The Influence of Individual Differences on Skill in End-User Computing

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ABSTRACT: Using survey data from 776 knowledge workers from a university, this exploratory study generates and tests eight propositions concerning the relationship between individual differences and computer skill. A multiple regression analysis showed that the male gender, younger age, more experience with computers, an attitude of confidence regarding computers, lower math anxiety, and a creative cognitive style are individual difference variables associated with higher computer skill. The regression also indicated that the individual difference variables accounted for 56 percent of the variance associated with computer skill. These findings suggest that organizations should manage EUC using two complementary processes: a global process and an individual process. The global or organizationwide process would be responsible for areas such as standards, controls, and security. The individual process would address issues such as education and training, selection and recruitment, and the introduction of new technology into the workplace.

KEY WORDS AND PHRASES: end user, end-user computing, individual differences, computer skill.

THE RAPID AND CONTINUOUS GROWTH IN END-USER COMPUTING (EUC) over the past decade has been widely documented [e.g., 8, 9, 12, 53]. Benjamin [8] predicted that

Acknowledgment: The authors wish to acknowledge the contributions of the Editor-in-Chief and of the anonymous reviewers to the final version of this paper.

*The authors contributed equally to the conceptualization, design, and writing of this research.

by 1990, EUC would consume as much as 90 percent of the organization's computing resource. Amoroso and Cheney [2] stated that many firms spend between 60 and 80 percent of their information technology budgets on EUC activities.

A further illustration of EUC growth comes from the 1988 and 1989 *Computerworld* listings of the 100 firms that most effectively managed their information systems [13, 14]. Fifty firms appeared on both lists. The magazine used six criteria to determine inclusion in the lists. One criterion was the number of microcomputers or terminals as a percentage of the number of employees. The percentages increased substantially, from 35.8 percent in 1988 to 48.8 percent in 1989.

The EUC literature provides varying definitions of end users and end-user computing [e.g., 20, 34, 39, 62]. A distinction should be made between the two terms. End-user computing is the direct, hands-on use of computers by persons with problems for which computer-based solutions are appropriate [11, 22, 28, 59]. End users are people who interact with computer-based information systems only as consumers of information [15]. For example, a manager who does not make hands-on use of a computer, but only receives and utilizes computer printouts, would be an end user, but would not be practicing end-user computing. In this study, we refer to persons practicing EUC as EUC personnel.

The growth in EUC can result in benefits to the organization [e.g., 9, 28, 45, 53]. However, EUC can also result in problems, particularly, control and standardization of end-user-developed applications [e.g., 1]. In general, the consensus of the EUC literature is that organizations should formally support EUC to maximize potential benefits while reducing potential problems [12, 30, 53].

Formal support of EUC is difficult and complex, mainly because there is a wide diversity of EUC personnel in an organization. EUC personnel are now found throughout the firm, from clerical workers to executives and in all functional areas. These people exhibit individual differences—that is, they have different personal characteristics, attitudes, anxieties, and thinking styles. Individual differences clearly contribute to the complexity of managing EUC.

Individual differences are essential determinants of work behavior [60]. The growth of EUC suggests that the hands-on use of computers is becoming an important behavior in effective job performance. To provide effective support for all EUC personnel, firms should be aware of how individual differences relate to computer skill. Therefore, the purpose of this research is to investigate the relationship between individual differences and computer skill.

Review of the Literature and Proposition Generation

THE SUCCESSFUL USE OF INFORMATION TECHNOLOGY depends on the technology itself and the level of skill or expertise of the individual using the technology [48]. In other words, computer-oriented work behavior is controlled by external factors associated with the work environment (e.g., characteristics of the job, including technology, job scope, responsibility, physical comfort, etc.) and internal characteristics of the person (e.g., age, education, attitudes, perceptions, etc.).

In a recent review of the literature, Nelson [48] uses an interactionist psychology perspective to examine the impact of individual difference and situational factors on acceptance of information technology. Nelson argues that job characteristics or situational factors have received the majority of research attention [e.g., 10, 33]. She concludes that most studies simply correlate individual characteristics with computer attitudes. In addition, she notes that studies examining individual differences do not completely address their impact on work outcomes. Nelson also criticizes the lack of relevant work behaviors as outcome variables.

Igbaria and Parasuraman [32] conclude that prior research on individual differences and computer-related outcomes has limitations, including: use of students as subjects, which limits the generalizability of results to employed adults; examination of bivariate relationships of demographic and personality variables to computer-related outcomes; and lack of multivariate linkages among a variety of individual difference variables.

The lack of research on individual differences is also evident in the literature regarding management of EUC. Most research in this area focuses on managing EUC as a global entity rather than on an individual basis [e.g., 1, 12, 53].

Managers of EUC who wish to create an effective work environment need to be aware of the impact of individual differences on work behaviors. To understand these individual differences and their influence, research is needed to thoroughly assess the relationship between a variety of individual difference variables and work behavior in a true work environment. This research is designed to address these issues.

Individual Differences

In an attempt to assess the influence of individual differences on MIS success, Zmud [64] categorized individual-difference variables into three groups: demographics, personality, and cognitive style. Demographic variables are personal characteristics such as age, gender, education, and experience with computers. Personality variables relate to the individual's cognitive and affective structures used to understand events and people. Cognitive style represents the individual's modes of perceptual and thinking behavior. Zmud's categorization of individual-difference variables will be used to outline the propositions regarding the relationship of each individual difference variable and computer skill level.

Demographics

Gender

Much prior research has examined the relationship of gender to computer-related outcomes. Gutek and Bikson [27] found that men tend to bring more computer-relevant skills to the workplace than women. Computer use has been perceived to be a male-oriented activity and males have also demonstrated a greater liking for the computer [63]. Females have reported more health problems from computer usage

[23], and women have expressed higher levels of anxiety when imagining sitting down at a computer [29]. Therefore, given these findings,

Proposition 1: Male EUC personnel will demonstrate higher levels of computer skill than female EUC personnel.

Age

Raub [52] reported a positive relationship between age and computer anxiety, suggesting that older employees have less computer knowledge and training. Raub also found that older employees hold unfavorable attitudes toward microcomputers. Based on a sample of computer operators, Nickell and Pinto [50] found age to correlate negatively with computer attitudes. In an attempt to examine the ability of people from different ages to learn computer skills, Czara et al. [18] found age group differences in learning skills do exist. Younger subjects achieved significantly better results than did older subjects. Thus, based on the previous research,

Proposition 2: Younger EUC personnel will demonstrate higher levels of computer skill than older EUC personnel.

Experience

Experience with computers has served as a correlate to a variety of computer-related outcomes. Levin and Gordon [40] found subjects owning computers more motivated to familiarize themselves with computers and to possess more affective attitudes toward computers than did subjects not owning computers. In a study of adoption of advanced manufacturing technology, shop-floor employees who had worked with computers had more favorable attitudes toward complex uses of computers than those who had not [43]. Dambrot et al. [19] found that subjects failing an assembly-language programming course had significantly less computer experience than those passing the course. The findings suggest,

Proposition 3: EUC personnel with more experience with computers will demonstrate higher levels of computer skill than those with less computer experience.

Education

Davis and Davis [21] found end users with higher levels of education to perform significantly better in a training environment than those with less education. Education has been reported to be negatively related to computer anxiety and positively correlated with computer attitudes [27, 32, 52]. Lucas found that less educated individuals possess more negative attitudes toward information systems than individuals with more education [41]. Such findings suggest,

Proposition 4: EUC personnel with more education will demonstrate higher computer skill levels than those with less education.

Personality

The personality variables represent the affective component of individual differences. These variables should reflect the individual's feelings or emotions regarding computers and computer use [32]. Personality variables include various types of anxiety and attitudes. Computer attitudes demonstrate the individual's degree of like or dislike for computer use, while computer anxiety indicates the tendency for an individual to be apprehensive regarding the use of computers.

Computer Attitudes

In a survey of social workers, Mandell [42] found that many subjects viewed computers as dehumanizing in nature. Further, these subjects thought that computers gave organizations power and control over workers. Munger and Loyd [46] discovered that positive attitudes toward computers are positively related to math performance. Arndt et al. [3] explored the relationship between attitudes and computer use. Subjects viewing the computer with positive attitudes had significantly more use than subjects with a pessimistic view. Kerber [35] found similar results, suggesting that experience with computers is correlated with the perception of the computer as efficient, humanizing, and enjoyable. These findings lead to the following proposition:

Proposition 5: EUC personnel with positive attitudes toward computers will demonstrate higher computer skill levels than those with negative attitudes.

Computer Anxiety

The relationship between computer anxiety and actual computer use has been largely unexplored. Heinssen et al. [29] found that college students with higher computer anxiety had lower self-confidence in their abilities and poorer performance outcomes than subjects with lower computer anxiety. When an actual computer task was performed, subjects with higher levels of computer anxiety took longer to complete the task. These finding suggest:

Proposition 6: EUC personnel indicating lower computer anxiety will demonstrate higher levels of computer skill than those with higher computer anxiety.

Math Anxiety

Math anxiety is fear and apprehension related specifically to mathematics [32]. Munger and Loyd [46] found a positive relationship between math performance and attitudes toward computers. Mathematics aptitude and experience were significant predictors of failure in a computer programming course [19]. In a study using student subjects, Glass and Knight [26] found that poorer performers on a computer task reported higher levels of math anxiety than the more adequate performers. Thus:

Proposition 7: EUC personnel with lower levels of math anxiety will demonstrate higher levels of computer skill than those with higher math anxiety.

Cognitive Style

Cognitive style refers to the way an individual collects, analyzes, evaluates, and interprets data. Coventry [16] found evidence to imply that cognitive style affects how people learn about a system and what they learn. Vernon-Gerstenfeld [61] found that women with a preference for abstract thinking were more likely to adopt a computer for use on their jobs. Similarly, Davis and Davis [21] found intuitive thinkers to outperform all other cognitive styles in a computer training environment. The findings in the cognitive style area lead to the following proposition:

Proposition 8: EUC personnel with an intuitive or innovative cognitive style will demonstrate higher levels of computer skills than those with other cognitive styles.

Methodology

THE STUDY WAS CONDUCTED DURING THE FALL OF 1990, to investigate the relationship between individual differences and computer skill. The authors mailed a multipart questionnaire to the salaried personnel at a large university in the southern United States. The questionnaire was not sent to hourly personnel because the authors wanted to restrict the population to knowledge workers. Hourly personnel at this university are not knowledge workers. Their job classifications include, for example, gardeners, janitors, maids, and the like.

The literature presents various definitions of knowledge workers. Zwass [65] states that knowledge workers can be categorized as knowledge workers proper and information workers. Knowledge workers produce new knowledge or add value to information. Information workers perform basically clerical tasks of processing information without significantly changing it. Our sample contains both knowledge and information workers. We do not distinguish between the two types of personnel in our data analysis because the information workers (e.g., clerical workers) in our sample demonstrate a wide range of computer skill and therefore should not be eliminated from consideration.

The first part of the questionnaire gathered demographic data on the respondents. The second part sought data on individual characteristics of each respondent. The final section addressed the level of computer skill of each respondent. Suggested changes made after two pretests were incorporated into the final instrument.

The nine-page, 250-item questionnaire required approximately thirty minutes to complete. Nonusers of computers were encouraged to complete the portions of the survey relating to individual differences. The respondents were assured anonymity.

The survey population consisted of the 3,488 knowledge workers of the university. Seven hundred and seventy-six usable responses were received, for a response rate of 22.3 percent. Nonresponse bias was checked with random telephone calls to forty people who had not completed the questionnaire. (A follow-up mailing was prohibited by university regulations.) All forty stated that the length of the questionnaire was the reason they had not responded, but agreed to complete the questionnaire. *T*-tests comparing the demographic variables revealed no significant differences between the first and second groups of respondents. The conclusion was reached that nonresponse bias was not present and that the results could be generalized to the university population of salaried employees.

The Sample

The sample included respondents from four job categories: faculty, technical, administrative, and clerical. The sample consisted of 43 percent faculty, 7 percent technical, 20 percent administrative, and 30 percent clerical, approximately reflecting the proportions of each category in the population. Fifty-five respondents (7.1 percent) stated that they did not use a computer at all, but completed applicable portions of the questionnaire. Fifty-one percent of the respondents were male and 72 percent possessed at least a bachelor's degree. The mean age of the respondents was 38 years, and they averaged 7.5 years of experience with computers.

The sample is notable for several reasons. First, it includes respondents from every administrative and academic department in the university. Second, respondents represent nearly all levels in each job category: clerical (Secretary I to Administrative Assistant IV); technical (Research Technician I to Research Technician VIII); faculty (Instructor to Professor); and administrative (Department Head to Vice-President). Third, the research did not use students as surrogates. Fourth, the response rate is noteworthy, considering the length of the survey instrument.

Measures

To assess the relationship between individual differences and computer skill, the study used a series of existing scales. The following section describes each scale and the variable it measures.

Computer Anxiety

Computer anxiety was measured by the nineteen-item Computer Anxiety Rating Scale (CARS) [29]. Because the CARS had not been factor-analyzed, the authors performed an exploratory factor analysis of the scale. The principal component factor solution with an orthogonal rotation resulted in two factors with eigenvalues greater than one (see Table 1).

The first factor, containing statements such as, "I hesitate to use a computer for fear of making mistakes I cannot correct" and "I feel apprehensive about using computers," consisted of ten statements. This factor, labeled fear, yielded an internal consistency reliability coefficient of 0.85. The second factor consisted of eight questions, including statements such as, "The challenge of learning about computers is exciting" and "I am confident that I can learn computer skills." This factor was labeled anticipation and resulted in an internal consistency reliability coefficient of 0.84.

Table 1 Factor Analysis of the Computer Anxiety Rating Scale (CARS)

CARS Items	Fear	Anticipation
I hesitate to use a computer for fear of making mistakes that I cannot correct.	.71	
I feel apprehensive about using computers.	.68	
I feel insecure about my ability to interpret a computer printout.	.67	
I have avoided computers because they are unfamiliar and somewhat intimidating to me.	.64	
It scares me to think that I could cause the computer to destroy a large amount of information by hitting the wrong key.	.60	
I have difficulty in understanding the technical aspects of computers.	.57	
You have to be a genius to understand all the special keys contained on most computer terminals.	.52	
I do not think I would be able to learn a computer programming language.	.46	
I dislike working with machines that are smarter than I am.	.45	
I am afraid that if I begin to use computers I will become dependent upon them and lose some of my reasoning skills.	.39	
The challenge of learning about computers is exciting.		.72
I am confident that I can learn computer skills.		.65
I look forward to using a computer on my job.		.64
Learning to operate computers is like learning any new skill--the more you practice, the better you become.		.63
If given the opportunity, I would like to learn about and use computers.		.62
I am sure that with time and practice I will be as comfortable working with computers as I am in working with a typewriter.		.57
Anyone can learn to use a computer if they are patient and motivated.		.52
I feel computers are necessary tools in both educational and work settings.		.49
I feel that I will be able to keep up with the advances happening in the computer field.		.37

Computer Attitudes

Computer attitudes were measured by the twenty-item Computer Attitude Scale (CAS) [50]. This scale was originally designed to measure attitude as a single construct, but exploratory factor analysis revealed three independent factors. An orthogonal rotation resulted in a three-factor solution with eigenvalues in excess of one (see Table 2).

Factor one, labeled pessimism, contained eight items. The pessimism factor included statements such as, "Soon our lives will be controlled by computers" and "Soon our world will be completely run by computers." The internal consistency reliability for the pessimism factor was 0.82.

The second factor embedded in the CAS, labeled optimism, consisted of seven items relating to the positive aspects of computers. Example statements include "The use of computers is enhancing our standard of living" and "Computers are responsible for many of the good things we enjoy." This factor had an internal consistency reliability coefficient of 0.79.

The third attitudinal factor relates to the belief that computers are intimidating. Labeled intimidation, this factor consisted of four statements: for example, "Computers make me uncomfortable because I don't understand them." The internal consistency reliability coefficient for this factor was 0.86.

Math Anxiety

Math anxiety was measured with the Fennema–Sherman Mathematics Anxiety Scale

Table 2 Factor Analysis of the Computer Anxiety Scale (CAS)

CAS Items	Pessimism	Optimism	Intimidation
Soon our lives will be controlled by computers.	.67		
Computers turn people into just another number.	.67		
Computers are lessening the importance of too many jobs now done by humans.	.61		
People are becoming slaves to computers.	.58		
Computers are dehumanizing to society.	.56		
The overuse of computers may be harmful and damaging to humans.	.52		
Soon our world will be completely run by computers.	.50		
Computers will replace the need for working human beings.	.42		
Computers will never replace human life.	.13		
Computers are bringing us into a bright new era.		.68	
The use of computers is enhancing our standard of living.		.68	
Life will be easier and faster with computers.		.63	
Computers are a fast and efficient means of getting information.		.60	
There are unlimited possibilities of computer applications that haven't even been thought of yet.		.51	
Computers are responsible for many of the good things we enjoy.		.51	
Computers can eliminate a lot of tedious work for people.		.45	
Computers make me uncomfortable because I don't understand them.			.75
I feel intimidated by computers.			.74
Computers intimidate me because they seem so complex.			.73
Computers are difficult to understand and frustrating to work with.			.65

[24]. The one-dimensional scale contained twelve statements and had a 0.96 internal consistency reliability coefficient.

Cognitive Style

Cognitive style was assessed with the Kirton Adaption-Innovation Inventory (KAI) [36]. The thirty-two-item survey included three subscales measuring trait components of the adaptor-innovator dimension. The Originality subscale describes the creative individual and is related to the intuitive cognitive style described by McKenney and Keen [44]. The Methodical Weberianism subscale describes the person who is precise, reliable, and disciplined. The Mertonian conformist subscale identifies the bureaucratic individual who respects authority and rules, similar to McKenney and Keen's description of the systematic individual. The internal consistency reliability coefficients for the three factors were 0.66, 0.68, and 0.82 respectively.

Computer Skill

The Computer Self-Efficacy Scale (CSE) [47] was used to measure the respondents' perceptions of their capability regarding specific computer-related knowledge and skills. Respondents expressed their perceptions on thirty-two statements using five-point Likert scales, from (1) strongly disagree to (5) strongly agree. The thirty-two statements addressed specific computer skills ranging from elemental abilities to more advanced, complex skills. The CSE had an internal consistency reliability coefficient of 0.95. Table 3 shows the entire CSE instrument.

Table 3 The Computer Self-Efficacy Scale

I feel confident entering and saving data (numbers or words) into a file.
I feel confident calling up a data file to view on the monitor screen.
I feel confident storing software correctly.
I feel confident handling a floppy disk correctly.
I feel confident escaping/exiting from a program or software.
I feel confident making selections from an on screen menu.
I feel confident copying an individual file.
I feel confident using the computer to write a letter or essay.
I feel confident moving the cursor around the monitor screen.
I feel confident working on a personal computer (microcomputer).
I feel confident using a printer to make a "hardcopy" of my work.
I feel confident getting rid of files when they are no longer needed.
I feel confident copying a disk.
I feel confident adding and deleting information from a data file.
I feel confident getting software up and running.
I feel confident organizing and managing files.
I feel confident understanding terms/words relating to computer software.
I feel confident understanding terms/words relating to computer hardware.
I feel confident describing the function of computer hardware (keyboard, monitor, disk drives, computer processing unit).
I feel confident troubleshooting computer problems.
I feel confident explaining why a program (software) will or will not run on a given computer.
I feel confident understanding the three stages of data processing: input, processing, output.
I feel confident learning to use a variety of programs (software).
I feel confident using the computer to analyze number data.
I feel confident learning advanced skills within a specific program (software).
I feel confident using the computer to organize information.
I feel confident writing simple programs for the computer.
I feel confident using the user's guide when help is needed.
I feel confident getting help for problems in the computer system.
I feel confident logging onto a mainframe computer system.
I feel confident logging off the mainframe computer system.
I feel confident working on a mainframe computer.

This study employs the CSE because each of the thirty-two statements represents a discrete, task-specific, work-related outcome. Bandura [5] defines self-efficacy as an estimation of one's ability to perform target behaviors successfully. Bandura also suggests that individuals who view themselves as capable in performing tasks will tend to do so successfully. Research has shown that when detailed measurements of efficacy are made, efficacy judgments and subsequent performance are highly correlated [5, 6, 7, 56, 57]. Measurement of the self-efficacy construct is then facilitated by identification of a clearly defined set of skills. The authors felt that the specific nature of each statement of the CSE met these criteria and therefore would allow the measure of computer self-efficacy to serve as an indicator of computer skill.

A limitation of the CSE is that it is a self-reported measure of computer skill. However, overcoming this problem would necessitate observing and objectively measuring the computer skill of each respondent. Such an undertaking was not feasible, given that this research examined a large sample of personnel in a complex, dynamic work environment.

Results

THE STUDY UTILIZED MULTIPLE REGRESSION ANALYSIS to examine the relationships between individual differences and computer skill. Table 4 summarizes the variables

Table 4 Description of Variables

Dependent Variable

Computer Skill: computer-related knowledge and skills

Independent Variables

Demographics

Age: age of respondent
Gender: 0=male; 1=female
Education Level:
1= some high school
2= high school diploma
3= technical school
4= some college
5= college diploma
6= some graduate school
7= graduate degree
Experience: years of hands-on computer use

Personality

Computer Anxiety

Fear: apprehension and fear associated with computer use
Anticipation: confidence and comfort with the idea of learning and using computer skills

Computer Attitudes

Pessimism: belief that computers are dominating and controlling humans
Optimism: belief that computers are helpful and useful
Intimidation: belief that computers are intimidating

Math Anxiety: fear and apprehension related to mathematics

Cognitive Style

Weberian: cognitive style of precise, reliable, disciplined individual
Mertonian: cognitive style of bureaucratic individual
Originality: cognitive style of creative individual

used in the model. Table 5 presents scale means, standard deviations, correlations, and reliability coefficients. Table 6 reports the results of the regression analysis. The results of the multiple regression indicate that there is a relationship between certain individual difference variables and computer skill.

Demographic Variables

Regarding the influence of demographic variables, three of four propositions were supported. As predicted, females exhibited significantly lower skill levels than males. Age demonstrates a significant negative relationship with computer skill. The propo-

Table 5 Descriptive Statistics[a]: Means, Standard Deviations, Correlations, and Reliabilities[b]

Variables	Means	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	
1. Gender (0=male, 1=female)	.49	.50														
2. Age (years)	37.52	10.46	-.28													
3. Education Level	5.69	1.54	-.47	.31												
4. Experience	7.74	6.12	-.30	.37	.27											
5. Fear	4.06	.59	-.13	.02	.17	.31	**.85**[b]									
6. Anticipation	4.30	.52	.09	-.05	-.05	.14	.54	**.84**								
7. Pessimism	3.74	.71	-.15	.02	.22	.19	.51	.34	**.82**							
8. Optimism	4.18	.56	.02	.04	-.01	.10	.32	.53	.35	**.79**						
9. Intimidation	4.08	.80	-.07	-.09	.06	.25	.76	.48	.48	.28	**.86**					
10. Math Anxiety	3.57	.97	-.20	.03	.18	.20	.40	.17	.24	.12	.34	**.96**				
11. Weberian	3.51	.55	.17	-.02	-.14	-.03	.05	.17	.03	.19	.06	.07	**.68**			
12. Mertonian	3.01	.53	.17	-.07	-.26	-.13	-.25	-.02	-.23	-.04	-.20	-.01	.30	**.82**		
13. Originality	3.51	.40	-.12	.06	.08	.13	.27	.19	.16	.26	.21	.12	.11	-.29	**.66**	
14. Skill	116.81	14.83	-.08	-.13	-.03	.32	-.60	.47	-.30	.26	-.59	.35	.09	-.12	.27	**.95**

[a] $N = 620$. [b] Reliabilities are shown in bold type on the diagonal.

Table 6 Results of Regression Analysis, Dependent Variable: Skill

Variables		Beta	t
Demographics			
	Gender	-3.19	-2.19*
	Age	- .46	-6.91***
	Education	- .29	- .62
	Experience	.65	5.63***
Personality			
Computer Anxiety			
	Fear	-10.70	-5.97***
	Anticipation	9.07	5.58***
Computer Attitudes			
	Pessimism	-1.98	-1.88*
	Optimism	.08	.06
	Intimidation	-6.77	-5.60***
Math Anxiety		-2.25	-3.19***
Cognitive Style			
	Weberian	.15	.12
	Mertonian	-1.06	- .78
	Originality	5.33	3.15**
R^2	.57		
Adjusted R^2	.56		
N	620		

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

sition that more experience with computers would have a positive relationship with computer skill was also supported. However, the relationship between education and skill level was not significant for this sample.

Personality Variables

Five personality variables exhibited significant relationships with computer skill. Fear and anticipation, latent variables of computer anxiety, were both significant. Fear of computers was significantly negatively related to computer skill, while anticipation had a significant positive relationship with computer skill. Math anxiety, as hypothesized, shows a significant negative relationship with computer skill.

The impact of computer attitudes was also assessed. A pessimistic attitude toward computers and intimidation by computers both have significant negative relationships with computer skill. However, a positive or optimistic attitude toward computers was not significantly related to computer skill.

Cognitive Style Variables

Respondents could exhibit one of three possible cognitive styles. The originality construct of Kirton's [36] Adaption-Innovation Inventory was significantly related to higher computer skill, while the remaining two constructs were not significant. This relationship suggests that individuals exhibiting greater creativity also demonstrate higher computer skill.

Discussion

THE FINDINGS OF THIS STUDY STRONGLY SUGGEST that EUC should not be viewed solely from a global or situational perspective. The personal characteristics of the individual EUC personnel in this study accounted for 56 percent of the variation in their computer skill. Such powerful evidence of the influence of individual differences has several implications for managers, including training and education of end users, human resource decisions regarding recruitment and selection, the change process associated with the introduction of new technology in the workplace, and the impacts of technological advances on individual EUC personnel.

Training and Education

An important finding of this study is the relationship between attitudes and computer skill, given that individuals' attitudes toward an object (computer) influence their responses to that object [25]. The study results indicate that overcoming negative attitudes may remove one barrier preventing individuals from increasing their computer skill. Education and training can be used to overcome negative attitudes toward computers [21].

The Aptitude Training Interaction (ATI) paradigm in educational psychology emphasizes adapting instructional methods to meet individual characteristics [17]. The basis for this approach is the critical importance of the prior knowledge and cognitive skills each person brings to the training process [51]. Therefore, knowledge of individual characteristics will help organizations tailor techniques to train and educate their employees most effectively in computer use.

Nelson and Cheney [49] found that training is positively related to computer-related ability. The literature discusses a variety of education and training techniques, such as one-on-one tutorials, professional development seminars, computer-assisted instruction, and software help features [21, 49, 53, 58].

Math anxiety, found to be lower for highly skilled EUC personnel, is another phenomenon relevant to training and education. There is evidence indicating that math anxiety is treatable [4]. As with attitude change, reduction of math anxiety may be accomplished by increased knowledge, skill improvements, and education. Organizational education efforts should be designed to attain such outcomes.

The negative relationship between age and computer skill suggests that more education and training may be required for the older person if he or she is to master needed computer skills successfully. Organizations should realize that older employees missed the "personal computer" revolution. However, the increase in EUC suggests that these people are now directly using computers in their work (e.g., executives with executive information systems). Our results indicate that older subjects demonstrate lower levels of computer skill but the results do not imply that they cannot readily learn these skills.

Change Process

The study results suggest that lower-skilled EUC personnel possess more anxiety and more negative attitudes toward computers than other EUC personnel. This condition may present problems during the change process that occurs when organizations introduce new technology. Organizations must address these attitudes if the change effort is to be successful. Again, organizational awareness of this problem should facilitate the change process. Managers and supervisors can employ various techniques such as discussions, educational sessions, question/answer sessions, and the like, to decrease anxiety and negative attitudes, in turn, leading to a greater readiness for and acceptance of change.

This study suggests that the employee who is less conforming to rules, social norms, and accepted work patterns is more likely to demonstrate advanced level computer skills [e.g., 54]. This finding adds support to the idea that highly skilled EUC personnel, who also have less anxiety and negative attitudes, will be more likely to accept and adapt to information technology innovations.

Human Resource Issues

This study has implications for human resource management issues, including recruitment, selection, and placement. The findings suggest that EUC personnel with more computer experience will perform better in jobs requiring advanced computer skills than persons with less experience. Selection of individuals for jobs requiring computer skills deserves careful attention. First, jobs requiring computer-based tasks should be identified, and job analysis should be performed to identify the computer skills necessary. Finally, the job applicant's experience and computer skills should also be assessed to match the applicant to the job properly.

Education is often used as a selection criterion for jobs. In this study, education was not significantly related to computer skill. This finding, however, could be a sample artifact. The EUC personnel in this university sample had unusually high levels of education, typically not representative of education levels of organizations at large. Findings may differ in an organization where employees attain more diverse levels of education.

The result that males were more likely than females to possess advanced computer skills has serious implications for career advancement of women. Researchers have suggested that failure to attain computer skills may become a filter for women that blocks their access to many careers or higher positions in their existing jobs [31, 37]. This research suggests that preparing females for jobs requiring advanced level computer skills may necessitate additional training.

Organizations may be required to recruit and hire women for jobs demanding advanced computer skills to comply with nondiscrimination guidelines. If jobs involving advanced computer skills proliferate, firms may have to expand their recruitment practices or be prepared to train women internally for such positions.

Technology

Advances in hardware and software are making it increasingly easier for organizational personnel to use computers. Hardware advances include, for example, mice, touchscreens, voice interfaces, color graphics monitors, and greater storage capacity. Software advances include graphical user interfaces and object-oriented programming. These advances, by contributing to the ease of computer use, will help to diminish anxieties and negative attitudes toward computer use.

Conclusion

END-USER COMPUTING HAS EMERGED AS A VITAL COMPONENT of the overall information resource of the organization. Organizations and previous research have generally focused on EUC as a global, corporate entity. This study, however, investigates the relationships of individual differences to a behavioral outcome, namely computer skill. By noting these relationships, the research suggests that EUC management should consist of two, complementary processes: a macro (global or organizationwide) process and a micro (individual) process.

The macro process would view EUC as a single entity. In this area, management would be concerned with standards (e.g., hardware,. software, communications), controls (e.g., application development, access to corporate data), and security. The micro process would manage EUC on an individual basis. As we have noted previously, this process would include issues such as training and education, selection and recruitment, and the introduction of new technology into the workplace.

The management of end-user computing is complex and difficult. Considering certain aspects of EUC management from a macro standpoint and other aspects from an individual standpoint will help the organization maximize benefits from EUC while minimizing drawbacks.

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