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Standardised instruments for measuring computer attitude and computer anxiety are not necessarily standardised

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STANDARDISED INSTRUMENTS FOR MEASURING COMPUTER ATTITUDE AND COMPUTER ANXIETY ARE NOT NECESSARILY STANDARDISED

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Abstract

Computer attitude and computer anxiety are two determining constructs of success with computer related work. In order to enhance the learning process, improve performance, reduce computer resistance, and ensure job satisfaction computer attitude should be improved and computer anxiety minimised. Several instruments for measuring these constructs are available in the literature but not all of them are necessarily applicable to people with a different mother tongue and educational profile than that of the original survey group. Negatively worded items can specifically be responsible for inconsistent findings. Two standardised instruments from literature were applied to a group of labourers with below-average education and an indigenous African language as mother tongue. It was found that, although an instrument can still appear to be internally consistent, it may have a different factor structure than originally intended by the compilers. Recommendations are made of aspects to keep in mind when instruments for measuring computer attitude and computer anxiety are developed for people with a different profile.

Keywords: Computer attitude, Computer anxiety, Measuring instruments, Negatively worded items.

1 INTRODUCTION

Computers in the workplace are a given. Although the advantages of computers are well-known and proven, many people still try to avoid using them. It is extremely important to find out which factors influence the success of end-user computing. What are the reasons that some people excel on a computer while others have problems and even build up a resistance towards the use of computers?

This paper focuses on computer attitude and computer anxiety as determining constructs of success with computer related work. In order to know the extent to which these constructs are present amongst people, it is essential to be able to measure the levels at which they exist.

Several instruments have been developed, but questions regarding their application to people that differ in some or other respect from the original survey group, exist. Are they universally applicable to all cultures? Can they be translated without changing the meaning of items? Can/should they be localised for specific survey groups? If necessary to adapt for local use, in which way should it be done? This paper deals with some of these issues.

2 COMPUTER ATTITUDE AND COMPUTER ANXIETY

The concepts of computer attitude and computer anxiety, as well as instruments to measure them are as old as computers are. The first instruments date back to 1966 (Shaft, Sharfman & Wu 2004). Although computing technology has improved drastically over the last forty years, the humans who utilise them did not. Although computers are now an inherent part of society, people who has never before had access, might still feel threatened by them. In the discussion below, some of the references dates back several years, but since they address the human side of IT, they are still applicable today.

2.1 Computer attitude

Gordon Allport defined the concept of attitude in general as follows: "An attitude is a mental and neural state of readiness, organized through *experience*, exerting a directive or dynamic *influence* upon the individual's *response* to all objects and situations with which it is related" (Allport 1935). In other words, attitude is determined by experience and impacts upon the individual's behaviour. Specifically, a person's attitude towards a computer is influenced by a variety of aspects, e.g. the *social issues* relating to computer use (Popovich et al. 1987), computer *liking*, computer *confidence*, computer *anxiety* or *comfort* (Delcourt & Kinzie 1993, Loyd & Gressard 1984(a), *achievement* (Bandalos & Benson 1990), *usefulness* and *value* (Francis-Pelton & Pelton 1996).

Several studies have been undertaken to explore potential factors associated with a positive attitude toward computers (Brodt & Stronge 1986, Scarpa et al. 1992, Sultana 1990, Schwirian et al. 1989; Bongartz 1988, Burkes 1991). Some of the factors that were considered were level of education, years of experience in the work environment, computer experience, age, gender, and job title. The only factor that was repeatedly, although not consistently, found to have a positive effect on computer attitude, was computer experience.

Positive attitudes enhance the learning process (Shneiderman 1980), specifically the motivation to learn and the ability to retain information in a given situation (Jawahar & Elango 2001). A negative attitude may lead to computer resistance (Sheiderman 1980), a phenomenon that can be found among experienced as well as inexperienced users (Negron 1995). A person's attitude towards computers and related technology could determine his/her performance with the technology and the satisfaction he/she draws from the experience.

2.2 Computer anxiety

According to Henderson, Deane & Ward (1995) anxiety is viewed as "a drive that motivates the organism to avoid the stimulus for anxiety". This implies that an individual will avoid the use of a computer in the presence of computer anxiety. Specifically, computer anxiety involves an array of emotional reactions, including fear, apprehension, uneasiness and distrust of computer technology in general (Negron 1995, Rohner & Simonson 1981). Computer anxiety is also influenced by a variety of aspects, e.g. *general anxiety* and *confidence* (Harrison & Rainer 1992), *computer liking* (Chu & Spires 1991; Loyd & Gressard 1984(b)), *impact of computers on society* (Raub 1981), *equipment-related anxiety* (Marcoulides 1989), *comfort* and *value* (Violato et al. 1989), and *corporate pressure*.

Anxiety affects people's thinking, perception and learning (Kaplan & Sadock 1998). It also produces confusion and distortions of perception relating to time, space, people, and the meaning of events. These distortions usually have a negative effect on learning ability by lowering concentration, reducing recall ability, and impairing the ability to make associations.

Specifically, computer anxiety can be recognized by an expression of fear regarding present or future interactions with computers or computer related technology, negative global attitudes about computers, or self-critical internal dialogues during computer interactions. People with computer anxiety experience the incidence of physical, phobic symptoms such as stomach cramps and cold sweats as well as psychological symptoms such as a resistance to use and a negative attitude towards a system (Shneiderman 1980).

Computer anxiety seems to be a good predictor of computer achievement. Marcoulides (1988) found that computer anxiety influenced the effectiveness with which college students could utilize the computer. Rosen, Sears & Weil (1987) also found that computer-anxious undergraduate students, enrolled in computer-based courses, were twice as likely to drop out of the course and received lower course grades than non-anxious students.

Although anxiety usually has a negative connotation, there appears to be optimal levels of anxiety which help people to function effectively (Higgins 1989) and which make them more alert and aware of what is going on (Lugo & Hershey 1981, Beck & Emery 1985).

Computer anxiety is something that will not just disappear on its own, but something that has to be dealt with. It is considered to be a temporal emotional state rather than a permanent personality trait, and therefore can be remedied through positive computing experiences (Cambre & Cook, 1987). Easy-to-use computer systems and basic training for the most routine tasks have been suggested, *inter alia*, as possible strategies to relieve anxiety (Appelbaum & Primmer 1990, Cambre & Cook 1987, Lewis 1988).

2.3 Measurement of computer attitude and computer anxiety

Several scales have been developed to measure either or both computer attitude and computer anxiety. Shaft, Sharfman & Wu (2004) presents an extensive list of 31 instruments to measure computer attitude that have been developed since 1966. They compared the various instruments with regard to length, complexity, specialized focus, and psychometric issues. Barbeite & Weiss (2004) also list several instruments together with the value for Cronbach's that was obtained in each case.

From these sources the instruments of Gressard & Loyd (1986) and Marcoulides (1989) were identified as being the most frequently used, a fact noted also by Francis, Katz & Jones (2000) as well as Mizrachi & Shoham (2004).

2.4   Ensuring and assessing reliability of measuring instruments

2.4.1   Use of negatively worded items

King (2005) refers to work by Nunnaly (1967) who recommends the use of negatively and positively worded items to reduce response set when measuring the same construct. Response set occurs when respondents fail to discriminate among the items and respond to every question in the same manner (e.g. circle all 4's on a 5 point Likert scale). In an effort to ensure that respondents read the questions in a thoughtful manner, negatively worded items should be included.

Negatively worded items do not necessarily contain a negative indicator such as "no", "not", or "never". It does, however, expect from a respondent to disagree with a statement if he/she is positive about an aspect. For example, if a respondent feels comfortable with computer work, he/she should disagree with the statement *"I experience stress while working with a computer"*.

Unfortunately, negatively worded items have a tendency to load onto a separate factor rather than contribute uniquely to the construct of interest (Pilotte & Gable 1990, Kelloway et al. 1992, Roberts et al. 1993). Schmitt & Stults (1985) provided compelling evidence suggesting that when a small percentage (as little as 10%) of respondents was careless, separate factor structures could emerge as a result of negatively worded items.

Given the apparent problems associated with negatively worded items, researchers need to be extremely careful when attempting to explain unique factors associated with the reversed items. When respondents have difficulty disentangling the meaning of the phrase from the wording of the phrase, factors can emerge based on measurement artefacts rather than actual constructs.

2.4.2   Cronbach α

Cronbach α is a measurement of the internal consistency reliability of an instrument. In other words, it is an indication of the extent to which a respondent's responses agree with one another. The higher the value of α, the more reliable the test is with regard to internal consistency. George & Mallery (2003) provide the following rule of thumb for the values of α: > 0.9 excellent, > 0.8 good, > 0.7 acceptable, > 0.6 questionable, > 0.5 poor, < 0.5 unacceptable.

Table 1 shows a fictitious example of a 5-point Likert scale survey with four items and five respondents. Although the respondents differed notably from one another, the consistency over items for every respondent was 100%, resulting in $\alpha = 1$.

Respondent	Item 1	Item 2	Item 3	Item 4
A	2	2	2	2
B	4	4	4	4
C	1	1	1	1
D	3	3	3	3
E	5	5	5	5

Table 1.   Illustration of the meaning of a high Cronbach α

It is important to note that Cronbach α is not an indication of test validity or test-retest reliability. A test may have a high α but may still provide an inaccurate reflection of the constructs that are measured.

2.4.3   Replicable factor structure

A principal components factor analysis of a survey aims to (1) reduce the number of variables that comprise a specific construct and to (2) detect structure in the relationships between variables (StatSoft 1996). If an instrument claims to be a reliable measuring tool for a specific construct, the factors that comprise that construct should be extracted during every survey in which it is used. Also, the factor loadings of each item in the instrument should be similar from one application thereof to the next.

Kay & Mannell (2005) studied the stability of the factor structure of a standardised instrument for measuring leisure motivations (Beard & Ragheb 1983) when administered to ethnic sample populations and called it a test of cross-cultural universality. They found that the factor structure of the instrument differed for Chinese and Italian groups, which in turn differed from the original factorisation reported by Beard and Ragheb (1983). The question therefore arises whether the established instruments for computer attitude and computer anxiety are universally applicable.

3   PUTTING TWO INSTRUMENTS TO THE TEST

A study was undertaken to assess whether two well-known instruments for computer attitude and computer anxiety, *viz*. the Gressard & Loyd test (Gressard & Loyd 1986) and the Marcoulides test (Marcoulides 1989), can be applied to a survey group that differs in profile from the original survey group. The Gressard & Loyd test consists of both positively worded and negatively worded items while the Marcoulides test consists of only negatively worded items, e.g. "*I feel anxious when I walk past a computer store*". The aim was specifically to determine if the results with regard to Cronbach and the factor structures as reported in the original papers could be replicated.

The experimental design for the study referred to the question whether a small amount of computer experience has a significant positive impact on a person's computer attitude and computer anxiety if he/she has never before touched a computer. The two instruments were used to determine the computer attitude and computer anxiety for a group of labourers with no previous computer exposure and an African language as mother tongue. They were then exposed to a simple computer program for one hour after which they had to complete a similar, but not identical, survey. Results of the pre- and post tests were compared statistically.

It was noted above that computer experience was repeatedly found to have a positive effect on computer attitude. It was also noted that computer anxiety can be alleviated through hands-on experience. It was thus expected that the average score for computer attitude should at least stay the same or increase while the average score for computer anxiety should at least stay the same or decrease.

3.1   Respondent profile and Methodology

A group of 57 female cleaners employed by the University of the Free State, South Africa, was brought into the computer laboratories of the Department of Computer Science and Informatics. The majority of the respondents fell in the age groups 36-50 (32) and 51+ (22). Most of them only had primary school education (24) or junior secondary education (23). Only 10 of them indicated that they completed high school training (grade 12). All the respondents had one of the indigenous African languages as mother tongue, i.e. Sesotho (29), Tswana (21), Xhosa (5) or other (2). None of these people had ever used a computer.

The respondents were asked to complete surveys on their computer attitude and computer anxiety when they entered the laboratory (pre-test). They were then asked 10 questions for which they had to use the Microsoft® Calculator program to find the answer. A group of senior IT students assisted them to load the program and to get going with it. The idea was not to measure how correct their

answers were but to give them a feeling of computer work. The assistants were instructed to help them as much as possible without doing the actual work for them. The questions were simple addition, subtraction, multiplication and division operations with one operator and two operands of four digits each. Thereafter, the respondents were once again presented with a survey on their computer attitude and computer anxiety (post-test). All surveys were given to respondents in two languages, viz. English and Sesotho. It should be noted that Sesotho and Tswana are closely related languages and speakers of Tswana normally have no problem to understand Sesotho.

For measuring computer anxiety, the standardised instrument of Marcoulides (1989) was used. This instrument has 20 Likert type items and respondents had to select one option from SD (Strongly disagree), D (Disagree), NS (Not sure), A (Agree) or SA (Strongly agree). A factor analysis revealed that the items could be divided into two factors, *viz.* general computer anxiety and equipment oriented anxiety (Marcoulides 1989). Because of the possible effects that repetition of the same items in the pre- and post-test would have, it was decided to include half the items of each factor in the pre-test and the other half in the post-test.

The standardised instrument of Gressard & Loyd (1986) was used to measure the respondents' computer attitude. This instrument has 30 Likert type items (also ranging from SD through SA) with 10 items for each of the three sub-scales, *viz.* computer liking, computer anxiety and computer confidence. Since computer anxiety was tested with the Marcoulides instrument (Marcoulides 1989), only the items for the computer liking and the computer confidence factors were split between the pre-test and the post-test surveys of this study.

3.2 Results

For each respondent the average score on the Likert scale was calculated for each factor for the pre-test and post-test separately. For negatively worded items, the score was inversed. Table 2 shows the average of the scores for all the respondents as well as the values for Cronbach for each one of the sub-scales. The results of a paired t-test are also shown.

	Pre-test				Post-test				Paired t-test	
	N	Avg	SD	Cronbach	N	Avg	SD	Cronbach	T	p
Liking	55	3.683	0.751	0.848	55	2.988	0.546	0.634	6.14	<0.000
Confidence	53	3.227	0.862	0.882	53	3.809	0.927	0.968	-3.95	<0.000
Anxiety	42	3.538	1.132	0.981	42	3.293	1.090	0.974	1.48	>0.05

Table 2: Average score and Cronbach per sub-scale for each of the pre-test and post-test. Results of a paired t-test for significance of difference between the factors are also shown.

The Marcoulides items for computer anxiety (Marcoulides 1989) were all worded negatively, all starting with "*I feel anxious when I think of …*". This repeating structure allowed the respondents to mark all items in a specific pattern without contemplating each one individually and carefully. The very high values of 0.97 or more for these items (Table 2) confirmed this impression. In fact, a value of 0.97 was also reported in the original paper by Marcoulides (1989).

Some of the Gressard & Loyd items (Gressard & Loyd 1986) for computer liking and computer confidence were worded negatively, thereby forcing respondents to think carefully about every item. Once again, the reported values agree very well with the values reported in the original paper by Gressard & Loyd (1986).

Although the values of Cronbach reported in Table 2 do not give any hint that there has been a problem with the survey, the results appeared to be contrary to what was expected and also inconsistent. The confidence and liking showed contradictory results in that respondents experienced

a significant decrease in liking of computer work but a significant improvement in confidence. No significant difference in computer anxiety was detected. These results could either be because of true effects or because the survey was not valid for the specific respondent group.

3.3 Investigating reliability

A better measure of reliability would be to do a factor analysis on the results and check if the same factors could be extracted that were extracted with the original studies. Because the items for computer anxiety originated from one standardised instrument (Marcoulides 1989) and those for confidence and liking from another (Gressard & Loyd 1986) separate analyses were done on the anxiety items and the items on confidence and liking. Separate analyses were also done for the pre-test and post-test. In all analyses the Kaiser criterion was used to determine the number of factors to extract, i.e. each factor should extract as least as much meaning as the equivalent of one original item. In all cases the factor structures have been rotated using Varimax normalisation for easier identification of the underlying factors.

Table 3 shows the results of a factor analysis of the anxiety items of the pre-test. This extraction accounted for 72.2% of the total variance. General anxiety and equipment anxiety loaded on the same factor while another factor emerged which was difficult to label.

Item	Intended factor	Factor loadings	
		Factor 1	Factor 2
11	Equipment anxiety		0.787
12	General anxiety	0.565	0.683
13	Equipment anxiety	0.534	0.538
14	General anxiety	0.829	0.307
15	Equipment anxiety	0.381	0.654
16	Equipment anxiety	0.878	
17	General anxiety	0.521	0.707
18	General anxiety	0.874	0.316
19	General anxiety	0.743	
20	General anxiety	0.895	

Table 3:   *Results of a principal components factor analysis for the anxiety items of the pre-test (Varimax normalised). Only loadings larger than 0.3 are shown. Loadings higher than 0.5 are underlined.*

Table 4 shows the results of a factor analysis of the confidence and liking items for the pre-test. This extraction accounted for 66.7% of the total variance. The negatively worded items for liking and confidence factorised into separate factors, but the positively worded items for these two constructs were combined into a single factor.

Item	Intended factor	Factor loadings		
		Factor 1	Factor 2	Factor 3
1	Liking	0.880		
2 (N)	Liking		0.768	
3	Liking	0.857		
4 (N)	Liking		0.848	
5	Liking	0.771		
6 (N)	Confidence			0.704
7	Confidence	0.896		
8 (N)	Confidence		0.404	0.619
9 (N)	Confidence			0.689
10 (N)	Confidence			0.679

Table 5 shows the results of a factor analysis of the anxiety items for the post-test. This extraction accounted for 80.5% of the total variance. As was the case in the pre-test, general anxiety and equipment anxiety loaded on the same factor but this time two other factors emerged. Also, the discrimination between the items was more distinct with fewer items loading on more than one factor.

Item	Intended factor	Factor loadings		
		Factor 1	Factor 2	Factor 3
11	Equipment anxiety	0.564		0.728
12	General anxiety	0.750		
13	Equipment anxiety	0.596		
14	Equipment anxiety	0.785		
15	General anxiety		0.877	
16	General anxiety			0.899
17	General anxiety		0.851	
18	General anxiety	0.770		
19	General anxiety	0.895		
20	General anxiety	0.849		

Table 5:   *Results of principal components factor analysis for anxiety items of the post-test (Varimax normalised). Only loadings larger than 0.3 are shown. Loadings higher than 0.5 are underlined.*

Table 6 shows the results of a factor analysis of the confidence and liking items for the post-test. This extraction accounted for 69.8% of the total variance. As was the case for the pre-test, the positively worded items for computer confidence loaded all on the same factor (factor 1) with smaller contributions from the positively worded liking items. Factors 2 and 3 comprised largely of the negatively worded items from both the confidence and liking constructs as well as negative loadings for some of the positively worded items. The distinction between these two factors was, however, not clear.

Item	Intended factor	Factor loadings		
		Factor 1	Factor 2	Factor 3
1 (N)	Liking		0.441	0.727
2	Liking	0.542	0.388	-0.521
3 (N)	Liking		0.788	
4 (N)	Liking			0.849
5	Liking	0.386	-0.662	-0.314
6	Confidence	0.837	-0.319	
7	Confidence	0.798		
8	Confidence	0.893		
9 (N)	Confidence		0.512	
10	Confidence	0.742		-0.315

Table 6:   *Results of principal components factor analysis for anxiety items of the post-test (Varimax normalised). Only loadings larger than 0.3 are shown. Loadings higher than 0.5 are underlined. Negatively worded items are indicated with (N).*

4   DISCUSSION

Initially, the objective of this study was to determine whether a small amount of computer experience has a significant positive impact on a person's computer attitude and computer anxiety if he/she has never before touched a computer. This study was done amongst non-English mother tongue speakers with lower levels of general education. Results were found that contradicted the expectations. These contradictions could either be because of true experimental findings or because of an unreliable instrument. In this study the latter possibility was explored.

Relatively high values of Cronbach   which also agreed with the values reported in the original studies indicated that the respondents responded in a consistent way but principal components factor analysis failed to replicate the original factorisation. Although there were some agreement with the original factors, the occurrence of positively worded and negatively worded items had a considerable effect.

Negatively worded items have their place to force respondents to think carefully over every item before responding. If all items are worded similarly, it allows respondents to go hastily and unthinkingly over the items while marking all of them in more or less the same way. The results reported above for the anxiety items confirm this as a very high Cronbach   was found with limited factorisation.

In order to ensure that positively worded and negatively worded items load to the same factor, respondents should recognise items such as *"I am no good with computers"* and *"I am sure that I can work with a computer"* to be equal and mark them in exactly opposite ways. Even if a small number of respondents in a survey group don't recognise a negatively worded item as such, the effect of their responses will influence the average, thereby creating an extra factor with an average somewhat nearer to the middle of the Likert scale.

If the respondents are mostly non-English mother tongue speakers with lower levels of general education the probability of them not recognising negatively worded items is higher. The effect of negatively worded items not being recognised as such is that the overall average score on a Likert scale will be affected. Therefore, the results reported in Table 2 could be inaccurate.

5   RECOMMENDATIONS FOR SURVEY DEVELOPMENT

Opportunity exists for researchers to compile a survey form for measuring computer attitude and computer anxiety for use amongst speakers of indigenous African languages with below-average reading and writing skills.

Several items should be compiled from existing instruments. These items should be separated into different, manageable, survey forms. The survey forms should then be tested by recruiting large numbers of respondents for each. Cronbach   can be used as an initial screening to determine which items to remove when consolidating the separate survey forms. Factor analysis should be done on the final survey form while keeping in mind that positively and negatively worded items can load onto different factors.

It is suggested that the following aspects should be considered when compiling a survey form. Although some of them might seem to be common sense, the mere fact that they are not always adhered to, is justification to reiterate them here:

Focus on items that apparently refer to attitude, anxiety and their comprising constructs only.

Negatively and positively worded items should be alternated in no fixed pattern as to force respondents to think about every item.

In order to reduce the effects of negatively and positively worded items, items aimed at a specific construct should be consistently formulated. For example, all items aimed at measuring computer anxiety should be negatively worded and all items aimed at measuring computer confidence should be positively worded.

Items on the different constructs should be alternated so as to prohibit respondents to get in a certain mode of answering.

If the target group consists of people who have never before used a computer, items should be rephrased to refer to an expected feeling rather than an experienced feeling. For example *"I have a lot of self-confidence ..."* (Gressard & Loyd 1986) should be replaced by *"I will have lots of self-confidence ..."*.

Items should be simple and straight-forward. They should be easily comprehendible

Items should be formulated so that they can easily be translated. Indigenous African languages, e.g. Sesotho, are not always rich in terminology, adjectives and adverbs. It is often necessary to describe a single term when translating from English to Sesotho, thereby creating long-winded sentences with several fragments.

Double negatives (i.e. inherently positive) such as *"I do not feel threatened when others talk about computers"* (Gressard & Loyd 1986) should be replaced by simple negatives, e.g. *"I feel threatened when others talk about computers"*. Of course, respondents' feedback should be reversed when analysing the results.

Negative/positive emotions should be formulated straight-forward instead of negating the corresponding positive/negative emotions. For example *"It wouldn't bother me at all to take computer courses"* (Gressard & Loyd 1986) should be replaced by *"I would like to take a computer course"*. *"I do not enjoy talking with others about computers"* as in (Gressard & Loyd 1986) can be replaced by either *"I like to talk with others about computers"* or *"I hate to talk to others about computers"*.

Terminology should be localised for the specific survey group. For example the concept of *"grades"* as an expression of assessment outcomes is not common in South Africa. Therefore *"I could get good grades in computer courses"* (Gressard & Loyd 1986) should be replaced with *"I will do well in a computer course"*.

6   SUMMARY

Computer attitude and computer anxiety are two determining constructs of success with computer related work. In order to enhance the learning process, improve performance, reduce computer resistance, and ensure job satisfaction computer attitude should be improved and computer anxiety minimised. Several instruments for measuring these constructs are available in the literature but not all of them are necessarily applicable to people with a different mother tongue and educational profile than that of the original survey group. Negatively worded items can specifically be responsible for inconsistent findings. Two standardised instruments from literature were applied to a group of labourers with below-average education and an indigenous African language as mother tongue. It was found that, although an instrument can still appear to be internally consistent, it may have a different factor structure than originally intended by the compilers. A methodology was proposed whereby researchers could develop instruments for measuring computer attitude and computer anxiety for people with a different profile.

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