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AUTHOR Campbell, N. Jo; Perry, Katye M.
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ABSTRACT

Factors affecting the motivation of high school students to learn to use computers were examined in this study. The subjects were 160 students enrolled in a large city high school, 89 females and 71 males who represented five ethnic groups--White, Black, Hispanic, Asian, and American Indian. The majority of subjects had prior computer coursework or other computer-related experience. A Computer Attribution Scale and a Computer Attitude Scale were developed to examine the use and study of computers in this population by modifying the Mathematics Attribution Scale of Fennema, Wolleat, and Pedro, and the Fennema-Sherman Mathematics Attitude Scale, respectively. Two separate path analyses were performed on the data in the current study, one model using the variable "coursework" and the other using the variable "proficiency" as the sole endogenous variables. In both cases, eight attribute variables and four attitude variables served as precursor or exogenous variables. All calculations were completed using the SPSS-X Regression procedure. Findings indicated that both models showed redundancy, and two reduced models were developed through theory trimming; for the variable "coursework," the reduced model showed an excellent fit to the data, but for the variable "proficiency," three of the retained paths were positive and one path was negative. Two major conclusions of the study are that early exposure to computers should take place in a high success environment, and that it should stress both the enjoyment and utility that one may experience with computers. One table and four figures are provided. (24 references) (CGD)

Predictors of Enrollment

in High School Computer Courses

N. Jo Campbell and Katye M. Perry

Oklahoma State University

Running head: ENROLLMENT IN COMPUTER COURSES

Predictors of Enrollment

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Loyd and Gressard (1984) report that computers have become such a necessary and integral part of the process of education that curriculum specialists have moved from debating the wisdom of using computers in the classroom to trying to establish the most effective implementation timeline and usage practices for computer use in the classroom. In fact, computer skills are becoming a requirement for entry and success in many occupational fields, and it appears computer usage has joined mathematics as a new "filter" limiting educational and career choices of secondary school students. For educators who are interested in motivating students to adequately prepare themselves in computer usage, knowledge of some of the factors impacting high school students' decisions regarding whether to engage in the study of computers and develop proficiency in the use of computers is vitally important.

A student's perception of his/her own competency in an area is related to the willingness with which the student will attempt to complete tasks in that area. Students typically choose school tasks that they are more confident will result in successful achievement; therefore, an understanding of the extent to which students' self-perception of their own computer abilities interact with other factors to affect their decisions to take computer courses is needed.

Many students are enthusiastic about learning about computers and develop a fairly high level of competency in computer usage. However, a large number of students perceive their contact with computers as very unpleasant (Marcoulides, 1988). These students experience emotional reactions that may enhance or slow down, and in some cases prevent, the development of effective computer utilization skills (Byrnes & Johnson, 1981; Leader & Klein, 1977; Sherman, 1981). Another factor that may impact students' motivation to learn to use computers is their perceptions of the reasons for their actual or potential successes and failures in computer courses, or the casual attributions students make relative to computer courses.

Causal attributions of academic performance deal with the reasons students give for success or failure at an academic task and have been demonstrated to be significant predictors of both student persistence and achievement in school subjects (Bar-Tal, 1978; Dwek, Davidson, Nelson, & Enna, 1978). Weiner (1979, 1985, 1986) 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 reports 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. Therefore, attention should be devoted to the examination of causal attributions related to computer usage because students' beliefs about the factors affecting their performance using computers have important implications for their electing to enroll or not enroll in computer courses and for their own self-evaluations of their proficiency in use of computers.

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 also has implications for the study of factors that may affect students' decisions to enroll in computer courses and students' perceptions of their competency in the use of computers. In a 1981 study, Pedro, Wolleat, Fennema, and Becker identified certain mathematics attitudes that have been shown to be logically or statistically related to election of mathematics courses. 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, were investigated by those researchers as potential predictors of the decision to enroll in mathematics courses. Based on their study, it seemed important to include the related computer variables of usefulness of computers, computer anxiety, perceptions of computers as a male domain, and effectance motivation of computers in this study since the relationship of those variables to students' decisions to engage in and persist in coursework focusing on computers has not been explored to any extent.

Methods

Subjects

The subjects of this study were 160 students (89 females and 71 males) enrolled in a large city high school. The subjects represented five ethnic groups, White (60%), Black (23%), Hispanic (7%), Asian (5%), and American Indian (5%), and approximately 63% of the students had completed one or more semesters of computer coursework. Over 76% of the students reported they had used computers, and of those, 27% had written computer programs. The instruments for this study were administered by the students' homeroom teachers. Participation in the study was voluntary.

Instruments

Computer attributions. The 32-item Computer Attribution Scale was developed by modifying the 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) when the subscale designed to measure unstable and external attributions was expanded to include causes related to behaviors of the teacher.

Four of the subscales on the Computer Attribution Scale list success events in the use and study of computers as stems and four list failure events. Each of the stems is followed by four attribution statements, each of which represents one of the four attribution categories, ability, effort, task, and environmental.

The students are asked to read each event stem and identify on a five-point Likert 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 success event item is:

Event: You got the grade you wanted for the semester in a computer science/programming course.

1. The content of the class is easy.
2. You spent a lot of time each day studying for the computer science/programming class.
3. The teacher is good at explaining the content of the computer science/programming class.
4. You have a special talent with computers.

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, and 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.

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

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 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 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.

Personal and educational information were collected with a brief demographic questionnaire. These data include sex, race, grade level, self-perceived level of proficiency using computers, semesters of computer courses completed (including any current enrollment), and semesters of computer courses planned. The number of semesters of computer courses completed and the number of semesters of computer courses each student planned to enroll in before graduating from high school were summed to yield a measure of the variable computer coursework. Values on this variable ranged from 0 to 8, with a median of three semesters. Level of proficiency using computers was measured by student's selection of a response to an item listing five levels of increasing proficiency ranging from "I have no experience with a computer" to "I am proficient in programming in one or more computer languages."

Analysis

Two separate path analyses were conducted on the data in the current study: one model using the variable "coursework" as the sole endogenous variable and one model using the variable "proficiency" as the sole endogenous variable. In both cases, the eight attribute variables and the four attitude variables served as precursor or exogenous variables. All calculations were completed using the SPSS-X Regression procedure (SPSS-X Inc., 1986).

Results

The data pool for this study consists of 14 measures: self-perceived level of proficiency of computer use, enrollment in computer courses, four computer attitudes, and eight computer attributions. Means and standard deviations of responses to the variables are listed in Table 1.

Insert Table 1 about here

The full models for the two path analyses completed for this study are shown in Figures 1 and 2. In these figures, path coefficients are listed first, followed by the

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Insert Figures 1 and 2 about here

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zero-order correlation between the two variables in parentheses. Individual intercorrelations (N=66) between the exogenous variables are not shown to reduce the complexity of these figures.

As notes in these figures, both full models show a great deal of redundancy with many of the path coefficients at or near zero. Theory trimming (Pedhazur, 1982) was then conducted to yield the most parsimonious model which still accurately reflected the data. These reduced models are shown in Figures 3 and 4.

Insert Figures 3 and 4 about here

For the variable "coursework" the R^2 for the full model was 0.2242. In the reduced model, involving only effectance motivation of computers, usefulness of computing and the failure-ability attribution, R^2 was 0.202. Using formulas suggested by Specht (1975), a Q value of 0.97273 was calculated. The test of Q yielded a value of W of 2.02; d.f. = 9. This reduced model showed an excellent fit to the data ($p \cong .99$). Further, all retained paths were significant ($p < .05$), with positive values for effectance motivation of computers and usefulness of computers, but a negative value for the failure-ability attribution.

For the variable "proficiency" the R^2 for the full model was 0.286098 while the R^2 for the reduced model was 0.266104. Retained paths for this reduced model included the success-ability attribution, computer anxiety, the failure-environment attribution, and the success-task attribution. The Q value of 0.98799 yielded a value of W of 2.03; d.f. = 8; indicating an excellent fit of this reduced model to the data ($p \cong .99$). For this model, three of the retained paths were positive (success-ability attribution, computer anxiety, and failure-environment attribution), while one path was negative (success-task attribution).

Discussion

The two reduced models not only appear to make intuitively "good sense," but they also have important implications for computer education in the public school setting. The results of this study appear to indicate that two quite different strategies should be undertaken for: 1) initiating students to the computer and, 2) developing student computer competency.

For the coursework variable (high school computer courses taken plus high school computer courses anticipated), only three significant paths were located. These paths were positive for computer effectance, the enjoyment and challenge one gains from working with computers, and computer usefulness, the usefulness of computers in relationship to one's own future education and career activities, but negative with respect to the failure-ability attribution, belief that task failures are due to a personal lack of ability. An implication for education is that early exposure to computers should take place in a high success environment (low failure-ability), and should stress both the enjoyment (effectance) and utility (usefulness) which one may experience with computers. Furthermore, positive computer attitudes do have important practical implications for learning motivation because according to Atkinson (1964) and Weiner (1980, 1985, 1986), 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. Furthermore, Gage and Berliner (1984) report, "Attitudes. . . arouse and direct purposeful activity" (p. 376).

The proficiency variable, which is more complex, appears to be strongly related to students' perceptions of their personal experience with computers. Students appear to perceive themselves as having a greater degree of computer proficiency, if they perceive that their own talents have contributed (success-ability) to development of that proficiency, rather than simply that the task was easy (negative success-task). Further, those failures that are experienced by students who perceive themselves as proficient in computer use are not perceived to be personally related to student efforts, but are attributed to irrelevant external factors (failure-environment).

Somewhat more puzzling is the significant positive contribution of anxiety to the prediction of perceived proficiency. Perhaps this finding might be best related to similar findings in the area of motivation where the highest levels of achievement occur only when an individual is challenged to perform at a level just beyond their actual level of competence, thereby creating a degree of performance anxiety.

A two-stage development plan for computer education is thus implied by these data. Initially, counselors might work with teachers to plan computer activities that inspire and excite students. Additionally, counselors should illustrate the importance of computers in the students' future educational and career plans.

As students progress in their level of computer education, the educational strategy should show a concomitant change - focusing largely on individual student's perception of the causes of success and failure. At this stage of learning, educators might be wise to insure that students believe that their successes are largely due to their own efforts, while their failures are due to circumstances beyond student control. This advanced instruction should be conducted in a challenging environment.

Computer education has often been linked to the teaching of mathematics. The two-level teaching model presented here not only provides a strategy for teacing computer courses, but may also be appropriate for the teaching of mathematics. However, it should be noted that in each model less than 30% of the variance of each endogenous variable was accounted for by the retained precursor variables. Further work should be completed to identify additional presumed causes of these two endogenous variables.

This study indicates that if students develop both positive computer attitudes and computer attributions, they will be more likely to persist in the study of computers. However, the information provided in this study needs to be cross-validated, and should therefore be interpreted with caution. Even without the needed cross-validation research it can be asserted that educational interventions planned by counselors and based in an understanding of the factors affecting students' enrollments in computer courses have the potential to provide students with more flexibility in their educational and career choices than if they are prevented from entering scientific and technical occupations due to inadequate preparation in use of computers. Campbell and Dobson (1987) have provided descriptions of intervention strategies reported in the literature as effective methods of enhancing the positive development of computer attitudes in students. Another valuable source of intervention strategies related to increasing the participation of students in computer courses is Sex and Ethnic Differences in Middle School Mathematics, Science, and Computer Science: What Do We Know? (Lockheed, Thorpe, Brooks-Gunn, Casserly, McAlnoon, 1985). The intervention strategies described in these publications can be used to encourage continued study of computers by all high school students.

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Table 1

Means and Standard Deviations of Selected Variables

N = 160[a]

	Variables	M	SD
(1)	Computer Proficiency[b]	2.76	1.29
(2)	Computer Coursework[c]	3.51	1.98
(3)	Usefulness of Computers	48.07	7.24
(4)	Effectance Motivation of Computers	44.39	7.48
(5)	Computer Anxiety	26.02	7.35
(6)	Computers as a Male Domain	50.66	7.62
(7)	Success-Effort	13.63	2.96
(8)	Success-Ability	12.98	2.78
(9)	Success-Environment	14.48	2.55
(10)	Success-Task	13.31	2.52
(11)	Failure-Effort	12.62	3.02
(12)	Failure-Ability	11.50	2.62
(13)	Failure-Environment	10.61	3.07
(14)	Failure-Task	12.58	2.49

a Females, n = 89; males, n = 71.

b Self-report of computer proficiency on a five-point scale ranging from 1 (never used a computer) to 5 (proficient in one or more computer languages).

c Sum of number of semesters of computer courses completed and number of semesters of enrollment in computer courses planned before high school graduation.

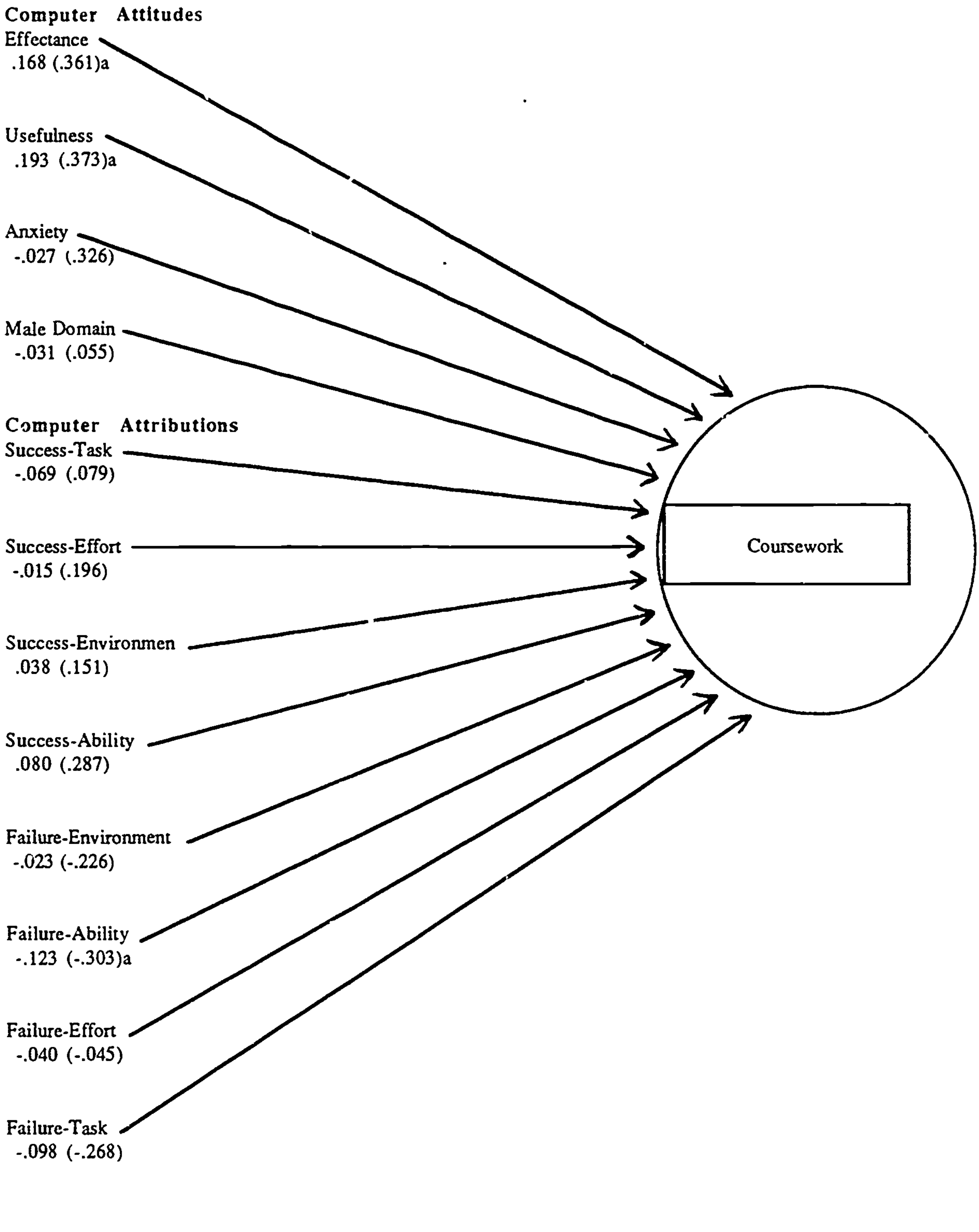

Figure 1. Full model path analysis results using prior and planned coursework in computers as the endogenous variable.

Note. Path coefficients are listed first, followed by zero-order correlation in parentheses.

a Variables selected for reduced model.

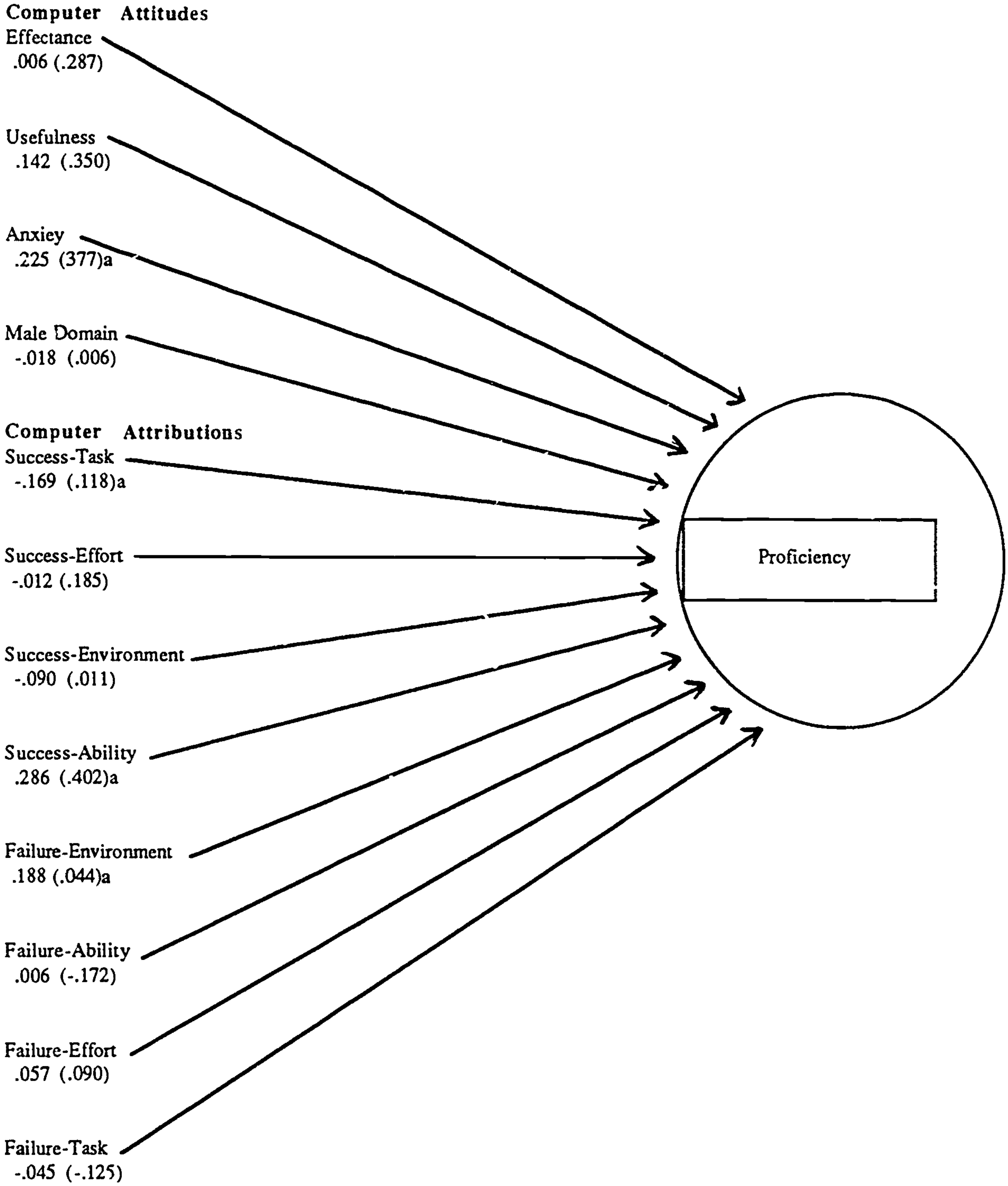

Figure 2. Full model path analysis results using self-evaluation of computer proficiency as the endogenous variable.

Note. Path coefficients are listed first, followed by zero-order correlation in parentheses.

a Variables selected for reduced model.

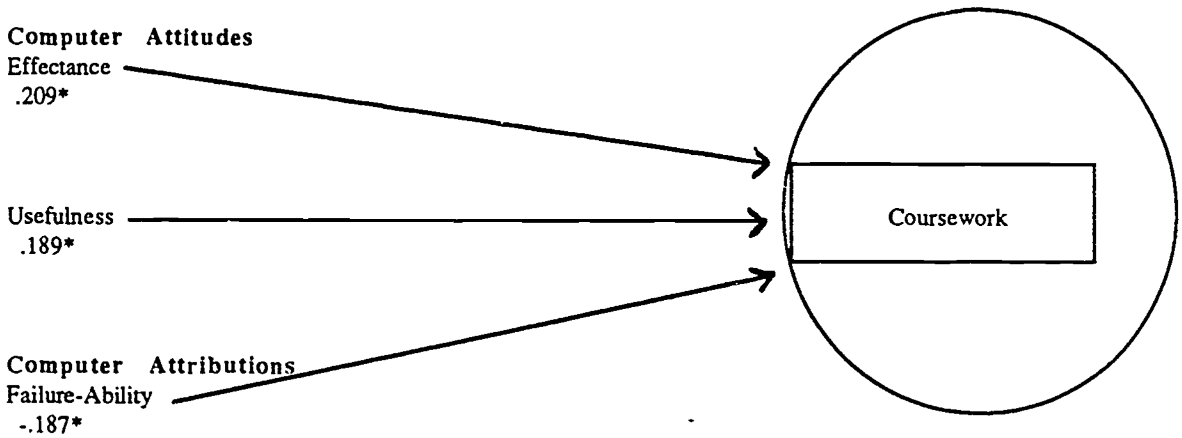

Figure 3. Reduced model path analysis results using prior and planned coursework in computers as the endogenous variable.

* p <.05

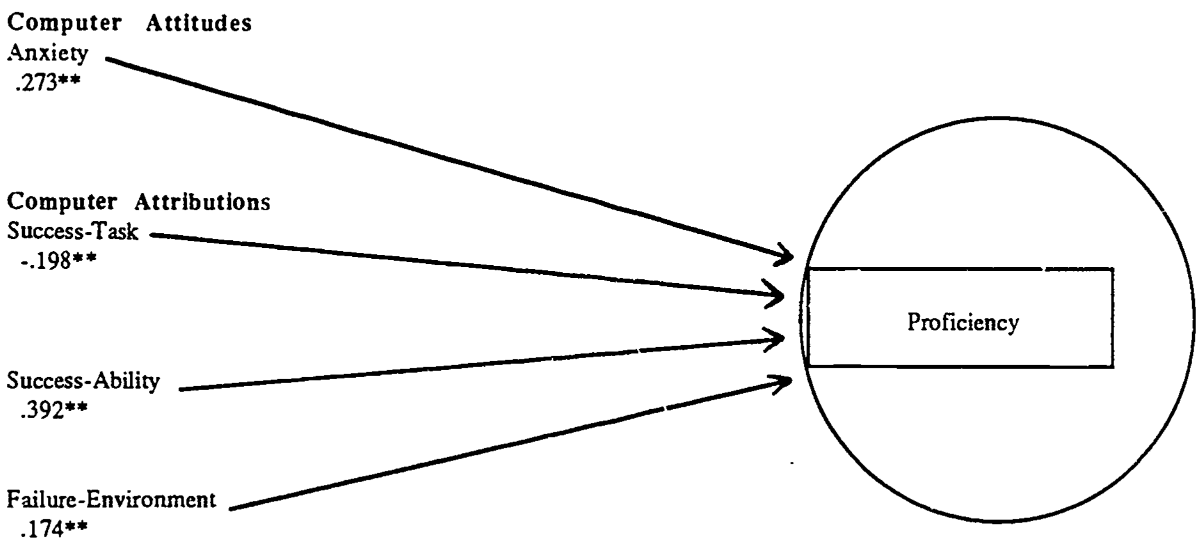

Figure 4. Reduced model path analysis results using self-evaluation of computer proficiency as the endogenous variable.

* p <.05.

** p< .01.