PASAA
Volume 38
April 2006

Thai University Students' Variables as the Predictors of Computer-Based Test Performance

Prateep Kiratibodee
English as an International Language Program,
Chulalongkorn University

Abstract

This article aims at studying (1) the relationships between three selected variables (computer attitudes, computer anxiety, and computer familiarity) and reading comprehension Computer-Based Test (CBT) performance of Thai students and (2) the extent to which the three variables predict their reading comprehension CBT scores. A correlational study was conducted. The data were collected from 90 undergraduate Thai students. They are assigned to three groups of high, average and low English language ability. Two research instruments of this study are a questionnaire and a reading comprehension CBT. The findings indicated that computer attitudes and computer anxiety are significantly correlated with CBT scores of students with all levels of language ability. Furthermore, computer familiarity was found to be a significant predictor of CBT scores of students of average language ability while computer attitudes were found to be a significant predictor of CBT scores of students with high language ability.

Introduction

In this era of globalization, English is certainly an international language. It plays a crucial role as a common language for international communities. In countries where English is a foreign language such as Thailand, reading skills are very useful and practical tools for learning English. For most reading classes, testing and evaluation are executed at the end of the course and the most common format of language testing is paper-and-pencil. This format of language testing has been used to measure student achievement in language learning for a long time.

In the United States of America, computers have been used in language testing since the 1980s. However, the use of computers in the language classrooms of Thailand is mainly for instructional purposes. If computerized testing is employed, it will increase the utilization of the existing computers of those educational institutes. However, if the mode of language testing is moved to be computerized, test-takers with different characteristics might think and react to this new mode differently. The test-takers' characteristics that are related to the computerized testing might affect the elicitation of their language used during the testing. The affected test scores, thus, can not be claimed to represent the true abilities of the students. In order to minimize extraneous variables of the test scores, we need to identify test-takers' characteristics and observe if they are significantly related to the test scores.

Many studies have confirmed the equivalence or the comparability of the modes of testing (Mead & Drasgow, 1993; Young, Shermis, Brutten, & Perkins, 1996; Choi, Kim, and Boo, 2003). However, those studies of score equivalence between CBT and paper-and-pencil (P&P) tests largely ignored individual differences of the test-takers. Studies suggested that there are three individual differences or characteristics that have potential effects on test scores (Shermis & Lombard, 1998; Taylor, Kirsch, Eignor, & Jamieson,1999; Desai, 2001; Kenyon & Malabonga, 2001; Goldberg & Pedulla, 2002; McDonald, 2002). They are computer anxiety, computer attitudes and computer familiarity.

There are studies on the impacts of those three characteristics on test scores (Lee, 1986; Russell, 1999; Chou, 2001; Sawaki, 2001). However, very few studies investigate the relationships among those three characteristics of test-takers or the relationships among those variables and CBT reading comprehension in particular. The relationships, if found, can provide significant explanations of student success or failure in taking computer-based reading comprehension tests.

Therefore, it is important to investigate the relationships among those three factors and the CBT reading comprehension ability of the test-takers. This study, thus, aims to investigate the relationships among the three test-taker characteristics and their relationships with CBT reading comprehension scores.

Research Method and Procedure

This study aims to determine relationships among three test-taker variables and the reading comprehension CBT scores of students with high, average, and low language ability. Correlational analyses are employed to calculate correlational coefficients. Subsequently, multiple regression analysis with the "enter" method is used to assess the extent to which the three test-taker factors can predict the reading comprehension CBT scores of the sample.

Research Instruments

The instruments employed in the study are 'Computer Anxiety, Familiarity, and Attitudes Rating Scale' (CAFARS) and 'Reading Comprehension Computer-Based Test' (RC-CBT).

CAFARS, a paper-and-pencil questionnaire, consists of two parts. The first part asks for general demographic information. The second part which contains 30 questions is designed to determine students' computer anxiety, computer familiarity, and computer attitudes in the form of Likert-type scales. The time allowed to complete this part is 20 minutes.

RC-CBT contains 36 multiple-choice questions, consisting of four passages ranging from about 200 to about 500 words. The

texts are taken from magazines, journals, books, and newspapers. The topics are in business, economics, and social issues in general. RC-CBT takes 60 minutes.

Both instruments have gone through the validation process. They were first checked by three content specialists. Pilot studies were conducted with 30 fourth-year Communication Arts students of Dhurakit Pudit University to try out data collection techniques and to develop and verify the instruments. The instruments were adjusted after to analysis of the data collected from the pilot study and also as a result of written and verbal feedback from students. An item analysis was conducted to improve the validity and reliability of the RC-CBT. The calculated Cronbach alpha reliability coefficient of the RC-CBT was .893 and the Cronbach alpha reliability coefficient of CAFARS obtained was .863.

Sample and Data Collection

Ninety EFL fourth-year Communication Arts students of Dhurakit Pundit University were randomly selected and assigned to three groups of language ability-high, average, and low-according to their previous performances in their Foundation English courses.

Demographic data of the samples is presented in Table 1.

Table 1: Demographic Data

Student Groups	Male	Female	Age Range
High Ability	14	16	20-26
Average Ability	12	18	20-27
Low Ability	15	15	20-28

The data collection sessions were carried out in July 2005 in a computer laboratory on the campus of Dhurakit Pundit University. Both instruments were administered to the participating students within the same session.

Data Analysis

The data were analyzed in two steps for each of the three groups of students. Firstly, descriptive statistical analysis including mean, standard deviation, and range of score for each variable were carried out. Secondly, Pearson product-moment correlation coefficients were calculated via the SPSS 11.0 for Windows program to indicate the relationships among the three variables and student performance. Finally, multiple regression analysis was conducted to indicate the predictors of reading comprehension CBT performance.

Results

Descriptive Statistics

Descriptive statistical measures of the computer attitudes, computer anxiety, computer familiarity, and CBT scores of the high English language ability group are presented in Table 2. Computer attitudes and computer familiarity had more or less the same variability from the central point in their distribution, 4.32 and 4.31 respectively. The standard deviations of computer anxiety and CBT scores were 3.70 and 2.95, respectively.

Table 2: Descriptive Statistics of the High Ability Group

Variables	Mean	SD	Max	Min
CBT Scores	22.17	2.95	27	17
Attitudes	33.30	4.32	39	21
Anxiety	20.17	3.70	31	14
Familiarity	28.60	4.31	38	20

N = 30

Table 3 presents descriptive statistics of each variable of the average English language ability group. Computer familiarity had the greatest standard deviation, 3.80. The standard deviations of computer anxiety, computer attitudes, and CBT scores were 3.46, 3.20, and 3.10 respectively.

Table 3: Descriptive Statistics of the Average Ability Group

Variables	Mean	SD	Max	Min
CBT Scores	18.00	3.10	23	12
Attitudes	32.43	3.20	40	27
Anxiety	20.57	3.46	28	15
Familiarity	29.63	3.80	36	20

N = 30

Table 4 provides descriptive statistics of each variable of students with low language ability. The standard deviations of computer attitudes, computer anxiety, and computer familiarity were 4.63, 4.49, and 4.07 respectively. CBT scores had the least standard deviation of 2.97.

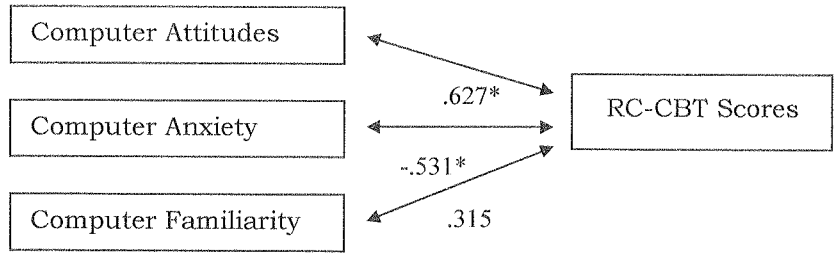
Table 4: Descriptive Statistics of the Low Ability Group

Variables	Mean	SD	Max	Min
CBT Scores	13.07	2.97	18	7
Attitudes	32.30	4.63	40	23
Anxiety	19.70	4.49	26	10
Familiarity	28.40	4.07	37	22

N = 30

Correlational Analysis

Figure 1 represents the relationship between the independent variables and the reading comprehension CBT scores of the high language ability group.

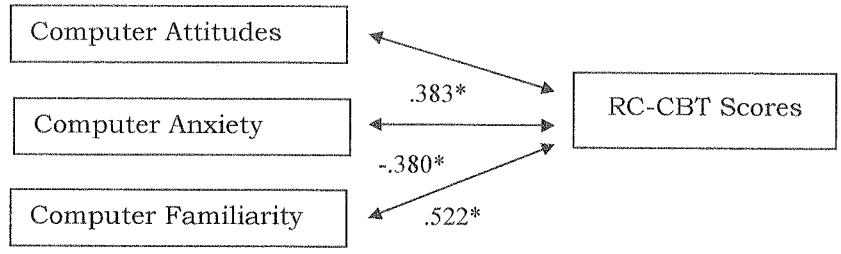


* Correlation is significant at the .05 level (2-tailed).

Figure 1: The Relationship between each Test-Taker's Variable and the RC-CBT Scores of the High Language Ability Group

The correlation between computer attitudes and reading comprehension CBT scores is .627 ($p < .05$). Therefore, they are significantly correlated with each other at a moderate level. As expected, computer anxiety correlates negatively with CBT scores. The correlation coefficient is -.531 ($p < .05$). The relationship between computer familiarity and CBT score is not significant.

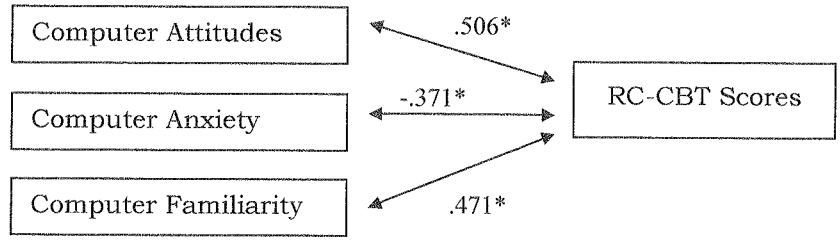
Figure 2 represents the relationship between the independent variables and the CBT reading comprehension scores of the average language ability group. The strength of the relationship between computer attitudes and CBT scores is weak ($r = .383$, $p < .05$). This is similar to the correlation between computer anxiety and CBT scores ($r = -.380$, $p < .05$) although the direction of the relationship is different. There is a moderate and significant relationship between computer familiarity and CBT score ($r = .522$, $p < .05$).



* Correlation is significant at the .05 level (2-tailed).

Figure 2: The Relationship between each Test-Taker's Variable and the RC-CBT Scores of the Average Language Ability Group

Figure 3 represents the relationship between the independent variables and the CBT reading comprehension scores of the low language ability group. The relationship between computer attitudes and CBT scores is moderate ($r = .506$, $p < .05$) which is similar to the relationship between computer familiarity and CBT scores ($r = .471$, $p < .05$). There is a weak negative relationship between computer anxiety and CBT score ($r = -.371$, $p < .05$).



* Correlation is significant at the .05 level (2-tailed).

Figure 3: The Relationship between each Test-Taker's Variable and the RC-CBT Scores of the Low Language Ability Group

Overall, the CBT scores are correlated with computer attitudes of the high, average, and low language ability groups at strong, weak, and moderate level respectively (r = .627, .383, .506, p < .05). There is a moderate and negative relationship between CBT scores and computer anxiety of the high language ability group (r = -.531, p < .05) while there is a weak relationship for the moderate and low language ability groups (r = -.380, -.371, p < .05). Finally, the correlation coefficients between CBT scores and computer familiarity show a moderate relationship for average and low language ability groups (r = .522, .446, p < .05). There is no significant relationship for the high language ability group.

Multiple Regression Analysis

Table 5 demonstrates the model summary of the high language ability group. The R coefficient value of .639 indicates that the relationship between the CBT score and the predictors is moderate and positive. R square is equal to .409, which means that 40.90% of the variation in the CBT score is accounted for by the independent variables or predictors. The standard error of the estimate of 2.395 means that, on average, the predicted values of the CBT score could vary between ±2.395 in the estimated regression equation for each value of the independent variables.

Table 5: Model Summary of the High Language Ability Group

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.639	.409	.340	2.395	.409	5.987	3	26	.003

a Predictors: (Constant), Computer Familiarity Score, Computer Attitudes Score, Computer Anxiety Score

b Dependent Variable: CBT Score

The results from an analysis of variance (ANOVA) of the high language ability group is presented in Table 6. In ANOVA, variation both within and between each group of the variables is analyzed, yielding an F value. This F value is then checked to see

if it is statistically significant. The F test is used to test the significance of R coefficient which is the same as testing the significance of R^2 where the significance of the regression model as a whole is tested (Garson, 2004). In Table 6, the F value is 5.987 with p-value at .003. The full Linear Regression Model is statistically significant at .05 significant level.

Table 6: ANOVA of the High Language Ability Group

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	103.031	3	34.344	5.987	.003
	Residual	149.136	26	5.736		
	Total	252.167	29			

a Predictors: (Constant), Computer Familiarity Score, Computer Attitudes Score, Computer Anxiety Score

b Dependent Variable: CBT Score

Table 7 demonstrates the coefficients of the high language ability group. "Computer attitudes" is the only predictor variable that produces a t value that is statistically significant at the α = .05 level (B = .347, t = 2.358, p = .026). The regression equation for the high ability group can thus be written as CBT Score = .347(Computer Attitudes Score).

It can be said that "computer attitudes" has a significant influence on CBT score. For every one unit increase in computer attitudes, the CBT score will increase by .347 with a standard error of .147.

Table 7: Coefficients of the High Language Ability Group

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	14.106	9.010		1.566	.130		
	ATTI	.347	.147	.507	2.358	.026	.492	2.034
	ANXI	-.148	.186	-.185	-.795	.434	.419	2.388
	FAMI	-1.731E-02	.126	-.025	-.137	.892	.665	1.503

Dependent Variable: CBT Score
ATTI: Computer Attitudes Score
ANXI: Computer Anxiety Score
FAMI: Computer Familiarity Score

The model summary of the average language ability group is presented in Table 8. The R coefficient value of .620 indicates that the relationship between the CBT score and the predictors is moderate and positive. 38.40% of the variation in the CBT score is explained by the independent variables or predictors. The standard error of the estimate is 2.565.

Table 8: Model Summary of the Average Language Ability Group

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.620	.384	.313	2.565	.384	5.413	3	26	.005

a Predictors: (Constant), Computer Familiarity Score, Computer Attitudes Score, Computer Anxiety Score

b Dependent Variable: CBT Score

Table 9 presents the results from an analysis of variance (ANOVA) of the average language ability group. From the ANOVA table, the F coefficient is 5.413 with p-value at .005. The full Linear Regression Model is statistically significant at .05 level.

Table 9: ANOVA of the Average Language Ability Group

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	106.884	3	35.628	5.413	.005
	Residual	171.116	26	6.581		
	Total	278.000	29			

a Predictors: (Constant), Computer Familiarity Score, Computer Attitudes Score, Computer Anxiety Score

b Dependent Variable: CBT Score

Table 10 demonstrates the coefficients of the average language ability group. Computer familiarity is the only predictor variable that produces a statistically significant t value at the α = .05 level (B = .386, t = 2.892, p = .008). The regression equation of the average language ability group can be written as CBT Score = .386 (Computer Familiarity Score).

Computer familiarity has a significant influence on CBT score. For every one unit of increase in computer familiarity, the CBT score will increase by .386 with a standard error of .134.

Table 10: Coefficients of the Average Language Ability Group

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-2.103	10.072		-.209	.836		
	ATTI	.297	.180	.307	1.644	.112	.680	1.470
	ANXI	-4.673E-02	.176	-.052	-.266	.793	.612	1.633
	FAMI	.386	.134	.474	2.892	.008	.881	1.135

a Dependent Variable: CBT Score

ATTI: Computer Attitudes Score

ANXI: Computer Anxiety Score

FAMI: Computer Familiarity Score

The model summary of the low language ability group is presented in Table 11. The R coefficient value of .579 indicates that the relationship between the CBT score and the predictors is moderate and positive. Only 33.60% of the variation in the CBT score is explained by the independent variables or predictors. The standard error of the estimate is 2.557.

Table 11: Model Summary of the Low Language Ability Group

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.579	.336	.259	2.557	.336	4.377	3	26	.013

a Predictors: (Constant), Computer Familiarity Score, Computer Attitudes Score, Computer Anxiety Score

b Dependent Variable: CBT Score

The results from an analysis of variance (ANOVA) of the low language ability group are presented in Table 12. From the ANOVA table, the F value is 4.377 with p-value at .013. The full Linear Regression Model is statistically significant at .05 level.

Table 12: ANOVA of the Low Language Ability Group

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	85.864	3	28.621	4.377	.013
	Residual	170.003	26	6.539		
	Total	255.867	29			

a Predictors: (Constant), Computer Familiarity Score, Computer Attitudes Score, Computer Anxiety Score

b Dependent Variable: CBT Score

Table 13 demonstrates the coefficients of the low language ability group. None of the predictor variables can predict the reading comprehension CBT scores of the test-takers with low language ability at the $\alpha = .05$ level.

Table 13: Coefficients of the Low Language Ability Group

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	-4.044	8.199		-.493	.626		
	ATTI	.274	.143	.426	1.916	.066	.516	1.939
	ANXI	6.732E-02	.156	.102	.432	.669	.461	2.170
	FAMI	.244	.139	.335	1.759	.090	.705	1.419

a Dependent Variable: CBT Score

ATTI: Computer Attitudes Score

ANXI: Computer Anxiety Score

FAMI: Computer Familiarity Score

From the data presented, it can be concluded that computer attitudes have a significant influence on CBT scores (R = .639, R^2 = .409, p = .003; B = .347, p = .026) for students with high English language ability. For students with average English language ability, Computer familiarity has a significant influence on their CBT scores (R = .620, R^2 = .384, p = .005; B = .386, p = .008). However, none of the predictor variables can significantly predict the reading comprehension CBT scores of the test-takers with low language ability.

Discussion

This section discusses the relationship between each independent variable and the CBT scores of the three groups of participants identified in this study. Then, findings on the significance of the independent variables in predicting the CBT scores of test-takers with three levels of language ability are discussed.

The Relationship between Computer Attitudes and CBT scores

The findings show that the relationship between CBT scores and computer attitudes of the high, average, and low language ability groups of students are correlated significantly at rather strong, weak, and moderate levels respectively (r = .627, .383, .506, p < .05). Thus, test-takers who have higher computer attitudes scores can do the CBT test significantly better than those with lower computer attitudes scores. The results are consistent with Russell's (1999) study which found a significant relationship between the two variables.

The Relationship between Computer Anxiety and CBT scores

There is a moderate and negative relationship between CBT scores and computer anxiety of the high language ability group (r = -.531, p < .05) while there is a weak relationship for the moderate and low language ability groups (r = -.380, -.371, p < .05). Hence, test-takers with higher computer anxiety tended to have significantly lower CBT scores while test-takers with lower computer anxiety tended to have significantly higher CBT scores.

The results from this study are slightly similar to the results of Chou's (2001) study which suggests that there is a significant relationship between computer anxiety and performance. However, Chou shows the relationship between the two variables with respect to gender of the participants while this study does not separate the participants and results by gender.

The Relationship between Computer Familiarity and CBT scores

The findings show that there is a significant and moderate relationship between CBT scores and computer familiarity for average and low language ability groups ($r = .522, .446$, $p < .05$) while there is no significant relationship between the two variables for the high language ability group. The significant relationship found in average and low language ability groups confirms Lee's (1986) findings while the results of the high language ability group which indicate no significant relationship between the two variables is consistent with the studies of Taylor et al. (1999) and Sawaki (2001).

Significant Predictors of the Students with High Language Ability

Though the bivariate correlation between the independent variables and the CBT scores demonstrates a significant relationship for both computer attitudes and computer anxiety with the CBT scores ($r = .627, -.531$, $p < .05$), the multivariate analysis points out that computer anxiety is not a significant predictor of the reading comprehension CBT scores for the students with high language ability. The results from multiple regression analysis indicate that "computer attitudes" is the only significant predictor of the reading comprehension CBT scores for students with high language ability ($R = .639$, $R^2 = .409$, $p = .003$; $B = .347$, $p = .026$). The results confirm Russell's (1999) study which found the relationship between computer attitudes and test scores.

Significant Predictors of the Students with Average Language Ability

Multiple regression analysis of data collected from students of average language ability indicates that computer familiarity is the only significant predictor of the reading comprehension CBT scores ($R = .620$, $R^2 = .384$, $p = .005$; $B = .386$, $p = .008$). Though the correlational analysis between the independent variables and the CBT scores of the average language ability group demonstrates a significant relationship for all three variables (computer attitudes, computer anxiety, and computer familiarity) and the CBT scores ($r = .383$, $-.380$, $.522$, $p < .05$), multiple regression analysis demonstrates that computer anxiety and computer attitudes are not significant predictors of the reading comprehension CBT scores for the students with average language ability. The results from the multivariate analysis are consistent with Lee's (1986) which found that individuals with no computer experience received lower scores on a computerized test.

Significant Predictors of the Students with Low Language Ability

The results from the multiple regression analysis indicate that all three variables are not significant predictors of the reading comprehension CBT scores for the students with low language ability, though the multivariate correlation demonstrates a moderate and significant relationship ($R = .579$, $R^2 = .336$, $p = .013$) between the three variables and the CBT scores. This finding is consistent with Taylor et al.'s (1999) finding that computer familiarity does not play a major role in performance on CBT language tests. It also confirms Fulcher's (1999) findings that attitudes towards computers have no significant effect on test scores. However, it contradicts Chou's (2001) finding that computer anxiety is a significant predictor of students' performance.

The finding is relatively obscure when considering the descriptive statistics (the means and standard deviations) of the three variables of the three groups of students which are more or less the same. Further studies which compare the mean scores of

the three variables of the three groups of students may provide better understanding to the effects of these variables on CBT scores. In addition, since there should be other predictors that account for the remaining unexplained portion of the variation in the CBT scores of all groups, more studies are needed to explore other potential independent variables.

Conclusions

Since computer-based tests have been introduced, it appears that many universities will implement this mode of testing to their computer laboratories in the future. The findings for the computer related variables of language test-takers in the present study have important implications for language testing, especially in the implementation of computerized English language tests in Thailand.

1. This study found significant correlations between the three test-taker variables and CBT performances, which suggests that it is important that test developers and language instructors are aware of those variables if CBT tests are to be employed. Universities that employ CBT or intend to employ it in the future should keep people informed about this potential threat.

2. Thai university language instructors, proctors, and other people who are involved with language teaching and testing need to prepare themselves for the coming of CBT tests. They should gain more knowledge about computerized tests as well as information about test-takers' variables.

3. People concerned with language instruction and assessment should find ways to help test-takers cope with potential effects on their test scores. The negative effects of such variables on the computerized test scores should be minimized or eliminated. Additional training on basic computer knowledge and skills should be provided to students who need it. Giving a chance to students to try the language CBT tests can help them become familiarized with the test and reduce their level of anxiety. Introducing the advantages of computer and CBT application features to students should promote positive attitudes towards CBT as well.

4. Since computer-based testing appears to be inevitable and the three variables are directly related to the students themselves, they need to prepare themselves for this coming trend. They should have some fundamental computer knowledge, possess some basic computer skills, and if possible, should try different types of computer-based tests.

In sum, all people concerned with language testing should be aware of this coming mode of testing and should prepare themselves in order to be ready for this relatively new form of language assessment. The following section provides some recommendations for future research.

Limitation of the Study

One limitation of the study that needs to be addressed is the issue of external validity of the investigation, i.e. the extent to which the findings can be generalized. It must be noted that the aim of the study was to explore the pattern of relationships within a set of variables and not to establish the prevalence of a particular condition within a population. Samples in this study consisted of fourth-year undergraduates from one faculty of a university, thus it cannot be viewed as a representative of the larger population.

Future studies are suggested to include more samples from a larger population to increase external validity. A cause-effect study if applied could give more information on the investigated relationships. Furthermore, a qualitative study on this issue will provide better understanding of the relationship among these variables.

The Author

Prateep Kiratibodee holds his MA (Honors) in Language and Communication and his MBA in Management. He has worked for Thai Airways International Public Company as a flight attendant instructor since 2001. At present, he is a doctoral student of the English as an International Language Program of Chulalongkorn University, Bangkok, Thailand. His areas of interest include English Reading, Language Assessment, and Computer-Based Testing.

References

Choi, I., Kim, S. K., & Boo, J. (2003). Comparability of a paper-based language test and a computer-based language test. *Language Testing, 20(3),* 295-320.

Chou, H. W. 2001. Effects of training method and computer anxiety on learning performance and self-efficacy. *Computers in Human Behavior, 17,* 51-69.

Desai, M. S. (2001). Computer anxiety and performance: An application of a change model in a pedagogical setting. *Journal of Instructional Psychology, 28(2),* 70-78.

Fulcher, G. (1999). Computerizing an English language placement test. *ELT Journal, 53(4),* 289-299.

Garson, D. (2004) *PA765, Quantitative Research in Public Administration.* [On-line]. Available: http://www2.chass.ncsu.edu/garson/pa765/regress.htm

Goldberg, A. L. & Pedulla, J. J. (2002). Performance differences according to test mode and computer familiarity on a practice graduate record exam. *Educational and Psychological Measurement, 62(6),* 1053-1067.

Kenyon, D. M. & Malabonga, V. (2001). Comparing examinee attitudes toward computer-assisted and other oral comprehension assessments. *Language Learning and Technology, 5(2),* 60-83.

Lee, J. (1986). The effects of past computer experience on computerized aptitude test performance. *Educational and Psychological Measurement, 46,* 727-733.

McDonald, A. S. (2002). The impact of individual differences on the equivalence of computer-based and paper-and-pencil educational assessments. *Computer & Education, 33(3),* 299-312.

Mead, A. D. & Drasgow, F. (1993). Equivalence of computerized and paper-and-pencil cognitive ability tests: A meta-analysis. *Psychological Bulletin, 114(3),* 449-458.

Russell, M. (1999). Testing on computers: A follow-up study comparing performance on computer and on paper. *Education Policy Analysis Archives* [On-line serial], 7, 20. Available from: http://epaa.sau.edu/epaa/v7n20 [2005, March 6].

Sawaki, Y. (2001). Comparability of conventional and computerized tests of reading in a second language. *Language Learning and Technology, 5(2),* 38-59.

Shermis, M. D. & Lombard, D. (1998). Effects of computer-based test administrations on test anxiety and performance. *Computers in Human Behavior, 14(1),* 111-123.

Taylor, C., Kirsch, I., Eignor, D., & Jamieson, J. (1999). Examining the relationship between computer familiarity and performance on computer-based language tasks. *Language Learning, 49(2),* 219-274.

Young, R., Shermis, M. D., Brutten, S. R., & Perkins, K. (1996). From conventional to computer-adaptive testing of ESL reading comprehension. *System, 24(1),* 23-40.