to study computer attitudes is the use of computer attitude scale/measure. Since the 1970s, many such scales developed using mostly Likert type attitude scales were reported in the literature. The Loyd and Gressard's (1984) computer attitude scale (CAS) examines three affective dimensions: computer anxiety, computer confidence, and computer liking. Loyd and Loyd (1985) added a fourth dimension, namely, computer usefulness. Nickell and Pinto (1986) developed a 20-item computer attitude scale (CAS) to measure positive (12 items) and negative (8 items) attitudes towards computers. Although the CAS was a generic scale, it acquired an acceptable reliability and validity over time due to wide usage (LaLomia & Sidowski, 1990; Rainer & Miller, 1996). The Bath County Computer Attitudes Survey by Bear, Richards, and Lancaster (1987) was designed to measure the attitudes of students in grades four through 12 towards computers to be used in conjunction with two other instruments to determine the factors in the students' background which affect their attitudes towards computers. The first is a questionnaire concerning students' computer experience and usage, educational and career plans, and favorite school subjects using a United Kingdom sample. Selwyn (1997) developed a computer attitude scale for 16–19 year-olds. He named the subscales: affect attitudes towards computer, perceived usefulness of computers, perceived control of computers, and behavioral attitudes towards computers. Levine and Donitsa-Schmidt (1998) designed the computer attitudes and self-confidence questionnaire to measure seventh through 12th grade students' attitudes and self-confidence towards computer use. It was designed to test the hypothesis that positive computer attitudes and confidence lead to a commitment to learning to use computers. The computer use and experience scale questionnaire (CUE) is a 12-item instrument developed by Potosky and Bobko (1998) to assess the subject's knowledge of computers and the extent to which he or she has used a computer and how these factors affect how good people perceive themselves to be at using computers.

Although these computer attitude scales and measures have been credited for facilitating researchers to gain insights into the nature of computer attitudes and its relationship to computer use, these were developed and designed for older students and few, if any, was developed to be used among younger participants. There is a paucity of scales relating to younger people. As computers are used extensively across all levels in education, there is certainly a need for researchers to gain access to an instrument that is developed for use among younger students. The aim of this study is to construct a measure for use on young students from age 10 to 14 years.

2. Theoretical background

The theoretical framework for the construction of this scale was formulated within the framework of assessing computer attitudes proposed by Kay (1993) who drew on the tripartite model of attitude (Breckler, 1984) and the theory of planned behavior (Ajzen, 1988). Also considered by this study is Davis' (1993) technology acceptance model that was based on Fishbein and Ajzen's (1975) attitude paradigm. In his assessment, Kay (1993) identified four distinct components of computer attitudes: affect (feelings towards computers), cognition (perception and information towards computers), conation or behavioral (intentions and actions with respect to computers), and perceived behavioral control (perceived ease or difficulty in using the computer). In addition, Davis' (1993) technology acceptance model also included perceived usefulness (the extent to which the computer is perceived to be useful in enhancing one's work) as influential towards the use or beginning to use computers. Hence, anchoring the CAMYS within the above components ensures a comprehensive measure of attitudes towards computers.

3. Development of the CAMYS

A pool of items was created by writing new items and adapting from available scales including Selwyn (1997), Knezek and Christensen (1997), and Jones and Clarke (1994). A total of 41 items was selected to assess subjects' affective responses towards using computers, cognitive responses towards using computers at work, perceived usefulness, perceived control, and behavioral attitudes towards using computers.

A key consideration in the item selection process was to ensure that the items could be understood by the potential respondents. To this end, a group of seven 11 and 12 year-olds (non-participants in the pilot test) was shown the 41 items. They were asked to explain to the author what they thought each item meant. This was designed to allow for fine-tuning the semantics and syntax of each item so that they will be simple enough to be understood by students between 10 and 14 years.

Although it is common to find negatively-worded items among the existing scale (e.g. Jones & Clarke, 1994; Selwyn, 1997), these were either re-written into the positive form or excluded from this study. Research has found that negatively formulated questions, when used with children, have yielded responses of low reliability (Marsh, 1986). Borgers, Hox, and Sikkel (2004) reported that using negatively-worded statements on young children was inconsistent with the Piagetian theory of cognitive development as they (children of 12 and younger) have not developed the formal thinking that is necessary to understand logical negation. As a result, response unreliability is a natural consequence (Borgers & Hox, 2000).

These 41 items were presented, using a five-point Likert response scale, to a sample of 421 students aged 10–12 (mean age = 10.8 years, SD = 0.45 years) for an initial item analysis. Most researchers recommend a sample size of 100–200 cases for exploratory factor analysis (e.g. Hair, Black, Babin, Anderson, & Tatham, 2006). As such, the sample of 421 cases at this stage of analysis is regarded to be adequate. A few initial steps were taken at this stage:

(a) an initial exploratory factor analysis using principal components and varimax rotation was carried out on the 41 items. The extraction method of principal components was chosen to extract linear combinations of the variables explaining the majority of the variance (Kline, 2005). Various exploratory factor analyses were conducted to identify a coherent and interpretable structure. Items with factor loading of less than 0.40 were excluded (Raubenheimer, 2004);
(b) reliability analyses using SPSS were conducted for each subscale to provide quantitative data regarding item performance;
(c) within each subscale, items were evaluated quantitatively by examination of the corrected item–total correlation and the resulting coefficient alpha if the item was deleted;
(d) concurrent with (c), items were qualitatively examined in terms of readability, clarity, relevance, and length;
(e) based on the results of (c) and (d), items that performed poorly, either quantitatively or qualitatively, were deleted; and
(f) the remaining items were examined for content validity and congruence with the instrument's purpose.

This resulted in three interpretable components that explained about 59.18% of the variance. The final number of items for the computer attitude measure for young students (CAMYS) included perceived ease of use, affect towards computers (positive or negative), and perceived usefulness. The overall alpha coefficient is 0.85 and those for the perceived ease of use, affect towards computers (positive or negative), and perceived usefulness subscales are 0.64, 0.81, and 0.74, respectively. These coefficients (>0.60) are regarded as acceptable for scale construction (DeVellis, 2003).

4. Reliability and validity

The revised 12-item CAMYS was piloted with 256 students aged 10–12 with a mean of 11.9 years (SD = 0.31). The sample consisted of 48.4% female (n = 124) and was drawn from seven classes in a primary school with students of average academic ability. The mean year of computer usage by this sample was 2.53 years (SD = 1.92) and mean hours of computer use on a daily basis was 2.31 h (SD = 0.64). The measure was administered by the same person and items were presented on a five-point Likert scale (ranging from 'strongly agree' to 'strongly disagree'). Each item was randomly placed on the measure and a different version for each class was used, to prevent clustering effects. Data was analyzed using SPSS 12.0 to assess the reliability and validity of the measure.

Table 1
CAMYS normal distribution analysis

Statistics	
N	
Valid	256
Missing	0
Mean	51.0469
Standard error of mean	0.43698
Median	52.0000
Mode	54.00[a]
Standard deviation	6.99171
Variance	48.884
Skewness	−1.711
Standard error of skewness	0.152
Kurtosis	5.945
Standard error of kurtosis	0.303
Range	44.00
Minimum	16.00
Maximum	60.00
Sum	13068.00

[a] Multiple modes exist. The smallest value is shown.

Table 1 shows the normal distribution analyses of the 12-item CAMYS. The lowest and highest attained score are 16 and 60, respectively. The range between the lowest and highest score is 44, the mean of the scores of the CAMYS is 51.05, the median is 52.00, the standard deviation is 6.99. The skewness value was found to be −1.71, and the kurtosis value, 5.95. According to Kline (2005), these values indicate a fairly normal distribution.

4.1. Factorial validity

Factorial validity for the CAMYS was addressed through the use of confirmatory factor analysis using structural equation modeling (SEM) techniques. Maximum likelihood (ML) estimation, using AMOS 7.0 software, was employed for this analysis using a covariance matrix. It was hypothesized that confirmatory factor analysis of the CAMYS would result in the finding that responses to the CAMYS could be explained by three factors identified as perceived ease of use, affect towards computers (positive or negative), and perceived usefulness.

The SEM technique employs fit indices to provide estimates of how well the data fit the *a priori* hypothesized model. Because different indices reflect different aspects of model fit, researchers typically report the values of multiple indices. The fit indices selected for the analysis were as follows: (a) the goodness of fit index (GFI); (b) the comparative fit index (CFI); (c) the incremental fit index (IFI); and (d) the root mean square of approximation (RMSEA). The GFI measures "how much better the model fits as compared to no model at all" (Joreskog & Sorbom, 1996). The GFI is a measure of the relative amount of observed variance and covariance accounted for by the model and is analogous to R^2 in multiple regression analysis (Hoyle & Panter, 1995; Kline, 2005). The CFI compares how much better the model fits compared to a baseline model, typically the independence (null) model in which the observed variables are assumed to be uncorrelated (Kline, 2005). The IFI is similar to the CFI in that it compares how much better the model fits compared to a baseline model; however, the IFI takes into account the complexity of the model by rewarding more parsimonious models with higher values (Mueller, 1996). The RMSEA takes into account the error of approximation in the population and is a measure of discrepancy per degree of freedom (Byrne, 2001). Adequate model fit is represented by GFI, CFI, and IFI values greater than 0.90 (Hoyle & Panter, 1995) and RMSEA values below 0.05 (Byrne, 2001). The following values were obtained for the chosen fit indices: GFI = 0.96, CFI = 0.98, IFI = 0.98, and RMSEA = 0.04 (LO 90 = 0.02; HI 90 = 0.06).

In addition to fit indices, structural elements of the model such as factor loadings and squared multiple correlations should also be examined. As can be seen in Table 2, each CAMYS item loads on its

Table 2
R^2 and factor loading of the 12-item CAMYS

	R^2	PEU	ATC	PU
Perceived ease of use (PEU)				
I use the computer to learn things	0.29	0.626		
I feel that I am in control when I use a computer	0.20	0.469		
It is easy for me to learn how to use the computer	0.47	0.703		
The computer is easy to use	0.55	0.503		
Affect towards computer (ATC)				
I look forward to using the computer	0.55		0.627	
I am not scared to use the computer	0.39		0.653	
I enjoy using the computer	0.61		0.696	
It is fun to use the computer	0.55		0.730	
Perceived usefulness (PU)				
I use the computer to help me to do my work better	0.49			0.592
It does not take up much time for me to find things on the computer	0.34			0.657
I like to do assignments that allow me to use the computer	0.30			0.677
The computer allows me to do my work faster	0.56			0.710
Eigenvalue		2.865	2.514	1.722
% Variance explained		23.88	20.95	14.35

Table 3
Estimates of the 12-item CAMYS

	Unstandardised estimate	SE	*t*-Value*	Standardised factor loading
Perceived ease of use				
PE1	1.000			0.736
PE2	0.811	0.136	5.951	0.437
PE3	0.926	0.111	8.351	0.679
PE4	0.853	0.136	6.287	0.533
Attitude towards use				
ATC1	1.000			0.743
ATC2	0.951	0.102	9.291	0.618
ATC3	1.056	0.090	11.744	0.801
ATC4	0.864	0.080	10.814	0.723
Perceived usefulness				
PU1	1.000			0.591
PU2	1.071	0.152	7.066	0.580
PU3	1.195	0.155	7.696	0.750
PU4	1.271	0.158	8.046	0.725

* <0.05.

intended factor with factor loadings ranging from 0.47 to 0.73, and each factor loading is statistically significant ($\alpha = 0.05$). The range of the factor loadings is consistent with the range recommended for social science research; that is 0.40–0.70 (Costello & Osborne, 2005).

Examination of the squared multiple correlations (R^2) for each item permits an assessment of the extent to which the measurement model is adequately represented by the observed measures. The R^2 values range from 0.20 to 0.61 for individual items, indicating that between 20% and 61% of the variance on individual items can be accounted for by the factor to which they are assigned. Given that the selected fit indices are consistent in their reflection of a good-fitting model, the factor loadings are statistically significant and of sufficient size, and the squared multiple correlations are reasonable, the results support the factor structure of the CAMYS.

Table 3 shows the unstandardized estimates, standard error (SE), *t*-value, and standardized estimates for each of the 12 items in CAMYS. The significance of each parameter estimate (observed variable) was determined by examining the *t*-value (or critical ratio, which represent a *z*-score) to see if it is greater than 1.96 or not. If any parameter estimate is greater than 1.96, it is significant at $p < 0.05$. All the *t*-values shown in Table 3 are greater than 1.96, indicating that the parameter estimates of all 12 items in CAMYS are significant at the $p < 0.05$ level.

4.2. Criterion validity

An essential element of validation of a measure is to ensure that the measure is meaningful in terms of other constructs within the domain of the study, in this case, computer attitudes. If the factors within this measure can be empirically supported, then the factors in this measure are said to have nomological validity (Bagozzi, 1980). It follows that computer attitudes should correlate positively with important variables that impact on computer attitudes. In this study, nomological validity was established by correlating the scores with computer use and computer experience (defined as the years of having used the computer and amount of time spent using the computer daily) and computer attitudes. These variables have been found in many studies to be factors that significantly affect computer attitudes (Bovee et al., 2007; Carey, Irwin, & Chisholm, 2002; Shapka & Ferrari, 2003). Table 4 shows the results of correlation coefficients of the subscales and the selected variables.

5. Administration and scoring

The CAMYS can be administered in 10–15 min. It should be presented so that no two items from the same construct appear next to each other, using a five-point Likert scale (worded ‘strongly agree’,

Table 4
Criterion validity of the CAMYS

	PEU	Affect	PU	CAMYS
Number of years having used the computer	0.12	0.19**	0.14*	0.18**
Daily computer usage	0.16**	0.15**	0.05	0.14*

* $p < 0.05$.
** $p < 0.01$.

'agree', 'neutral', 'disagree', and 'strongly disagree'). Students should be told that this is not a test and that there are no right or wrong answers. Thus, they should answer as honestly as possible. The scores for each item could be computed by assigning a numerical value to each response: 5 for 'strongly agree', 4 for 'agree', 3 for 'neutral', 2 for 'disagree', and 1 for 'strongly disagree'. The 12-item scores can be collectively summed to represent an individual's overall attitude towards computers ranging from 12 to 60.

6. Conclusion

This study demonstrates that validity and reliability of three factors: *perceived ease of use*, *affect towards computers*, and *perceived usefulness* that make up the computer attitude measure for young students (CAMYS). The findings of this study support prevailing studies in the literature that suggest the above three factors to be significant in explaining attitudes towards computers (e.g. Ngai, Poon, & Chan, 2007; Teo et al., 2008) Having demonstrated the psychometric properties of the CAMYS, it is important to discuss its possible role in educational research. Gaining a better understanding of computer-related attitudes will increase our understanding of computer-related behaviors. Several researchers have demonstrated that the attitudes towards computer construct affects users' acceptance and their overall satisfaction with computers (Venkatesh & Davis, 2000). As information technology is becoming more widely available in schools, the ability to measure easily the attitudes towards computers with the CAMYS will allow researchers and educators to understand the reasons why some students embrace the computer and other users remain passive or even resist using computer-related resources.

For instance, researchers investigating the implementation of new pedagogy involving the computer could use the CAMYS. Because attitude predicts behavior under many circumstances (Fishbein & Ajzen, 1975), the CAMYS may help researchers develop better theories about who among the students will choose to be information systems adopters as well who will choose to be non-adopters (Burkhardt & Brass, 1990).

Educators may find it helpful to administer the CAMYS prior to introducing new strategies that involve the use of computer to identify students who might benefit from extra training. If, prior to implementation, key students were found to have very negative attitudes towards computers, extra attention could be provided that might make the difference between a successful and an unsuccessful educational initiative.

It is anticipated that CAMYS would be further developed by conducting cross-cultural validation studies and subjecting to tests for model invariance for the three factors in CAMYS. These developments may lead to other versions that extend below or above the original age-range conceived for CAMYS (10–14) and provide useful tools for researchers to work with a wide range of participants in the area of computer attitudes.

One limitation in this study that should be addressed in future validations of the CAMYS is the issue of negative wording. Although there was support from the literature on the exclusion of negative wordings in a measurement scale that is designed for young children, there were instances where negative concepts have to be forced into positive ones by using double negatives. This may cause confusion and introduce error into the data. Two items that in the CAMYS may potentially introduce such error are 'I am not scared to use the computer" and 'it does not take up much time for me to find things on the computer'.

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