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The Prediction of Perceived Level of Computer Knowledge: The Role of Participant Characteristics and Aversion toward Computers

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Abstract

As we move into a new century, the ability to predict the impact of computer attitudes on computer knowledge is still a key component to the understanding of information sciences. Survey data about computer knowledge, interest, and level of interest were collected from 478 students at three types of colleges - a four-year liberal arts college, a business college, and a community college. The participants included individuals who fell within three self-rated computer knowledge categories, novice (n = 46), average (n = 286), or expert (n =146), Stepwise discriminant function analysis was used to find the best subset of surveyed characteristics with which to discriminate among respondents with novice, average, or expert levels of computer knowledge. Two composite measures extracted from a previous analysis, reinforcement expectations for computers, and efficacy expectations for computers, and the statement, "I know how to use computer programs," were significant predictors of computer competency. Conversely, traditionally examined demographic variables such as gender and age were not significant predictors. Implications for the present findings are discussed.

Keywords: discriminant function analysis, computer aversion, computer anxiety, computer attitude

Overview

Among the requisite skills necessary for the 21st century, computer literacy will be considered just as necessary as the ability to read, write effectively, and perform arithmetic calculations were in the 20th century (Anderson, Bikson, Law, & Mitchell, 1995; Hawkins & Paris, 1997; Peterson, 1995). Through the economic, cultural, and social institutions that impact society, the so-called "computer revolution" has had and, in the future, will have an even more ubiquitous impact on the lives of individuals (Dertouzos, 1991; Schellenberg, 1994).

Certainly, one negative consequence of this revolution is a concomitant increase in a concept-specific psychological state known as anxiety toward the use of or interaction with computers (Oetting, 1983; McPherson, 1998). Past research has demonstrated that college students enter higher education with differing levels of computer knowledge (Dologite, 1987; Hawkins & Paris, 1997; Lee, Pliskin, & Kahn, 1994). Such differences can have a profound impact as students with less computer experience tend to be less focused, have a more negative attitude toward computers, and have demonstrably less awareness of the role of technology in their proposed career (Malaney & Thurman, 1989-1990).

To date, no studies have been conducted using discriminant function analytic techniques to examine college student profiles in relation to computer knowledge. Therefore, the purpose of the present study was to determine what factors, if any, were predictive of perceived knowledge of computers and their operation. To accomplish this objective, students from three colleges completed an adapted version of Meier's Computer Aversion Scale (Meier, 1988, 1990), a series of demographic items, and rated their own level of computer knowledge.

Method

Participants

The participants were 579 college students (216 men and 363 women) from three colleges located in southern Florida. After exclusion of incomplete surveys, the data were analyzed for a total of 478 surveys appropriate for the present analyses. Age differences were observed among the three schools, $F(2, 565) = 38.65$, $p < .001$. Post hoc examination (Tukey, $p < .05$) of this observation revealed that the Business College (BC) students were significantly

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older (M = 27.79 years, SD = 6.93 years) than students from the other schools. The means for the Community College (CC; M = 22.95, SD = 7.29 years) and Liberal Arts College (LAC; M = 21.54 years, SD = 5.60) were not significantly different.

All sites were Southern Association of Colleges and Schools (SACS) accredited and granted undergraduate and graduate degrees appropriate to their charters. School A was a 2-year state mandated community college (CC) granting an Associates degree, having a student population of 42,000. It is a typical community college and thus most students are commuters, though there are a limited number of dorms available. Students have computers in numerous teaching labs and the library on each campus.

School B is a 4-year individually held private business college (BC) with a limited offering in majors. The school grants both Associate and Bachelor degrees and has a population of approximately 400 students. There are no dorms available and all students are considered commuters. Computers are available in the two computer teaching labs and library. Students included in the survey were primarily members of classes that met in the evening.

School C is a 4-year liberal arts private college (LAC) with a wide range of majors and chartered to grant Associate, Bachelor and Masters degrees. The school has a population of 2800+ with about half living on campus. Students included in the survey were members of day and evening classes in both the Bachelors and Masters programs from a number of disciplines including Arts, Education, Business, and Communications.

Instrument

The survey consisted of a series of true/false and multiple-choice questions as well as demographic items adapted by Burkett (1993) from the Computer Aversion Scale (CAV; Meier, 1988, 1990). Meier's survey was chosen for its brevity and the ability to assess three dimensions of computer use - reinforcement expectations for computers (REC), outcome expectations for computers (OEC), and efficacy expectations for computers, respectively (EEC). Factor analysis (Principle Components Analysis; PCA) with Varimax rotation of the adapted survey used in the present investigation also suggested a three-factor solution (Compton, Burkett, & Burkett, 2001). These factors are discussed elsewhere (Burkett, Compton, & Burkett, 2001). The internal consistencies of the resulting scales were then tested using Cronbach's alpha. Reliability analysis of these scales produced the following: REC, a = .87; OEC, a = .77; and EEC, a = .81. Nunnaly (1978) has indicated .70 to be an acceptable reliability coefficient but lower thresholds (e.g., > .60) are sometimes used in the literature.

The survey, titled, "Affective and academic results of computer-based training and learning," took approximately 15 minutes to complete and, in addition to the adapted CAV questions, included a series of four questions designed to assess student perception of the efficacy of on-line courses. The participants were also asked demographic data related to gender, age, academic discipline, and current degree program (i.e., associates, bachelors, etc.). All surveys were completed within a one-month span in early Spring 2001 and, in the majority of instances, in the presence of the three principle authors.

Discriminant function analysis was chosen because of its conceptual relationship to both multiple regression and a one-way multivariate analysis of variance. Specifically, use of the technique allowed us to identify the attributes that best described the three computer knowledge categories and then to develop predictive tools for quick but useful identification of these groups (Silva & Stam, 1995; Wilkinson, 1998).

The stepwise discriminant function analysis involved the consideration of four demographic variables as predictor variables. These were gender, age, major, and current type of college attended (i.e., CC, LAC, or BC). Additional potential predictors came from our adapted version of the CAV. These included the three scores from the subscales that constitute the three factors, Reinforcement Expectations for Computers (Factor I), Outcome Expectations for Computers (Factor II), and Efficacy Expectations for Computers (Factor III). Finally, four general statements designed to detect computer competency were included as potential predictor variables. The statements were, "I have taken/completed at least one on-line college course."; "I can use word processing software to write a letter."; "I know how to use computer programs."; and "A computer modem is where the computer's permanent memory is stored." Respondents were required to answer either true or false to these four statements.

Scoring and Statistical Analysis

As noted above, 101 individuals failed to complete at least one item on the survey. Of these, 26 were from the CC, 55 were from the LAC, and the remaining 20 were from the BC. Available data from these 101 individuals were not included in any of the univariate or multivariate analyses. Last, it is worth noting that group sample sizes were significantly different, $?^2(2) = 127.99$, $p < .001$.

All data were analyzed using Systat (Wilkinson, 1998). The data from the three self-rated groups were initially compared using chi-square or multivariate analysis of variance (MANOVA) as appropriate with the analyses arranged on the basis of the three factors and demographic characteristics described above. Before the results of the multivariate analyses were interpreted, the data were examined to determine if the appropriate multivariate assumptions were met (Stevens, 1992). The primary analysis of the present study involved the use of the multivariate technique, discriminant function analysis, as a means of predicting the three rated computer knowledge categories.

Results

All participants were classified into one of three computer knowledge categories: Novice (n = 46), Average (n = 286), or Expert (n = 146). Before submitting the demographic, factor, and knowledge scores to discriminant analysis, the data was examined to determine whether the three groups differed significantly on these quantitative and qualitative variables. Analysis of the quantitative variables revealed the following. As expected, the overall MANOVA was significant, Wilk's ? = .68, approximate F (10, 998) = 20.81, $p < .001$. Examination of the univariate analyses revealed the following. All three groups differed on Factors I, II, and III, Fs (2, 503) = 52.42, 3.75, 94.64, respectively, but not age.

Not surprisingly, differences in rated computer knowledge was associated with major, $?^2$(4, N = 478) = 10.16, $p < .05$, an observation worthy of further investigation. Differences in rated computer knowledge was also associated with school, $?^2$(4, N = 478) = 9.84, $p < .05$, with 32.03% of LAC and 28.16% of BC students rating themselves as experts. About 24% of CC students rated themselves as experts. Eighty-nine percent of CC students could use a word processing program, while 95.43% and 99.38% of LAC and BC students felt capable of using this type of computer program, $?^2$(2, N = 478) = 11.72, $p < .01$. Last, examination of the data revealed that perceived knowledge and location of where the computer's memory is stored were related, $?^2$(3) = 22.89, p < 001. Over 48% of the individuals who rated themselves as novice agreed with the statement that a modem is where the computer's memory is stored while among those with average- or expert-rated knowledge, the number of incorrect respondents dropped to 36.64% and 21.38%, respectively. Thus, even among those who consider themselves as competent to expert, such knowledge may not necessarily extend to the computer hardware and the results reported below should be considered with this result in mind.

Discriminant function analysis (Systat, 1998) was used to determine which variables of the total set, if any, were capable of discriminating among respondents with self-rated novice, average, or expert levels of computer knowledge. Because the resulting discriminant function indicated significant overall group separation, the relative impact of each predictor variable was analyzed. In order to reduce the possibility of bias (Crask & Perreault, 1977) the results of the jackknife classification matrix was used for cross-validation (Tabachnick & Fidell, 1992). Unlike a normal classification matrix, a jackknife classification matrix excludes the data for each case as the coefficients used to assign it to one of the categories in the classification scheme are computed. The net result of this exercise is a more realistic representation of how well a set of predictor variables can separate groups. A stepwise discriminant function analysis of the data resulted in a three variable model with a correct overall classification rate of 64%. The resulting discriminant function was significant, Wilk's ? = .67, $?^2$ (6, N = 478) = 222.15, $p < .001$. The jackknife classification table is presented as Table 1. Given the base rates of 12.5%, 50.4%, and 37.1% expected classifications respectively (Because there were 60 individuals who rated themselves as novices, 241 rated themselves as average, and 177 who rated themselves as expert.), the overall increase in accuracy was significant, $?^2$(2, N = 478) = 7.76, $p < .05$.

		Predicted Group Membership		
Actual Group	Number in Group	Novice	Average	Expert
Novice	46	22	17	7
		(48.3%)	(37.1%)	(14.6%)
Average	286	35	182	69
		(12.2%)	(64.0%)	(23.8%)
Expert	146	3	42	101
		(2.1%)	(28.7%)	(69.2%)

Table 1: Frequency of correct and incorrect classification of self-rated computer knowledge.

As shown in Table 1, the misclassification rate for novices was substantially higher than for individuals with average or expert levels of knowledge (48% vs. 64% & 69%). On the basis of bootstrap statistics (Dalgleish, 1994), the relatively large differences among the proportion of females appear to account for at least part of this discrepancy.

As can be seen in Table 2, the discriminant function separated the three groups on the Factor I (Reinforcement Expectations for Computers), Factor III (Efficacy Expectations for Computers), and the statement, "I know how to use computer programs." For both significant factors, the average score increased with the rated level of knowledge. Not surprisingly, better than 97% of both the average-rated and expert-rated respondents agreed that they knew how to use computer programs, while only 72.2% of the novices agreed with this statement, $?^2(2, N = 478) = 60.66$, $p < .001$. Thus, collectively, two of the factors from the modified Computer Aversion Scale and endorsement of knowledge about programs was predictive of the perceived expertise of college students.

	Mean Values				
Variable	Novice	Average	Expert	F	p
Gender[a]	.52	.67	.56	2.51	n.s.
Age	23.61	22.62	23.09	1.26	n.s.
Major[b]	6.46	6.41	5.94	0.24	n.s.
School[c]	.85	.64	.58	2.54	n.s.
Factor I	68.55	76.91	84.10	7.61	.01
Factor II	28.20	28.97	30.89	1.13	n.s.
Factor III	33.49	37.89	44.79	40.63	.001
1[d]	.913	.965	.99	1.30	n.s.
2[e]	.11	.12	.09	0.18	n.s.
3[f]	.76	.96	.99	9.93	.01
4[g]	.46	.37	.20	0.91	n.s.

Table 2. Results of the discriminant function analysis.
Notes. [a]*0 = female, 1 = male.* [b]*1 = social sciences, 2 = physical sciences, 3 = math, 4 = computer sciences, 5 = business, 6 = professional studies (e.g., premed), 7 = physical education, 8 = fine arts, 9 = humanities. These categories were coded for discriminant function analysis.* [c]*0 = BC, 1 = CC, 2 = LAC.* [d]*0 = true, 1 = false.* [e]*0 = true, 1 = false.* [f]*0 = true, 1 = false.* [g]*0 = true, 1 = false.*

Table 3 is a presentation of the canonical analysis and associated discriminant functions. As it relates to separation of the groups, the importance of the two canonical variables (i.e., Z_1 & Z_2) is reflected in their eigenvalues, here .426 and .077, respectively. Z_1 accounts for 84.69% and Z_2 accounts for 15.31% of the between-groups separation. Thus, as Table 3 shows, both make a significant contribution to intergroup separation. Last, examination of the canonical correlations in Table 3 reveals that the first canonical variable (Z_1) is strongly related to Factors I and III (rs = .959 & .711, respectively) and is moderately related to the statement that, "I know how to use computer programs."(r = .397). The second canonical variable (Z_2) only correlates with the "I know how..." statement (r = .867).

Discussion

Discriminant function analysis, although considered a useful tool for investigating group differences, can result in some interpretation ambiguities (Tabachnick & Fidell, 1992). However, jackknife techniques are considered robust often ameliorating interpretive difficulties (see Result section; see also, Dalgleish, 1994).

As noted above, computer literacy in the 21[st] century will become more and more of a necessity (Anderson et al., 1995) and is considered a prerequisite for a number of careers or college programs (Furste-Bowe et al., 1995-1996). Those individuals unaware of or not exposed to the myriad of exciting uses for computers may find themselves to be part of what has been termed a technological underclass (Mestre, 2000). Certainly, students who are competent with a variety of productivity tools (e.g., word processors & spreadsheets) and have a wealth of information accessible on the internet will be at a competitive advantage relative to students who will have to expend considerably more energy mastering computer software or completing tasks in a more inefficient, manual way.

While 38% of households with income of less than $30,000 were on-line by December of 2000, that number had increased from 28% six months earlier (Rainie, February, 2001). However, approximately 82% of families with incomes exceeding $75,000 were on-line. Women now exceed the number of men on-line and, in the last half of 2000 alone, a growth rate among African-American users of 22% was observed. Last, most Internet users continue to utilize "narrowband" (e.g., phone lines) services rather than broadband (e.g., DSL) services (General Accounting Office, 2001).

Compared to the past, today's college student typically enters college at least somewhat better prepared to use computers and may have a substantial amount of experience (Karsten & Roth, 1998). In fact, although the results are not unequivocal, almost any type of prior computer experience, including video game experience, has a positive impact on computer literacy (Brock, Thomsen, & Kohl, 1992). Unfortunately, past experience with computers is not necessarily associated with successful performance with a computer, particularly at the college level (Karsten & Roth, 1998; Larson & Smith, 1994).

al Vari- able	Unstandardized Regression Coefficients			Eigen- value	%	Constant	p	Standardized Regression Coefficients			Correlation between Predictors & Canonical Variables		
	X_1	X_2	X_3					X_1	X_2	X_3	X_1	X_2	X_3
Z_1	.032	.131	.350	.426	84.7	-.798	.001	.304	.786	.076	.959	.711	.397
Z_2	.025	-.098	4.55	.077	15.3	-2.39	.001	.241	-.586	.986	-.163	.206	.867

Table 3. Canonical Analysis

A number of variables have been identified that appear to be predictive of computer anxiety including age, gender, and prior experience (Anderson, 1996; Morris, 1996-1997) but, interestingly, not keyboarding skills (Hemby, 1999). Although some research has suggested that personality characteristics of the user are correlated with computer anxiety (see Mauer, 1994, for a review), in other investigations no such correlation was detected (e.g., McPherson, 1998). Nonetheless, as McPherson pointed out, this relationship may exist in specific contexts such as in business, education, or science courses. Within the context of the present report, learning style may be an important predictor variable worthy of future inclusion. Future research should examine in a more substantive fashion additional variables with predictive utility. Further, the interrelationships among these variables, as a way of developing more fruitful predictive models, requires addition examination.

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