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ABSTRACT

The attitudes of high school students toward the use of microcomputers were examined in terms of causal attributions, i.e., student perceptions of the causes of academic performance. The subjects for the study were 171 male and female students, representing 102 white and 69 minority students who were enrolled in a large city high school. The majority of these students had already completed computer coursework or had other previous computer experience. Two scales, the Computer Attitude Scale and Computer Attribution Scale, were developed from the Fennema-Sherman Mathematics Attitude Scale and the Mathematics Attribution Scale of Fennema, Wolleat, and Pedro, respectively, in order to examine the use and study of computers in this population. The primary focuses of this study--sex and ethnic differences in computer attitudes and computer attributions--were investigated using the multivariate analysis of variance technique. Results indicated that: (1) while there were no ethnic group differences in high school students' attributions of success or failure in using computers, there were significant sex differences in computer attributions, with males attributing their successes in using computers to their own abilities, and females attributing their success to uncontrolled environmental factors; (2) all groups involved had fairly positive attitudes toward computers; (3) both sex and ethnic group differences existed in computer attitudes, with white students perceiving computers as more enjoyable and challenging than minority students, and male students and white students tending to have a more positive attitude toward learning computer skills than female and minority students. Three tables are appended. (39 references) (CGD)

Sex and Ethnic Group Differences in High School Students' Computer Attitudes and Computer Attributions

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Running head: COMPUTER ATTITUDES AND ATTRIBUTIONS

Sex and Ethnic Group Differences in High School Students' Computer Attitudes and Computer Attributions

Usage of microcomputers in the schools has increased to such an extent in the past six years that microcomputers were used in almost 96% of the schools in the 1986-87 school year, compared to 18% in the 1981-82 school year ("Computer Use," 1987). This growth in usage has paralleled the growing importance of computers in our society as the nation's schools strive to prepare citizens and workers for the Information Age. The fast and simultaneous diffusion of microcomputers into schools, homes, and work environments is a unique characteristic of microcomputers when compared to other innovations (Chen, 1985) and has fostered concerns that a computer knowledge gap will result in wider divisions in our society. According to Tichenor, Donahue, and Olien (1970), a knowledge gap occurs when groups of people within the population learn new information faster than other groups within the same population. These researchers have also found that differences in knowledge acquisition tends to be related to characteristics of the subgroups and further separates the subgroups within the population.

A report prepared by the National Commission on Excellence in Education labels computer science along with English, math, science, and social studies as the "Five New Basics" (Lautenberg, 1984). Computer literacy has become a basic skill required for success in many academic areas and career fields. Therefore, some level of knowledge of computer skills is required for females and minority groups if rewarding and productive careers in our increasingly technological society are going to be career options for them. However, Pea (1987) believes that female and minority students have inadequate access to computers and are experiencing an extreme educational disadvantage that will seriously hamper their educational progress.

The learning of computer skills has been shown to be affected by affective variables such as computer attitudes (Byrnes & Johnson, 1981; Leader & Klein, 1977;

Marcoulides, 1988; Sherman, 1981). Other research has demonstrated that the computer attitudes of computer anxiety, computer confidence, and computer liking (Loyd & Loyd, 1988) are related to amount of computer experience. Several studies report students' attitudes toward computers become more positive after successful use (Fetler, 1984; Lawton & Gerschner, 1982; Sheingold, Kane, & Endreweit, 1983), although this is not always the case (Saracho, 1982).

Chen (1985) asserts that insights that can be gleaned from the large body of research on male-female differences in attitudes toward mathematics can be useful in planning investigations of computer attitudes. He further states that these studies tend to not focus on biological differences, but provide information relative to the interrelationships of both cultural and psychological variables that impact the interests and experiences of males and females. Computers have traditionally been associated with the mathematics curriculum (Campbell, 1988), and the use of computers is viewed as a mathematics skill by many students (Marcoulides, 1988). This association has implications for the study of sex and ethnic differences in computer attitudes. Researchers (Block, 1973; Dornbush, 1974; Fennema, 1977; Hilton & Berglund, 1971; Stein & Smithells, 1969) have previously identified relationships between sex and mathematics attitudes. Furthermore, Pedro, Wolleat, Fennema, and Becker (1981) identified four attitudinal variables that have ". . .been shown to be important in explaining sex-related differences in mathematics" (p. 208). These variables are usefulness of mathematics, mathematics anxiety, perceptions of mathematics as a male domain, and effectance motivation of mathematics, or intrinsic joy in the doing of mathematics. Based on the Pedro, Wolleat, Fennema, and Becker study, it seemed important to examine sex and ethnic differences in the related computer attitudes of perceptions of usefulness of computers, computer anxiety, perceptions of computers as a male domain, and effectance motivation of computers.

A second category of factors that may potentially affect some population subgroups' decisions to study computer applications is the causal attributions made by members of the subgroups relative to computer courses. Causal attributions of academic performance have been demonstrated to be significant predictors of both student persistence and achievement in school subjects (Bar-Tel, 1978; Dwek, Davidson, Nelson, & Enna, 1978). The results of other studies indicate this relationship may be a function of the emotional consequences of attributions. Atkinson (1964) and Weiner (1980, 1985, 1986) report negative emotions serve as inhibitors of the productive behaviors necessary for increased achievement levels, while positive emotions motivate students to engage in those productive behaviors.

Weiner (1979, 1985, 1986) further indicates that the underlying causal dimensions of students' attributions are more important as causes of achievement outcomes than are the specific perceptions of the causes of the achievement outcomes. Stipek (1988) has provided a very comprehensive description of the potential of causal attributions for affecting desired learning outcomes in the classroom. He believes that causal attributions or beliefs about the causes of academic performance outcomes are related to the achievement outcomes of both high- and low-performing students. According to him, effort attributions are assumed to be related to increased learning because effort, as opposed to task difficulty and luck, is controlled by the students. Students who then perceive their failures in a certain area are caused by lack of effort are more likely to believe they can succeed if they try harder in that area in the future than students who believe their failures are caused by external factors. Furthermore, Stipek believes that students who perceive their failures in a certain area are due to their own abilities are less likely to try very hard in the future in that area since devoting a great deal of effort to tasks in that area will probably not result in success when they do not have the prerequisite ability. For students who are successful, an effort attribution can also have positive effects on their behaviors in classroom situations because the students are acknowledging that effort is necessary for success along with prerequisite abilities.

Students who do not believe effort is particularly needed for success if they are highly skilled in an area generally do not expend a lot of effort and will achieve at a lower level.

Evidence of sex differences in general attributions for failure and success has been provided by Frieze (1975) and Deaux (1976). Dwek (1975) also reports males and females may react differently to success and failure in mathematics to the extent that females who have negative experiences in learning and/or using mathematics may exert little or no effort or give up easily when placed in a situation requiring the use of mathematics. These female students are exhibiting learned helplessness and usually attribute their failure to low ability. Therefore, attention should be devoted to the examination of sex and ethnic group differences in causal attributions related to computer usage because students' beliefs about the factors affecting their performance using computers can impact their decisions to study computers.

Methods

Subjects

A total of 171 students enrolled in a large city high school participated in this study. This sample included 102 white students and 69 minority students who indicated they belonged to one of the following ethnic groups, Black (n = 40), Hispanic (n = 12), Asian (n = 9), or American Indian (n = 8). Eleven of the students did not mark the item requesting them to indicate their sex; however, of those responding to that item, the sample included 71 males and 89 females. Sixty percent of the sample had already completed one or more semesters of computer coursework, while 89% planned to enroll in one or more semesters of computer coursework in the future. The instruments developed for use in this study were administered by the classroom teachers of the students who volunteered to participate in this study.

Instruments

Demographic questionnaire. Personal and educational information were collected with a brief demographic questionnaire. These data include sex, race, grade level, semesters of high school computer courses completed (including any current enrollment), and semesters of high school computer courses planned.

Computer attitudes scale. The Computer Attitude Scale was developed using the four scales of usefulness, effectance motivation, anxiety, and stereotyping of mathematics as a male domain from the Fennema-Sherman Mathematics Attitude Scales (Fennema & Sherman, 1976) as the basis. The four scales from the Fennema-Sherman Mathematics Attitude Scales were modified so that each item on the scale refers to computers instead of mathematics.

Each of the four scales has 12 items, and each item is responded to using a five point Likert-type scale ranging from strongly agree to strongly disagree. Half of the items on each scale are written with a positive orientation and half with a negative orientation. The items from the four scales were randomly ordered together to comprise the Computer Attitude Scale for this study. The four subscales were scored so that a high score reflects a high level of the attitude measured by the subscale, except for the Computers as a Male Domain subscale. Therefore, high scores on the Computer Anxiety subscale reflect a high level of computer anxiety; high scores on the Computers as a Male Domain subscale indicate a low level of stereotyping computers as a male domain; and high scores on the Usefulness of Computers and Effectance Motivation of Computers subscales indicate positive feelings about the usefulness of computers in relationship to one's own future education and career activities and about the enjoyment and challenge one gains from working with computers, respectively. Each of the computer attitude subscales yields scores ranging from 12 to 60, and the Cronbach's coefficient alpha reliability estimates of the subscale scores range from .85 to .89.

Computer attributions. The Computer Attribution Scale was developed by modifying the 32-item Mathematics Attribution Scale (Fennema, Wolleat, & Pedro, 1979) so that all references to mathematics were changed to computers. According to the authors, "The Mathematics Attribution Scale was designed specifically to measure high school students' attributions of success and failure experiences in mathematics. . ." (Fennema, Wolleat, & Pedro, 1979, p. 1). The Mathematics Attribution Scale has eight subscales with success and failure events paired with each of four attribution categories proposed in a 2 x 2 model of causal attribution by Weiner (1974). The four cells in Weiner's model are divided by stability (stable vs. unstable) and locus of control (internal vs. external) dimensions and the attributional categories assigned to the four cells are ability (internal and stable), effort (internal and unstable), task difficulty (external and stable), and environmental (external and unstable). The environmental category was originally referred to as luck by Weiner (1974), but was renamed environmental by Fennema, Wolleat, and Pedro (1979) after they included causes related to behaviors of the teacher on the subscale designed to measure unstable and external attributions.

The eight subscales of the Computer Attribution Scale include four subscales listing success events in the use and study of computers as stems and four listing failure events. Each of the stems is followed by four attribution statements, each representing one of the four attribution categories of ability, effort, task, and environmental. The students were asked to read each event stem, assume the event had happened to them, and identify on a five-point Likert-type response scale ranging from strongly agree to strongly disagree their perceptions of the extent to which each of the four causes really explained the event, assuming it had happened to them.

An example of a failure event item is:

Event: You got a low grade on a chapter test in a computer science/programming course.

1. You're not the best student in the course.
2. You studied, but not hard enough.
3. There were questions you'd never seen before.
4. The teacher had spent too little class time on the chapter.

Eight subscale scores were calculated for each student by adding responses across each of the success/failure events paired with the four attribution categories: success-ability, success-effort, success-task, success-environment, failure-ability, failure-effort, failure-task, failure-environment. Cronbach's alpha estimates of internal reliability for the eight 4-item subscales range from .39 to .69, with a median of .57. The subscales measuring the internal dimensions of ability and effort have the higher reliability coefficients.

Analysis

Chi-square tests of sex and ethnic group differences in the number of semesters of high school computer courses completed, including any courses currently enrolled in, and the number of semesters of high school computer courses planned were completed as preliminary analyses of the data. The primary focuses of this study, sex and ethnic differences in computer attitudes and computer attributions, were investigated using the multivariate analysis of variance technique which ". . .is designed to investigate differences among two or more levels of an IV (groups) in terms of their effect on a set of DV's" (Tabachnick & Fidell, 1983, p. 57). This analysis controls experimentwise Type I and Type II error rates and also takes into consideration the intercorrelations among the dependent variables (Haase & Ellis, 1987). Pillai's V was used as the test statistic for the omnibus-level test, and based on Haase and Ellis' (1987) recommendation, a significant Pillai's V value was further investigated by examining the discriminant function coefficients to determine the relative contributions of the dependent variables to the significant omnibus multivariate statistic. The chi-square analyses and the MANOVA analyses were completed using SPSS-X (SPSS-X, Inc., 1986), and an alpha level of .05 was used to identify statistically significant values.

Results

Four 2 x 5 chi-square analyses were calculated investigating sex and ethnic (white versus minority group) differences in the number of semesters of high school computer courses currently enrolled in and completed and in the number of semesters of high school computer courses planned. The categories for number of semesters of coursework ranged from none to four or more. No significant ($p > .05$) differences were found between males and females or between whites and minorities with regard to number of high school computer courses completed or planned in the future.

Four separate one-factor multivariate analyses of variance were computed to examine sex and ethnic group differences in computer attributions and in computer attitudes. The means and standard deviations by sex and by ethnic group for the measures of computer attributions and computer attitudes are reported in Tables 1 and 2, respectively. The factor of ethnic group membership has two levels contrasting white

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Insert Tables 1 and 2 about here

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students with non-white or minority students. The results of the MANOVAs of computer attributions indicate no differences in the dependent variables due to ethnic group membership (Pillai's $V = .08$, $F = 1.77$, $df = 8/162$, $p = .087$); however, significant differences due to sex (Pillai's $V = .12$, $F = 2.53$, $df = 8/151$, $p = .013$) were found. The standardized discriminant function coefficients computed using sex as the independent variable and each of the computer attribution variables as dependent variables are reported in Table 3. A review of these coefficients indicate that the success-ability attribution makes the largest relative contribution of any of the computer attribution

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Insert Table 3 about here

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variables to the multivariate discrimination. The success-environment computer attribution makes a somewhat smaller contribution to the discrimination followed by the failure-environmental and success-effort attributions. The multivariate strength of association for the significant Pillai's V is .12, indicating that 12% of the variance in the linear combinations of computer attribution variables is accounted for by the sex effect.

The results of the two MANOVAs of computer attitudes reveal significant effects on computer attitudes due to both ethnic group membership (Pillai's V = .09, F = 4.09, df = 4/166, p = .003) and sex (Pillai's V = .27, F = 14.11, df = 4/155, p = .000). Examination of the standardized discrimination coefficients computed using ethnic group membership as the independent variable and computer attitudes as dependent variables reported in Table 3 reveal stereotyped perceptions of computers as a male domain makes the largest relative contribution. Computer anxiety and effectance motivation of computers contribute much less, but at almost equivalent levels to the multivariate discrimination. The standardized discrimination coefficients computed using sex as the independent variable indicate perceptions of the usefulness of computers is the most important while the other three computer attitudes, computer anxiety, perceptions of computers as a male domain, and effectance motivation of computers, are of less importance in terms of relative contribution to the multivariate discrimination. Only 9% of the variance in the linear combinations of computer attitude variables is accounted for by sex, while 27% of the variance in the linear combinations of computer attitude variables is accounted for by ethnic group membership.

Discussion

The primary purposes of this study were examination of sex and ethnic group differences in high school students' computer attitudes and computer attributions. The ethnic group factor has two levels, white and minority. Prior to investigating the variables of primary concern, sex and ethnic group differences in numbers of high school computer courses previously completed or currently being completed and planned for enrollment in high school were examined because computer experience generally results in more favorable attitudes toward computers (Fetler, 1984; Lawton & Gerschner, 1982; Loyd & Loyd, 1988; Sheingold, Kane, & Endreweit, 1983). The findings of the preliminary analyses indicate no sex or ethnic group differences are present in these two measures of "formal classroom" experience and plans regarding enrollment in computer courses. Because of the extreme difficulty of evaluating the quality and depth of both the instruction provided in these "formal classroom" computer courses and the extracurricular computer experiences of the students involved in this study, no attempts were made to investigate sex or ethnic group differences in these two variables.

The results do not indicate the presence of ethnic group differences in high school students attributions of success or failure in using computers; however, a significant sex difference in computer attributions was identified. Males attributed their successes in using computers more to their own abilities than did females. Females, on the other hand, attributed their successes using computers more to environmental factors, forces not controlled by the individual and not related to the task, than did males. Students who believe their successes are due to some internal stable cause such as ability are more likely to feel proud of their accomplishments. The anticipation of such an emotion can encourage students' efforts on hard tasks and are therefore important motivators for persistence in an area of study (Stipek, 1988). When individuals attribute success to an unstable factor, such as environment, they may experience doubts as to whether they will repeat their prior successes and are less likely to persist in that area of study (Pedro, Wolleat, Fennema, & Becker, 1981). Because students' beliefs about the causes of their performance in coursework are related to their behaviors in those courses, educators should strive to assist female students in developing computer attributions that will motivate them to study computers and develop computer competencies.

Overall the means scores on all four of the computer attitude subscales indicated that all groups involved in this study have fairly positive attitudes toward computers. However, both sex and ethnic group differences in computer attitudes of high school students were found in this study. Minority high school students tend to more strongly stereotype computers as a male domain than do white students. Furthermore, white high school students report higher levels of effectance motivation related to computers than do minority students. This finding implies white s dents perceive computers as providing higher levels of active enjoyment and challenge than do minority students. Additionally, white students tend to have lower levels of computer anxiety than minority students. When compared to female students, male high school students perceive computers as having a greater usefulness in their future education and career activities, experience lower levels of anxiety about computer usage, perceive computers as providing higher levels of active enjoyment and challenge, and stereotype computers more as a male domain.

The gender and ethnic group differences in attitudes toward computers imply male students and white students tend to have attitudes that are generally more likely to have a positive effect on learning computer skills than female students and minority students. In order to increase the likelihood that more females and minorities will study computers and be able to subsequently participate to their fullest capabilities as citizens and employees in the technological society they will enter as adults, it is important for educators to develop interventions designed specifically to enhance positive computer attitudes of female and minority students. Lockheed and Frakt (1984) have suggested the two following changes in computer courses and curricula as ways of counterbalancing factors that tend to limit enrollment in computer courses to white male students. They recommend that teachers devise ways of demonstrating that computer technology has valuable applications in extracurricular and social activities. Furthermore, they point out the need to more aggressively encourage underrepresented groups of students to use computers. Another strategy which has been used successfully to increase enrollments of female and minority students in science and mathematics courses and has similar potential for computer courses is the implementation of intervention programs involving appropriate role models for females and minority students in both curricular and extracurricular activities (Lockheed, Thorpe, Brooks-Gunn, Casserly, & McAlnoon, 1985).

Understanding the causal attributions and attitudes students express regarding computer usage and the implications of those attributions and attitudes in students' educational choices is important for educators committed to helping female students and minority students prepare academically so that their post high school options will not be limited. This understanding and a knowledge of educational interventions previously shown to be effective in increasing female and minority enrollments in technical subjects can be used to impact high school course choices of female and minority students who have the potential to prepare for a wide variety of career options if they possess adequate computer skills.

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Table 1

Means and Standard Deviations of Computer Attributions by Sex and by Ethnic Group

	Success				Failure			
	Ability	Effort	Task	Envir.	Ability	Effort	Task	Envir.
Sex								
Male[a]								
M	13.82	13.82	13.41	14.37	10.90	12.38	12.10	10.11
SD	2.84	2.64	2.67	2.44	2.58	2.90	2.66	3.04
Female[b]								
M	12.37	13.75	13.24	14.72	11.99	13.00	12.99	10.99
SD	2.52	3.18	2.48	2.72	2.62	3.16	2.42	3.25
Ethnic Group								
White[c]								
M	13.30	14.22	13.41	14.56	11.26	12.69	12.49	10.40
SD	3.09	2.97	2.65	2.76	2.73	3.23	2.49	3.07
Minority[d]								
M	12.48	12.72	13.23	14.42	11.86	12.45	12.74	10.84
SD	2.17	2.78	2.38	2.30	2.50	2.73	2.58	3.08

[a] n = 71.

[b] n = 89.

[c] n = 102.

[d] n = 69; includes Black (n = 40), Hispanic (n = 12), Asian (n = 9), and American Indian (n = 8).

Table 2

Means and Standard Deviations of Computer Attitudes by Sex and by Ethnic Group

	Usefulness[a]	Anxiety[a]	Male Domain[b]	Effectance Motivation[a]
Sex				
Male (n = 71)				
M	49.13	23.76	47.44	45.80
SD	6.94	7.19	7.45	6.91
Female (n = 89)				
M	47.58	27.53	53.92	43.49
SD	7.22	7.32	6.11	7.85
Ethnic Group				
White (n = 102)				
M	49.67	24.61	51.56	45.21
SD	6.92	7.74	7.45	8.31
Minority (n = 69)[c]				
M	45.70	27.78	49.49	43.35
SD	7.02	6.36	7.85	5.95

[a]High score reflects high level of the attitude.

[b]High score reflects low level of stereotyping computers as a male domain.

[c] Includes Black (n = 40), Hispanic (n = 12), Asian (n = 9), and American Indian (n = 8).

Table 3

Discriminant Function Coefficients for the Dependent Variables of Significant* MANOVA Results

Independent Variable	Dependent Variable	Discriminant Function Coefficients
Sex	Computer Attributions	
	Success	
	Ability	.8120
	Effort	-.2124
	Task	.1237
	Environment	-.3525
	Failure	
	Ability	-.1779
	Effort	-.1588
	Task	-.1604
	Environment	-.2774
Ethnic Group	Computer Attitudes	
	Usefulness	-.0789
	Anxiety	-.3181
	Male Domain	.9608
	Effectance Motivation	-.3225
Sex	Usefulness	-.7681
	Anxiety	-.4677
	Male Domain	-.3302
	Effectance Motivation	.3908

*$p < .05$.