1987

TEACHING MICRO-COMPUTER SKILLS TO MANAGEMENT STUDENTS: ACADEMIC ACHIEVEMENT, GENDER, STUDENT EFFORT ON HOMEWORK, AND LEARNING PERFORMANCE

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ABSTRACT

This paper examines the relationship between previous computer exposure, past academic achievement, time spent on homework, and performance in a course teaching computer literacy by means of an exploratory study using undergraduate management students. The results show that male students with low past academic performance can gain most from previous computer exposure. Furthermore, female students are benefit more from an extra effort into the microcomputer course than having previously attended a course teaching traditional computer literacy. Females appear more effective in transferring time spent using the equipment into better performance than their male peers are, thereby closing the performance gap to their higher achieving peers of the same sex faster than do males do. The implications of the results for training and future research are discussed.

The effective use of rapid technological innovation requires a company to assure that its workforce is trained adequately. Unfortunately, training practices in the technology assessment domain have not received a thorough investigation from researchers. For instance, most studies dealing with training and computer literacy have used children and/or adolescents as subjects to investigate the acquisition of traditional computer skills (e.g., programming), while adults have rarely been studied (Hebenstreit 1985). For educators and training specialists alike, the issue remains: what training programs are most helpful in teaching computer skills to people of different aptitude levels in the shortest time possible?

Another important issue is whether or not individuals who are low academic achievers are able to close the performance gap if they spend more time on their training assignments (homework) than their peers who have more academic ability. Although time spent on assignments has compensatory effects for less academically able individuals in areas such as mathematics (Keith 1982), its effects using different teaching methods are still uncertain (Lepper 1985). For instance, it could be that computer-aided learning (CAL) will benefit individuals showing less academic ability most if they spend some time on their own practicing the skills using the equipment after class. In contrast, teaching computer skills in an environment emphasizing a traditional lecture format may not facilitate learning as much for less able students as for more able ones (Snow 1986). For trainers and educators alike, it is of utmost interest to determine how effort put into homework might most help students achieve levels of computer literacy, thereby possibly decreasing the effort and time needed to close the gap to higher achieving peers.

Another pertinent issue is whether gender effects exist. The results so far have been mixed. Some reports indicate that women are less computer literate than their male peers after attending a computer course in high school (Johnson, Johnson and Stanne 1986). Other research suggests that female high school students were superior to males in using computers for problem analysis and algorithmic applications expressing the problems verbally rather than mathematically (Anderson 1987). If there are gender differences, it is necessary to determine if these hinder the learning process for adult females and/or males, and thus affect their level of computer literacy. The most important issue remaining is to discover if females and males with less academic ability show the same learning patterns. A positive answer would allow trainers and information managers to design programs which include academically less able individuals of both sexes. A negative outcome, in turn, would suggest training females and males separately.

This paper presents a study into how gender and level of academic achievement may affect a person's performance in a course teaching microcomputer literacy/skills[1]. Most importantly, the paper will attempt to illustrate how traditional computer literacy[2], CAL and time spent on homework using a microcomputer affect the performance of a student with less academic ability in a course teaching microcomputer literacy. Another important issue investigated in this paper is how much time must be invested by less academically able individuals to close the performance gap to their more able peers of the same sex. These issues are of utmost importance to both trainers and personnel specialists who must decide what type of training should be offered to new and current employees to achieve the computer literacy level required for their jobs.

LITERATURE REVIEW

Although the educational literature has an abundant number of articles dealing with issues of motivation and learning, the effect of computerization on this process has scarcely been investigated. Lepper (1985) presented a conceptual analysis suggesting that one important research issue is how computers affect social equality. He emphasized that research should investigate ways to reduce possible social inequality and displacement from the labor force by providing academically less able individuals with educational settings allowing them to acquire a satisfactory level of computer literacy. More and more, computer skills are a prerequisite for the employment of today's graduate (Jones and Lavelli 1986). It is, therefore, of utmost importance to ensure that today's business graduates have the necessary skills to work with computer-based technology in office settings (Bikson and Gutek 1983).

Studies in three areas have direct bearing on this research: (1) teaching computer literacy/skills, (2) effort put in homework as well as previous exposure to traditional computer literacy, and (3) the effect of gender on learning. In the sections that follow, there will be a brief summary of recent work in these areas and an indication of how such work can be applied to the computer skills domain.

Teaching Computer Literacy

Computer literacy entails an individual's technical knowledge about computers and algorithms as well as knowledge of at least one programming language (Hebenstreit 1985). Gattiker and Paulson (1987) offered a definition for microcomputer literacy in offices which describes the worker's ability to use appropriate software programs for certain clerical tasks, including business correspondence, report writing and spreadsheets. An analogy to this level of microcomputer literacy would be that of the average skier who knows how to tackle a ski hill, but does not know the intricacies of world cup ski racing.

Computer science curricula still use the traditional definition of computer literacy, which is based more on abstract and logical thinking than the hands-on approach inherent in the computer literacy requirement for an office setting (Bjørn-Andersen 1983).

Effect of traditional computer literacy on learning microcomputer skills. Of interest to trainers and educators is the time that may be saved by prior acquisition of traditional computer skills needed to acquire microcomputer skills later on. One would generally assume that additional exposure would facilitate the learning of "new" microcomputer skills. Yet research has reported that high ability students do not benefit from having previously attended a computer science course (Gattiker and Paulson 1987). It must be remembered, however, that high achieving individuals tend to have different learning styles and patterns than their fellow students (Snow 1986). Thus it is still possible that students who show less ability could benefit from acquiring traditional computer literacy skills before learning about microcomputers, thereby reducing the time needed to learn these skills (cf. Natriello and McDill 1986).

Effect of time spent using the equipment on learning microcomputer skills. Time spent learning a skill has often been identified as the most important factor in achieving high performance. Stanley (1980) found that the main variable which differentiated students with similar aptitude in mathematics, for instance, was the amount of effort put into homework. Low ability students who spent three hours per week on homework, in fact, get the same grades as average ability students who spend no time on homework (Keith 1982).

This demonstrates that effort, expressed in additional learning time, leads to better performance. What is of interest to trainers and educators is *how much extra study time* is required of less qualified students to attain competency levels similar to their more academically inclined peers.

The question of which teaching method may most benefit lower achievers remains to be seen. For instance, some research indicates that using a lecture format when teaching about computers benefits highly able students more than others (e.g., Campbell and McCabe 1984). Other research suggests that some teaching methods may allow individuals to allocate a reasonable amount of time practicing, thereby improving their skills and closing the gap to more able peers (e.g., Frese et al. 1987; Gettinger 1985). This literature provides evidence that time is an important determinant of learning. For computers, however, it is necessary to clarify whether some teaching methods have a greater return on time put into homework and working with the equipment than others (e.g., Gettinger 1985; Hebenstreit 1985).

Learning Micro-Computer Skills

Today's technological change requires universities and firms to ensure that individuals learn new skills as quickly as possible (Jones and Lavelli 1986). University students who are high academic achievers may not represent the average level of academic ability and may require different training programs than individuals with lower levels of academic ability (Biggs and Kirby 1984). It is, therefore, of utmost importance to determine if individuals with lower levels of academic ability have different learning outcomes when acquiring microcomputer skills in a classroom setting.

Academic ability. For lack of a better definition, academic ability is often assessed through academic achievement, using an operational measure such as the student's grade-point average (e.g., Campbell and McCabe 1984). There is very little research available that deals with the effects of academic ability on end-user computer training. Educational psychologists have stated that a person's academic ability will influence how he/she learns and what performance outcomes may be expected (Lepper 1985; Snow 1986). Gattiker (1987) found that students with less academic ability did far better in a course teaching microcomputer skills if they had previously attended a course in computer science. In contrast, high ability students did not benefit.

It is especially important to see if students of average or below average levels of academic ability can achieve the same level of competency as their more able peers. Some literature argues that individuals learn differently and some training methods are less beneficial to lower ability individuals than others (Gettinger 1985; Lepper 1985). If the amount of time needed for less able students to close the performance gap to their peers could be identified, such a result would have a substantial impact on the design of training seminars for the vast group of employees who still need to acquire computer skills (e.g., Hebenstreit 1985; Menashian 1985).

Gender. An important issue for managers and educators alike is whether gender affects learning ability. While some research has produced results suggesting that females achieve lower levels of computer literacy than their male peers after attending a computer course (Johnson, Johnson and Stanne 1986), other research argues that females are better at solving analysis and algorithm problems expressed verbally rather than mathematically (Anderson 1987). Several comments are necessary here. Johnson, Johnson and Stanne (1986) used a survey measuring traditional computer literacy rather than actual competency levels with the computer. Anderson (1987) gave students problems which required programming and algorithm skills. This represents, however, traditional computer literacy skills which have very little to do with the microcomputer skills required in an office setting (Jones and Lavelli 1986).

The above research shows that, although gender effects may exist, results are contradictory. Furthermore, to this author's best knowledge, there is no research assessing possible effects of gender in microcomputer competency using job-like tasks requiring the individual to use the equipment. Another important question is if the learning process is the same for both sexes. Research in mathematics has shown that there are differences in learning styles between males and females (Ethington and Wolfle 1986). In learning microcomputer skills, for instance, females of lower ability use their time more efficiently than lower achieving males do, and thereby reduce the performance gap faster (cf. Robison-Awana, Kehle and Jenson 1986).

Summary and Conclusion

This literature review clearly illustrates that our knowledge of training for computer-mediated work is limited. Furthermore, although educational psychologists and sociologists have done extensive work with children and adolescents in studying training patterns and academic achievement (e.g., Gettinger 1985; Keith 1982; Natriello and McDill 1986), knowledge about adult learning is scarce (Snow 1986). This study answers the call for additional work with adults which investigates the effects of time on performance levels of academically less able individuals (cf. Hebenstreit 1985; Menashian 1985).

Research in this area has two dimensions: the organizational concern for training individuals so they can use the equipment effectively and the social concern that academically less able individuals acquire new skills to make them employable (Lepper 1985). At this stage, it is vital to determine which methods of training achieve the best results in the *least amount of time* for individuals with less academic ability.

RESEARCH ISSUES

What distinguishes this study from previous work is that it attempts to investigate how individuals showing lower levels of academic ability perform when acquiring microcomputer literacy. Second, it tests if previous experience acquired in a course teaching traditional computer skills helps female and male students alike when learning microcomputer skills. Third, the study examines if the amount of time spent using the microcomputer increases achievement similarly for academically less able students of both sexes trying to close the performance gap to their more academically able peers of the same sex. Finally, the study investigates how much extra time (hours) with the equipment will be necessary for the different groups of students to attain competency levels similar to their more able peers. To date, research has tackled these issues one at a time but has ignored interrelated effects.

Furthermore, this study specifically excludes academic high achievers. The reason for excluding this group is that most organizations will have to train people with lower levels of academic ability. Additionally, research has clearly identified that high academic achievers have different learning styles than their peers (e.g., Biggs and Kirby 1984). This is also true when comparing them to their peers in settings where they learn microcomputer skills (Gattiker and Paulson 1987).

Traditional hypothesis testing was not warranted at this exploratory stage (Blalock 1984). Instead, the following research questions were posed:

Question 1. Does acquiring traditional computer literacy before entering a micro-computer course *help* students of both sexes to improve their performance in the course?

Question 2. Can male or female students with low levels of academic ability (LOWACAD) close the *performance gap* to the average (MEDACAD) group by previously attending a computer science course?

Question 3. Can LOWACAD students of either sex close the performance gap to their more academically able peers of the same sex, by *investing more* time using the microcomputer to do their homework?

Questions 2 and 3 really address the issue of what type of exposure is most beneficial to learning microcomputer skills. One could justifiably argue that higher ability students will always do better than their less able peers. Nevertheless, research shows that certain teaching methods facilitate the learning process for less able students (e.g., Keith 1982). Additional effort put into studying by less able students could help them to improve. Increased exposure through previously acquiring traditional computer literacy, on the other hand, has been shown to have a positive effect on competency levels attained by students practicing microcomputer skills using the equipment (e.g., Gattiker and Paulson 1987). Testing these questions should shed more light on this interesting issue, clarify whether time savings can be achieved by previous acquisition of traditional computer literacy and, furthermore, discover how much extra study time is required of less qualified students in order to close the performance gap.

METHOD

Subjects

A total of 247 students who had completed a microcomputer course in any one of six consecutive university semesters was included in this study. The microcomputer course is usually taken by third and fourth year management undergraduate students and was designed to impart a degree of microcomputer literacy so that the student is more effective in a work environment employing microcomputers. Of this group, one-third were female, and slightly over 40% of the total population had previously taken a computer science course. About 20% of the students work full-time and study part-time, 30% work part-time while attending university full-time, and approximately 75% of the students major in business administration.

Table 1. Terms Used in the Regression Analyses

CAL	Computer-aided learning, computer-assisted learning
GPMICRO	The assigned grade point received by the student upon completion of the micro-computer course (A=4, B=3, C=2, D=1, F=0).
CLASS	Mark out of 100 received by the student on the traditional exams (equal weighting for each, based on lecture material only).
LAB	Mark out of 100 received on the combination of a CAL teaching components in the micro-computing course (20% Assignments, 40% Time constrained practical examinations, 40% Time constrained recall examinations).
GPA [2-3,M-F]*	The grade point average that the student had attained upon entering the micro-computing course.
CRBASIC [2-3,M-F]*	A dummy variable for completion (1=passing grade, 0=failing grade or not attended) of the university computer science course teaching traditional computer literacy.
HRS [2-3,M-F]*	Total number of hours that the student used the micro-computer facilities throughout the semester.
TERM [2-3-4-5-6]	Dummy variables for the term that the course was taken by the student (NB. 6 terms => 5 dummy variables).
MEDACAD	Average academic ability students representing group 2 in this study (e.g., GPA2M).
LOWACAD	Below average academic ability students representing group 3 in this study (e.g., CRBASIC3M).

*The suffix 2 or 3 on these variables represents the student's level or academic ability, while the suffix M or F denotes the gender of the student within the ability group.

The students are expected to spend between six and twelve hours studying for the class during a week, spend between 50 and 70 hours per twelve week term on homework using the microcomputer, and furthermore, 50 to 70 hours for studying and doing assignments based on the lecture part of this course. If previous exposure to microcomputers is substantial, individuals have the option to test out of this course. Thus, students attending this class usually have minimal previous exposure and microcomputer skills.

Evaluation was performed by requiring students to do several assignments on their own using the micro-computer. These tasks also required the use of a variety of software packages and represented possible job tasks. The students had to write a paper and pencil test, as well as a practical exam with imposed time constraints to assess their performance in the lecture portion of the course. A final test using the microcomputer required the student to show creative problem-solving under time pressure (cf. Table 1 for further explanation).

Measures

Historical information about each student's cumulative grade-point average, whether or not he/she had successfully completed (received a "D" or better) the optional mainframe computing course, as well as performance information for the microcomputer course was obtained.

To form equally sized groups of academic ability, it was necessary to rank the 247 students from highest to lowest according to GPA upon entering the course. The highest 33.29% of the students, considered to be those of "high" academic ability, were put into group 1. The next 33.29%, the MEDACAD students, were put into group 2. The lowest 33.29% were placed in the LOWACAD group (group 3). Each of the three groups consisted of 82 students with GPA breaking points at 2.94, 2.48 and 1.92 (i.e., group 3 GPA 1.92 $\geq$ 2.48). One student failed the course.

For this study, we only used data for MEDACAD and LOWACAD students. We will, therefore, only look at average and low academic ability individuals' performance, since some research indicates that learning strategies are different for highly able students (Biggs and Kirby 1984; Snow 1986). Furthermore, a greater range of teaching methods should be applicable to less able individuals to help them increase their competency to a satisfactory level (Gattiker and Paulson 1987).

Statistics

All of the computational analyses were performed on microcomputers using the SYSTAT statistical package. The Mann-Whitney test was used to determine if the two samples (males versus females) were from the same population of GPA students (Siegel 1956, pp. 116-127). The same test was also used to determine if the two samples (males versus females) were from the same population of GPMICRO students. The rationale for the use of this test is to determine whether or not male students come from the same population of GPA students as their female peers. Second, the test would also allow an assessment of whether or not female and male students fare equally well in this introductory course.

Multiple regression was used so that the significance of factors could be determined and the magnitude of effect on the dependent variable in conjunction with the other variables could be inferred (Kamenta 1971, pp. 374-376). The models for the overall course grade, lecture and assignment grades were put in the form of linear regression equations to estimate the significance of the variable and to facilitate an approximation of the relative weighting received by each independent variable (see equations 1, 2, 3 from Table 2). The order of the independent variables was taken, in part, from Gattiker and Paulson (1987).

As Table 2 indicates, respondents were divided into two groups according to GPA. The independent variables coded as HRS2 and HRS3 in Table 2 are associated with the number of hours during the term that students in each ability group spent using the micro-computing facility, as well as the academic ability group that is associated with the student. The five term variables (cf. Table 2) are placed in the model for statistical consistency to account for the fact that this course has been offered in six different semesters and to remove any direct data bias caused by comparing different classes.

Table 2. Regression Equations Used to Predict Male Student Performance

Equation Number	Dependent Variable	Independent Variables
1	GPMICRO	$= \alpha + \beta_1 GPA2M + \beta_2 GPA3M + \delta_1 CRBASIC2M$ $+ \delta_2 CRBASIC3M + \Phi_1 HRS2M + \Phi_2 HRS3M$ $+ \Upsilon_1 TERM2 + \Upsilon_2 TERM3 + \Upsilon_3 TERM4$ $+ \Upsilon_4 TERM5 + \Upsilon_5 TERM6 + \epsilon$
2	CLASS	$= \alpha + \beta_1 GPA2M + \beta_2 GPA3M + \delta_1 CRBASIC2M$ $+ \delta_2 CRBASIC3M + \Phi_1 HRS2M + \Phi_2 HRS3M$ $+ \Upsilon_1 TERM2 + \Upsilon_2 TERM3 + \Upsilon_3 TERM4$ $+ \Upsilon_4 TERM5 + \Upsilon_5 TERM6 + \epsilon$
3	LAB	$= \alpha + \beta_1 GPA2M + \beta_2 GPA3M + \delta_1 CRBASIC2M$ $+ \delta_2 CRBASIC3M + \Phi_1 HRS2M + \Phi_2 HRS3M$ $+ \Upsilon_1 TERM2 + \Upsilon_2 TERM3 + \Upsilon_3 TERM4$ $+ \Upsilon_4 TERM5 + \Upsilon_5 TERM6 + \epsilon$

Note. See Appendix for variable definitions. The equations used for female students requires the substitution of an F in place of the M at the end of the acronyms used for the independent variables (i.e. GPA2M => GPA2F).

RESULTS

To determine whether or not it would be appropriate to treat all students as coming from the same GPA population, the Mann-Whitney test was used. It ranks students according to historical academic performance (GPA) versus gender. The *U* statistic that resulted from this test was $X^2 = 1907$ (1 df, $p < .06$). This result indicates that male students originate from a different population of GPA students upon entering the course than do females. Based on these results, it was appropriate to use gender and the "a priori" GPA of the student as grouping variables (cf. Table 1 under GPA).

When determining if female and male students could be treated as members of the same population of GPMICRO students, the Mann-Whitney test was again used. The *U* statistic here was $X^2 = 2598$ (1 df, n.s.), indicating that female students originate from the same population of GPMICRO attained in this course as males. Since females and males failed to perform differently in this course, it is of utmost importance to assess if learning processes in different portions of the course and, moreover, subsequent learning outcomes are the same for both sexes. To facilitate comparisons and subsequent discussions, the results of this research have been divided into three sections according to the research questions posed previously.

Student Performance in the Microcomputer Course

The first research question asked if previously passing a computer science course teaching traditional computer literacy helps female and male students alike. The results in Table 3 indicate that the MEDACAD male students (CRBASIC2M) benefit significantly in all ways from this course while their LOWACAD peers seem to benefit from such additional exposure only in the LAB portion of the microcomputer course.

For the females, the results were very different. The only significant effect discovered was for MEDACAD females in the overall course grade. Nearly significant effects were recorded though ($p < .06$), suggesting that using a larger sample would lead to significant effects for both the CLASS and LAB sections. In contrast, LOWACAD females do not benefit from this additional exposure significantly. Based on these results, previous experience gained in a computer science course helps MEDACAD male students of this sample in every aspect of the course while MEDACAD female students are helped only in their overall performance. LOWACAD male students benefit only in the LAB portion, while LOWACAD females do not benefit at

Table 3. Regression Results of Student's Grade, Class, and CAL Performance

DEPENDENT VARIABLE	d.f.	adj.R^2	CONSTANT	GPA2M	GPA3M	CRBASIC2M	CRBASIC3M	HRS2M	HRS3M	TERM2	TERM3	TERM4	TERM5	TERM6
GPMICRO	127	0.406	-.216	.872	.697	.557	.247	.002	.010	.455	.743	.277	.693	.999
			(-0.41)	(4.00)*	(2.50)*	(3.34)*	(1.54)	(0.77)	(2.20)*	(2.70)*	(3.44)*	(1.36)	(4.13)*	(3.75)*
CLASS	127	0.273	49.754	8.476	8.840	4.963	-.425	-.003	.019	-9.863	.148	-2.193	-1.981	1.554
			(7.84)*	(3.24)*	(2.64)*	(2.47)*	(-0.22)	(-0.07)	(0.35)	(-4.86)*	(0.06)*	(-0.90)	(-0.98)	(0.48)
LAB	127	0.487	37.313	11.106	5.473	6.400	7.135	.067	.268	6.460	7.736	2.340	7.940	7.848
			(5.66)*	(4.08)*	(1.57)	(3.07)*	(3.57)*	(1.72)	(4.69)*	(2.87)*	(2.87)*	(0.92)	(3.79)*	(2.36)*
	d.f.	**adj.R^2**	**CONSTANT**	**GPA2F**	**GPA3F**	**CRBASIC2F**	**CRBASIC3F**	**HRS2F**	**HRS3F**	**TERM2**	**TERM3**	**TERM4**	**TERM5**	**TERM6**
GPMICRO	26	0.435	-3.547	1.982	1.643	1.252	.540	.009	.025	.350	-.635	.524	.249	-.051
			(-1.47)	(2.22)*	(1.63)	(3.76)*	(1.69)	(1.39)	(2.85)*	(1.10)	(-1.68)	(1.45)	(0.75)	(-0.15)
CLASS	26	0.391	32.309	13.967	14.341	6.089	3.716	.077	.102	-11.690	16.625	-6.481	-3.660	-6.886
			(1.08)	(1.27)	(1.15)	(1.48)	(0.94)	(0.92)	(0.95)	(-2.98)*	(3.56)*	(-1.45)	(-0.89)	(-1.68)
LAB	26	0.345	31.802	10.420	-1.274	9.312	6.479	.144	.493	12.901	.919	14.144	4.397	5.109
			(0.95)	(0.84)	(-0.09)	(2.01)	(1.46)	(1.53)	(4.07)*	(2.92)*	(0.18)	(2.81)*	(0.95)	(1.11)

Note. The equations have been arranged according to gender (M,F). For each gender the effect of 'a priori' GPA, having previously acquired traditional computer literacy (CRBASIC), and time spent on homework using the micro-computer (HRS) have all been appropriately subdivided by academic ability group (2=MEDACAD or 3=LOWACAD). Additionally, the possible effect of the semester during which the course was taken (TERM) was used to predict the dependent variable (cf. Appendix for variable definitions).

[1] *t* ratios are in parentheses beneath estimated coefficient * $p<0.05$.

all from a previous course in traditional computer literacy. Based on these results, question 1 cannot be answered positively for all students.

Student Performance and its Relationship to Gender and Academic Achievement

The second question posed in this study asked if previous attendance in a computer science course could reduce the performance gap between LOWACAD and MEDACAD students of either sex. Results in Table 4 indicate that the LOWACAD group of students (male and female) reduce the performance gap considerably by previously attending a computer science course teaching traditional literacy.

Table 4. Observed Values for the Different Gender Groups

	MEDACAD		LOWACAD	
	MALE	FEMALE	MALE	FEMALE
Mean GPA	-2.667	2.726	2.260	2.327
Mean HRS	66.839	72.519	67.992	68.453
S. Dev. HRS	27.708	22.136	19.389	18.567
Num. of obs.	61	21	65	17

Table 5. Estimated Performance Level by Each Academic Ability Group[1]

DEPENDENT	NO CRBASIC		WITH CRBASIC	
VARIABLE	MEDACAD	LOWACAD	MEDACAD	LOWACAD
		FEMALE		
GPMICRO	2.536	1.988	3.788	2.528
CLASS	76.198	72.663	82.287	76.379
LAB	71.082	62.585	80.394	69.064
		MALE		
GPMICRO	2.243	2.039	2.800	2.286
CLASS	72.159	71.024	77.122	70.599
LAB	71.411	67.904	77.811	75.039

[1] These values have been predicted by using the observed mean values found in Table 4 and the multiple regression equations from Table 3.

Overall then, both LOWACAD males and females close the performance gap almost perfectly by previously acquiring traditional computer literacy. While women of the LOWACAD group with a computer science course outperform MEDACAD women without such a course in the CLASS portion of the microcomputer class, LOWACAD males with the course outperform MEDACAD males without in the LAB portion. The results demonstrate that academically weaker participants gain from additional computer exposure previously acquired in a course teaching traditional computer literacy. The effects on their microcomputer performance, however, *are different* based on their gender and academic ability.

Effort and Performance

One issue remaining is whether performance differences between MEDACAD (CRBASIC = no) and LOWACAD (CRBASIC = yes) students can be reduced by increasing time spent using the microcomputer (Question 3). The last column of Table 6 indicates that for female students in the LOWACAD group no real adjustment in learning behaviour (i.e., time spent) is required to equate themselves with the MEDACAD females.

The results are quite different for male students. Even having previously attended a computer science course teaching traditional literacy, male LOWACAD students must still significantly adjust their behavior to equate themselves with the male MEDACAD group. For the CLASS portion, an additional 82 hours is required to do so. For the LAB portion, however, 54 additional hours are needed for the LOWACAD students who previously attended a computer science course to equal their performance with the MEDACAD students. The results suggest that question 3 can be answered positively. Once again, however, effects are different according to gender. Additional exposure attained previously in a course teaching traditional computer literacy results in LOWACAD women having to invest less time than their male peers to attain the MEDACAD competency levels of their peers of the same sex.

The results in Table 6 also demonstrate that the additional exposure gained by acquiring traditional computer literacy beforehand may not be worth the effort. It is obvious that both female and male students of the LOWACAD group may be better off spending more time using microcomputers instead of

Table 6. Additional Time Required by Academically Less Able Students to Equate within the Student's Gender with Those More Able[1]

DEPENDENT VARIABLE	LOWACAD = MEDACAD		LOWACAD = LOWACAD		LOWACAD = MEDACAD	
CRBASIC	NO	NO	NO	YES	YES	NO
			FEMALE STUDENTS			
GPMICRO	22*		22*		0	
CLASS	35*		36*		2	
LAB	17*		13*		4	
			MALE STUDENTS			
GPMICRO	20*		25*		22*	
CLASS	60*		22*		82*	
LAB	13*		27*		54*	

NOTE: The estimated additional time required to equate groups underlined numbers is in terms of the second group's time, since the former group had a higher estimated performance. All other estimates are in terms of the first group's time required to equate themselves with the later group.

[1] Estimated coefficients for time (HRS) from Table 2.

* $p < .05$. A two tailed t-test was used to determine whether or not additional time required according to gender group would place the student outside the 95% confidence interval for the originally observed time spent on microcomputers (by the gender group). For instance, the mean value of time spent in the lab for LOWACAD female students was 68.453 hours with a standard deviation of 18.567. Thus, an additional 17 hours would be required for LOWACAD female students to equate themselves with their female MEDACAD peers in the LAB portion of this course (assuming that neither has received credit for the computing science course). This would imply a total time commitment of 85.5 hours (68.453 + 17) for these LOW-ACAD female students, which is outside a 95% confidence interval of the originally observed mean (68.453). Consequently, an adjustment in both time and student behavior is required to equate the two academic ability groups.

attending a course teaching traditional computer literacy. The data also illustrate that, most importantly, the time effort needed by LOWACAD women to close the performance to their peers in the microcomputer course is lower than for men if the women did not have this previous computer exposure in a computer science course.

The Mann-Whitney test performed in this study indicated that male and female participants had different course grade distributions based on their GPA's. The results also suggest, however, that female and male students perform similarly in the course teaching microcomputer skills. Even though final performance assessment in the course may not indicate differences, the results indicate that females and males perform differently in the various sections of the course. It should also be noted that, in general, females outperformed males in the microcomputer course.

DISCUSSION

The primary purpose of this study was to examine if the performance of individuals with less academic ability in a microcomputer course would be affected

Table 7. Effects on Previously Attending a Course Teaching Traditional Computer Literacv on an Individual's Performance in the Microcomputer Course: A Summary

EFFECTS ON PREVIOUSLY ATTENDING A COURSE TEACHING TRADITIONAL COMPUTER LITERACY ON AN INDIVIDUAL'S PERFORMANCE IN THE MICRO-COMPUTER COURSE: A SUMMARY

ABILITY GROUP	FEMALES	MALES
MEDACAD		
Overall Performance	+	+
Class	--	+
Lab	--	+
LOWACAD		
Overall Performance	--	--
Class	--	--
Lab	--	+

-- regression coefficients obtained were not statistically significant
\+ regression coefficients obtained were statistically significant

Table 8. Effects of Effort (Time) Put into Homework on an Individual's Performance in the Micro-computer course: A Summary

EFFECTS OF EFFORT (TIME) PUT INTO HOMEWORK ON AN INDIVIDUAL'S PERFORMANCE IN THE MICRO-COMPUTER COURSE: A SUMMARY

ABILITY GROUP	FEMALES	MALES
LOWACAD		
Overall Performance	+	+
Class	+	+?
Lab	+	+

Note. Regression coefficients obtained were higher for females than males, thereby indicating that their transfer of time into performance is more effective than for males.

\+ additional effort put into homework using the micro-computer increases student's competency level
? additional effort put into homework using the micro-computer is very substantial, raising questions about males' capability of closing the gap in a short time

by gender and previous computer exposure. This study also attempted to discover if time spent using a microcomputer in the course would affect the performance of male and female students differently.

Gender and Previous Computer Exposure

Campbell and McCabe (1984) found that women and men majoring in computer science did equally well in their first year at university. The authors, however, argued that women choosing such a major may represent a group of individuals with different characteristics than their peers. Some research would confirm this notion, since females are usually noted to be less interested in computers than males during high school (Lockheed, Nielsen, and Stone 1985).

In relationship to the above studies, the current data would suggest that females who have taken a computer science course previously are more interested in computers than their female peers. The results in Table 5, however, also indicate that their performance increases more than that of their male peers. The results, most importantly, demonstrate that LOWACAD females gain more than LOWACAD males. The effects for females, however, are not always statistically significant (see Table 7). Additionally, females who have acquired traditional computer literacy previously tend to do better if the computer application problems are formulated verbally (Anderson 1987). Females could, therefore, improve the gap by having learned more in the previous computer science course and thus start the microcomputer course with an advantage. Also, by previously successfully finishing a computer course, females have moved beyond the traditional stereotyping which assumes that women are not technically inclined and know little about computers (e.g., Campbell and McCabe 1984; Lockheed, Nielsen, and Stone 1985). This, in turn, may have resulted in females having higher self-esteem and expectancy going into the microcomputer course, thereby improving their achievement potential (Eden and Ravid 1982; Robison-Awana, Kehle and Jenson 1986). Further research is needed, however, before this relationship can be identified.

The results of this study showed that, overall, MEDACAD males gain in all parts of the microcomputer course from previous computer exposure when attending a class teaching traditional compute literacy, while MEDACAD women benefit statistically significantly only for the overall course grade. LOWACAD males benefit in the LAB portion only, while LOWACAD females did not benefit statistically significantly in any portion.

The results would suggest, therefore, that acquiring traditional computer literacy *does* decrease the time requirements for learning microcomputer skills substantially for MEDACAD individuals. For LOWACAD individuals of both sexes though, time savings cannot be realized. This supports Gettinger's (1985) argument that less able individuals need more time to acquire the competency level. Limited access to computers is, therefore, detrimental to the learning process (Bikson and Gutek 1983).

Effort Put Into Homework and Performance Outcomes For Both Sexes

The study also explored relationships between time spent doing homework and performance in the microcomputer course. Results showed that additional time spent on homework increases performance for lower achieving students of either sex, which is supported by other research in education (e.g., Keith 1982; Gettinger 1985).

With regard to the sections of the course, however, it is important to note that males could not close the performance gap to their more academically able peers in the CLASS portion of the course unless a substantial additional time commitment was made. One explanation for this could be that males use different study techniques for the lecture portion of the course than females. Another, just as plausible, explanation is that lower achieving males have more difficulty with abstract topics than with the hands-on portion of this course.

The major issue raised with this data is that females seem to be more efficient in using their time working with the microcomputer. One explanation could be that females represent a minority in this course/sample. In having to break sex-role stereotypes, and by having already achieved a certain success level, females may expect more of themselves and may push themselves harder (Eden and Ravid 1982; Vollmer 1986). Another explanation could be that LOWACAD females gain a higher level of self-esteem than their female peers do based on their past achievement in the computer science course and, therefore, they may do better in all areas of the microcomputer course (e.g., Johnson, Johnson and Stanne 1986; Robison-Awana, Kehle, and Jenson 1986). Future research is needed which specifically addresses these issues.

Summary and Conclusion

Perhaps the most astonishing results in this study are the findings about female performance which contradict previous research. Earlier research found that females achieve lower levels of computer literacy than do males. This study found the opposite. Reasons for these contradictory results may include the different measurement methods and subjects enlisted. Lockheed, Nielsen and Stone (1985) used high school students, while this study involved post-secondary students with substantial work experience. Perhaps of greater importance, however, is that this study assessed computer literacy by testing the student's actual performance level using microcomputers, while most other studies employ self-assessing surveys (e.g., Lockheed, Nielsen and Stone 1985; Reece and Owen 1985).

In summary, this study found that the overall performance of females did not differ from that of their male colleagues in a course teaching microcomputer literacy. The results indicate, however, that LOWACAD females gain more from additional computer experience than men, thereby reducing the performance gap to the MEDACAD females. The inability of men to close their performance gap to their MEDACAD peers in the CLASS portion of the course raises another question: What else must be done to eliminate this gap? The study does not claim that traditional computer literacy might help the learning process when acquiring microcomputer literacy. The data suggest, instead, that while additional exposure attained in a computer science course previously attended helps men to improve their microcomputer competency level, investing more time in homework and thereby increasing exposure to the equipment helps weaker students of *both sexes* perform better.

The study also presents data which illustrate that females may be better off if they have not taken a computer science course previously. Instead, additional effort put into the microcomputer course by spending more time with the equipment is more beneficial for females. The overall time savings are significant since women have to spend less additional hours in the microcomputer course to increase their competency to the level of their female peers. A computer science course would, however, require the female student to spend another 70 hours working on the computer and studying in order to pass. Not taking a previous course, therefore, results in a *net gain of study time* for female students.

IMPLICATIONS FOR MANAGERS AND FUTURE MANAGERS

The most important result of this study is that the past academic achievement and computer exposure factors differ according to gender. Furthermore, the study confirms other results which suggested that less academically able females with additional exposure to computers appear to do better than their male peers in closing the performance gap to more able females (e.g., Gattiker 1987). The data also reveal that additional exposure to microcomputers, by either having previously attended a computer science course or increasing one's time spent on homework using the microcomputer, improves the performance of both males and females; however, females seem to outperform males.

Theoretical Implications

These results have several important implications for research on computer training in educational and organizational settings. Foremost, gender differences reported here and elsewhere need to be explored further. For example, the present study focused on computer literacy but not on the learning process itself; yet many individuals use different learning styles for educational tasks to achieve their highest performance levels (e.g., Snow 1986). Further research is needed to identify which learning styles and techniques are used by groups of individuals, and how gender differences relate to those styles.

In addition, this study did not evaluate if one group spent more time learning particular skills for microcomputers than the others. It would be interesting to see if learning the intricacies of the different software packages, such as word processing, database management and spreadsheets, have different effects on performance when acquiring computer literacy.

A further research issue raised with the data reported here is that men in the LOWACAD group outperformed their peers in the LAB portion of this course, if they had previously acquired traditional computer literacy. At this time, it should be explored in exactly which areas these individuals outperformed their peers. For example, did previous attendance of a computer science course aid their performance with job-like assignments or computer use under time constraints? Each case indicates future strategies for research investigating these phenomena to increase our knowledge about learning processes and their impact upon the acquisition of computer literacy.

Practical Implications

The results of this study suggest a variety of insights for training computer end-users. The most important result reported in this study is that academically lower achieving females can close the performance gap to their higher achieving peers, while men fail to do so in the conceptual portion of the course. This is important for managers trying to train employees to achieve the computer competency level required to do their computer-mediated work. The most important conclusion for managers is that, when hiring employees with limited computer knowledge, *women may be easier to train than men.*

Practitioners may perceive as one limitation of this study's results that it was done in a university setting. However, organizational research has shown that employees prefer computer training to take place away from their workplace. Training in a class-like setting leads to greater end-user satisfaction as well as increased application of the technology in the performance of work (Bikson and Gutek 1983).

This study indicates that training groups should be further differentiated. Since employees with less academic ability require additional time to acquire computer skills, a longer training period is recommended, allowing them to spend more time gaining new skills. Moreover, unlimited access to the equipment in order to practice skills is important for lower achieving individuals, so that they can attain the computer literacy level required for their jobs. Future research in this area should recommend additional ways for managers and educators to facilitate the computer training of today's workforce most effectively, benefitting employees and organizations alike.

ACKNOWLEDGMENTS

I would like to thank Cynthia Cunningham and Valorie Hoye for their help in preparing this manuscript and Julie Ellis for her helpful comments made on an earlier draft of this paper. My thanks also to Richard Williams for his help with entering and analyzing the data. Dan Paulson and Larry Merkley were instrumental in getting this project off the ground. Financial support for this research project was provided, in part, by a grant from the Alberta Manpower Post Secondary Training Program, and the Priority Employment Program, Contract No. 083080 as well as the Social Sciences Research Council of Canada, Contract No. 492-85-1022. The views expressed in this paper are the author's own and are not necessarily shared by these organizations. Please address all questions and comments to: Urs E. Gattiker, Technology Research Group, School of Management, University of Lethbridge, Lethbridge, Alberta, T1K 3M4, CANADA.

ENDNOTES

[1] Computer literacy for microcomputers requires the individual to have certain skills, such as the ability to use software packages for various applications (e.g., word processing, spreadsheets, database management and graphics). Therefore, in this paper, microcomputer literacy is considered synonymous with certain skills.

[2] Traditional computer literacy requires that an individual has interactive skills applicable to mainframe computers, such as knowledge of a programming language like Basic, sequential files, algorithms, programs, flowcharts, and the ability to find solutions to elementary numeric problems with computers. In this study, it is assumed that if a student has previously attended a computer science course, he/she has acquired the above skills as outlined in the course description.

REFERENCES

Anderson, R. E. "Females Surpass Males in Computer Problem Solving: Findings from the Minnesota Computer Literacy Assessment." *Journal of Educational Computing Research*, Vol. 3, 1987, pp. 39-51.

Biggs, J. B., and Kirby, J. R. "Differentiation of Learning Processes within Ability Groups." *Educational Psychology*, Vol. 4, 1984, pp. 21-40.

Bikson, T. K., and Gutek, B. A. *Training in Automated Offices: An Empirical Study of Design and Methods.* (Report No. WD-1904-RC). Santa Monica, CA: The Rand Corporation, 1983.

Bjørn-Andersen, N. "The Changing Roles of Secretaries and Clerks." In H. J. Otway and M. Peltu (eds.), *New Office Technology,* Ablex Publishing, Norwood, NJ, 1983, pp. 120-137.

Blalock, H. M. *Basic Dilemmas in the Social Sciences.* Sage Publications, Beverly Hills, CA, 1984.

Campbell, P. F., and McCabe, G. P. "Predicting the Success of Freshmen in a Computer Science Major." *Communications of the ACM,* Vol. 27, 1984, pp. 1108-1113.

Eden, D., and Ravid, G. "Pygmalion versus Self-Expectancy: Effects of Instructor-and Self-Expectancy on Trainee Performance." *Organizational Behaviour and Human Performance,* Vol. 30, 1982, pp. 351-364.

Ethington, C. A., and Wolfle, L. M. "A Structural Model of Mathematics Achievement for Men and Women." *American Educational Research Journal,* Vol. 23, 1986, pp. 65-75.

Frese, M.; Albrecht, K.; Altmann, A.; Lang, J.; Papstein, P.; Peyerl, R.; Pruemper, J.; Schulte-Goecking, H.; Wankmueller, I.; and Wendel, R. "The Effects of an Active Development of the Mental Model in a Training Process: Experimental Results on a Word Processing System." Working Paper, Ludwig-Maximilians-Universitaet, Munich, 1987.

Gattiker, U. E. "Teaching Microcomputer Skills to Post-Secondary Students: How Does Gender and Level of Giftedness Affect One's Learning Performance?" Paper to be presented at the Giftedness of Girls and Women Conference, Lethbridge, Canada, May 1987.

Gattiker, U. E., and Paulson, D. "Testing for Effective Teaching Methods: Achieving Computer Literacy for End-Users." *INFOR (Information Systems and Operations Research),* Vol. 25, 1987, pp. 256-272.

Gettinger, M. "Time Allocated and Time Spent Relative to Time Needed for Learning as Determinants of Achievement." *Journal of Educational Psychology,* Vol. 77, 1985, pp. 3-11.

Hebenstreit, J. "Computers in Education: The Next Step." *Education and Computing,* Vol. 1, 1985, pp. 37-44.

Johnson, R. T.; Johnson, D. W.; and Stanne, M. B. "Comparison of Computer-Assisted Cooperative, Competitive, and Individualistic Learning." *American Educational Research Journal,* Vol. 23, 1986, pp. 382-393.

Jones, J. W., and Lavelli, M. A. "Essential Computing Skills Needed by Psychology Students Seeking Careers in Business." *Journal of Business and Psychology,* Vol. 1, 1986, pp. 163-167.

Kamenta, J. *Elements of Econometrics.* The Macmillan Company, New York, 1971.

Keith, T. Z. "Time Spent on Homework and High School Grades: A Large-Sample Path Analysis." *Journal of Educational Psychology,* Vol. 74, 1982, pp. 248-253.

Lepper, M. R. "Microcomputers in Education." *American Psychologist,* Vol. 40, 1985, pp. 1-18.

Lockheed, M. E.; Nielsen, A.; and Stone, M. K. "Determinants of Microcomputer Literacy in High School Students." *Journal of Educational Computing Research,* Vol. 1, 1985, pp. 81-96.

Menashian, L. S. "Training the Office Worker." In K. T. Quinn (ed.), *Advances in Office Automation,* Vol. 1, John Wiley and Sons, Chichester, Great Britain, 1985, pp. 161-189.

Natriello, G., and McDill, E. L. "Performance Standards, Student Effort on Homework, and Academic Achievement." *Sociology of Education,* Vol. 59, 1986, pp. 18-31.

Reece, M. J., and Owen, S. V. "Bloom Revisited: A School Learning Model of Computer Literacy." *Journal of Educational Computing Research,* Vol. 1, 1985, pp. 23-35.

Robison-Awana, P.; Kehle, T. J.; and Jenson, W. R. "But What About Smart Girls: Adolescent Self-Esteem and Sex Role Perceptions as a Function of Academic Achievement." *Journal of Educational Psychology,* Vol. 78, 1986, pp. 179-183.

Siegel, S. *Non-Parametric Statistics for the Behavioral Sciences.* McGraw-Hill, New York, 1956.

Snow, R. E. "Individual Differences and the Design of Educational Programs." *American Psychologist,* Vol. 41, 1986, pp. 1029-1039.

Stanley, J. C. "Manipulate Important Educational Variables." *Educational Psychologist,* Vol. 19, 1980, pp. 164-171.

Vollmer, F. "Why Do Men Have Higher Expectancy than Women?" *Sex Roles,* Vol. 14, 1986, pp. 351-362.