DOCUMENT RESUME

ED 258 554 IR 011 709

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TITLE School Computing: Some Factors Affecting Student Performance.
PUB DATE 1 Apr 85
NOTE 14p.; Paper presented at the Annual Meeting of the American Educational Research Association (Chicago, IL March 31-April 4, 1985).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150) -- Tests/Evaluation Instruments (160)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Computer Literacy; Family Environment; Intermediate Grades; Junior High Schools; *Mathematics Anxiety; Microcomputers; Programing; *Sex Differences; *Student Attitudes; Teaching Methods
IDENTIFIERS BASIC Programing Language; *Computer Anxiety

ABSTRACT

This study addresses three questions: (1) whether sex is related to ability and interest in computers; (2) whether a relationship exists between the presence of a computer in the home and a child's ability and interest in computing; and (3) the combination of factors that account for students' perceptions of success in developing programming ability. To investigate these questions, a study was conducted in a central Iowa school district using 380 students in grades 6, 7, and 8. A computer laboratory consisting of 29 microcomputers was used, and class size was limited to 28. The instruction centered on programming in the BASIC language, and additional instructional objectives related to keyboarding skill development, computer operation, and societal impact of computers were included. A survey was administered to all participating students after they had completed the course. An analysis of this data revealed (1) girls were somewhat less likely than boys to express confidence in working with a computer prior to the class, but instruction diminished their fears; (2) having a home computer improved confidence in programming ability in both boys and girls; and (3) the differences between the "have" and "have not" students was reduced after instruction. Also included is the attitude survey used in the computer literacy class. (JB)

SCHOOL COMPUTING: SOME FACTORS AFFECTING STUDENT PERFORMANCE

Roger P. Johanson

Microcomputers are rapidly making their way into our schools. At the same time, the ill-defined subject, computer literacy, appears to be on its way to becoming a standard part of the elementary and middle school/junior high curriculum. The pace of this change suggests that there is a strong potential for error in instructional and policy planning. It is hoped that the accumulating body of research on school computer instruction, including the present study, may serve to guide such planning.

A distinction is made here between teaching WITH the computer and teaching ABOUT the computer. The discussion which follows is primarily limited to the latter. We deal here with instruction which has as a primary aim the increase of knowledge about computing rather than some other content for which the computer is used as an instructional tool. Specifically, the following research questions are central to this study:

1) Is there a relationship between the presence of a computer in a child's home and pre- or post-instructional computing ability and attitudes toward computers?
2) Is sex related to pre- or post-instructional computing ability and attitudes toward computers?

Paper presented to the American Educational Research Association Annual Meeting, Chicago, April 1, 1985

3) What combination of these and other factors best accounts for students' perceptions of success in developing programming ability?

The related issues of mathematics anxiety and sex-differences in mathematics have received much attention in recent years. In part because of the public perception and the school reality that computing and mathematics are closely allied disciplines, many of the issues raised have also been taken up in the study of educational computing. Thus we have a growing body of literature addressing sex-equity in computer access, use, abilities and attitudes. (See for example, Lockheed and Frankt, 1984; Naiman, 1982; Sanders, 1984; Schubert, 1984; and Stalker, 1983.) Several studies of school uses of microcomputers have encompassed factors other than sex in an attempt to describe present practice (Becker, 1982), or to account for attitudes (Loyd, 1984) or computer literacy in high school students (Lockheed, et al., 1983). The present study builds on those cited using a population of 380 middle school students within the context of a district-wide computer literacy program.

PARTICIPANTS

Students at the middle school in a central Iowa school district served as participants in the present study. The district

consists of a mix of suburban and rural families. All students in grades four through eight were included in a program to teach computer literacy. The study was conducted during the first year of the program, so that none of the students had received previous formal instruction in computer literacy. 380 students in grades six, seven and eight were included in the analysis. Fourth and fifth grade students were not included because their instructional program was different.

FACILITIES

A computer laboratory consisting of 29 Radio Shack Model 4 microcomputers was used. The computers were assembled in a single classroom using a network to allow demonstration programs to be sent to each student's computer. Student access to the master computer's disk drives was limited in this arrangement. As a consequence, student work did not involve saving or loading programs. The lab is located in a central elementary school building which serves three elementary schools as well as the middle school. Students from the middle school were bussed approximately one half mile to attend the classes. Class sizes were limited to twenty-eight to allow a one-to-one student-to-computer ratio.

INSTRUCTIONAL PROGRAM

Each sixth and seventh grade student received ten ninety-minute lessons in the lab. These were scheduled on consecutive school

days so that in general, two weeks of classes were used. In order to schedule the computer instruction, it was necessary for students to miss two regular classes from their daily program each day for the two weeks invclved. Eighth grade students' schedules were similar except that they received fifteen lessons over a three-week period. Total instructional time then was approximately 15 hours for sixth and seventh grade students, and 22 hours for eighth grade students.

The instruction centered on programming in the BASIC language. Additional instructional objectives related to keyboarding skill development, computer operation, societal impact of computers, history of computers, and terminology were also included, though not emphasized. All students worked on the following topics/projects: immediate, program and edit modes; punctuation and syntax; low-resolution graphics; arithmetic in BASIC; loop structures; computer memory; binary numeration; and simple animation. The third week of instruction for eighth graders added the concepts of subroutines, algorithms, data, flowcharting, and an introduction to word processing.

THE RESEARCH STUDY

Data and findings reported here are the results of a survey administered to all participating students after they had completed their computer literacy instruction. The survey questionnaire used is included as Appendix A. Findings may be

viewed as preliminary; subsequent data collection and analysis from the second year of the program's implementation is now in progress. Because of instructional program limitations, it was necessary to use student self-assessment of learning rather than a more direct measure of actual computer knowledge.

A brief discussion of the variable names used will facilitate the discussion of the findings. Table 1 below lists each of these.

Table 1
Variable names used in discussing results

Variable name	questionnaire item number	comments
Sex	2	
Home	3	existence of a computer at home
Program0	4	self assessment of initial programming ability
Concern0	5	initial concern about using a computer
Program1	6	self assessment of programming ability after instruction
Enjoy	7	enjoyment of computer class
Learn	8	self assessment of learning from the class
Interrupt	10	did student feel the class was an interruption to the regular school schedule?
Continue	11	desire to continue computer instruction
Comfort1	12	post-instructional assessment of comfort at working with a computer

Findings are summarized below within the broad categories of the initial questions listed above. Primary analysis is correlational, however since some items have response options which may not be best categorized as a forming a pure

continuous variable, chi-square contingengy table analysis was also performed. Furthermore, some recategorization of the variables was done in an attempt to make the analysis more sensitive to possible existing relationships. These results are included only if they differ from or add to the correlational findings.

EFFECTS OF A HOME COMPUTER: Of the 380 participants, 119 (about 31%) reported having a computer at home. (This is considerably higher than most reports of the national average. However, this large percentage makes assessment of the effects considerably easier.) Correlations between this variable and others in the study are summarized in Table 2. Several relationships are of particular interest. There was a significant relationship between having a home computer and both pre- and post-instructional self-assessed programming ability. While the post-instructional correlation is considerably smaller than the pre-instructional correlation, it is apparent that 15 hours of instruction is insufficient to eliminate the home computer as a factor influencing programming ability. No other variables were found to be significantly correlated with having a home computer. However, chi-square analysis suggests that there is a significant relationship between students' post-instructional sense of comfort in working with a computer and having a home computer (chi-square=9.913, df=2, $p<.01$). A recoding of the data yields

Table 2
Correlations between having a home computer and other variables

	correlation of Home and:		
Sex	.036	Program0	.510 *
Concern0	-.090	Program1	.207 *
Enjoy	.034	Learn	-.033
Interrupt	-.061	Continue	.066
Comfort1	.083		

* p<.01

very similar results (chi-square=6.576, df=1, p<.01) but makes interpretation somewhat easier. In the recoding, students who were unsure of feeling comfortable were combined with those who said they were not comfortable using a computer. Students who had home computers then were more likely to express comfort at using the computer than students who did not have home computers, even after 15 hours of on-computer instruction.

EFFECTS OF SEX: As previously noted, approximately equal proportions of boys and girls reported having a home computer. While several variables were significantly correlated with sex, none of the correlations can be considered high (see Table 3). The significant correlations suggest that girls were somewhat less likely than boys to feel they could program before instruction, somewhat less likely than boys to express enjoyment at working with a computer, and somewhat more likely to express concern at working with a computer prior to instruction. The generally low correlations seem to indicate that, at least after a computer literacy course required of all

Table 3

Correlations between sex and other variables studied.

	correlation of sex and:			
Program0	.107	*	Concern0	.102 *
Program1	.070		Enjoy	.104 *
Learn	.100		Interrupt	-.026
Continue	.086		Comfort1	.009

* p<.05

students, sex is not a major variable in determining computer attitudes. It should be noted that correlations between sex and post-instructional programming, and sex and post-instructional comfort with computers were both non-significant. Thus initial differences in these areas appear to have been affected by the instruction.

Contingency table analysis of the relation of sex to other studied variables yielded some ambiguous statistically significant results which deserve further attention. Sex was found to be related to enjoyment of computer class (chi-square= 11.39, df=2, p<.01) and to self-assessment of learning (chi-square=14.035, df=3, p<.01). Lower than expected numbers of girls reported both extremes of the responses - not enjoying AND enjoying the class. That is, they tended to have a higher frequency of responding in the middle of the enjoyment continuum. Since only 8% of all students reported not enjoying the class, it may be reasonable to exclude these responses in the analysis. If this is done, a more clear pattern emerges in which girls are less likely than boys to express strong enjoyment of computer classes.

A similar pattern exists when relating self-assessment of learning to sex. Girls' responses cluster in the middle; they tended to be less likely to feel they had learned either "a great deal" or "nothing." Preliminary analysis of actual achievement as measured by a post-test of students in the second year of instruction shows no significant difference based on gender. If so, then the findings of this particular analysis relate primarily to gender-related attitude differences rather than differences in actual ability.

FACTORS AFFECTING PROGRAMMING ABILITY: Multiple regressions were performed using self-assessed pre- and post-instructional programming ability as dependent variables in an attempt to determine the relative influence of the factors studied on these two variables. For pre-instructional programming, both sex and having a home computer were significant contributors to the regression equation (Program0 = .357 +.785 Home +.129 Sex). Of the two variables, having a computer in the home accounted for much more of the variance than sex.

Using self-assessed post-instructional programming ability as the dependent variable yielded a rather different picture. Neither sex nor having a home computer contributed significantly to the regression equation (Program1 = 1.25 + .228 Program0 -.193 Interrupt + .165 Enjoy). The primary reason for the shift appears to be that pre-instructional programming ability is the most significant factor in

predicting post-instructional programming ability, and, when it is held constant, the effects of sex and home computers are no longer significant. The second significant factor in the equation, the feeling that computer class is interrupting the regular schedule, is very interesting. The negative weight indicates that the sense of interruption some students felt was related to lower programming ability. The third factor, enjoyment of computer class, is consistent with the large body of research relating positive affect to learning.

DISCUSSION

The relatively small relationships found between sex and the factors related to computer use studied are encouraging, for they suggest that differences between boys and girls are slight. It is possible that the required program for all students reduces any differences which may have existed. The finding is consistent with those of Becker's (1982) national survey which found that computer lab arrangements promoted more equitable access to computers.

While some relationship between having a computer in the home and computers attitudes and ability was found, the differences between "have" and "have not" students was reduced after instruction. Consistent with popularly reported studies on home computer use, students and parents interviewed indicated that home computers were generally used very little except for games. It seems quite possible that the effect of

having a computer in the home may acutally be important primarily as an indicator of socio-economic status which is known to correlate with school achievement. To reduce any potential negative effect of not having a home computer, schools can provide additional access to computers. The school in which this study was performed has done this by installing a smaller computer lab in the middle school building which is open to students during their "free time" within the school day.

Finally, the attitudes of students regarding the intrusion of the computer into the school is a potentially important and as yet unreported variable. The addition of any content into the curriculum necessitates concomitant deletions from the curriculum. In the arrangement used in the school studied, students were "pulled out" of two regular classes for two or three weeks. Some students saw this as a significant interruption to their regular classes. This sense of interruption was negatively correlated with post-instructional programming ability ($r = -.296$, $p < .01$), with their enjoyment of computer class ($r = -.302$, $p < .01$), with self-assessed learning ($r = -.254$, $p < .01$) and with students' interest in continuing computer instruction. While other arrangements such as a full marking period in which a single class in devoted to computer study may be superior, it will always be necessary to cut something else out. The result may well be a feeling of interruption of the natural order and a resultant negative

effect on the outcomes of the instruction. Administrators should take steps to reduce this appearance that computer instruction is interfering with regular classes.

Additional study is in progress to verify the findings reported here. The information accumulating from this and other studies offers guidance to those planning instruction in computer literacy while trying to promote equitable access to this important new technology.

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APPENDIX A
COMPUTER CLASS -- ATTITUDE SURVEY

Please answer the following questions concerning the computer literacy class you took at East Elementary School. THANK YOU.

CIRCLE YOUR ANSWERS

1. GRADE: 4 5 6 7 8

2. SEX: FEMALE MALE

3. DO YOU HAVE A COMPUTER AT HOME? NO YES

4. DID YOU KNOW HOW TO PROGRAM A COMPUTER BEFORE TAKING THIS CLASS?

NO A LITTLE YES, FAIRLY WELL

5. WERE YOU CONCERNED ABOUT USING A COMPUTER BEFORE TAKING YOUR COMPUTER CLASS? (WERE YOU AT ALL WORRIED ABOUT WORKING WITH A COMPUTER?)

NO NOT SURE YES

6. DO YOU FEEL THAT YOU CAN PROGRAM A COMPUTER NOW?

NO A LITTLE YES, FAIRLY WELL

7. DID YOU ENJOY THE COMPUTER LITERACY CLASS?

NO IT WAS OK YES, I ENJOYED IT

8. HOW MUCH DO YOU FEEL YOU LEARNED FROM THE CLASS?

NOTHING VERY LITTLE QUITE A BIT A GREAT DEAL

9. HOW MUCH TIME DO YOU THINK THERE SHOULD BE FOR COMPUTER CLASSES?

NONE	LESS THAN WE HAD	THE AMOUNT WE HAD WAS GOOD	THERE SHOULD BE MORE TIME THAN WE HAD

10. DO YOU FEEL THAT GOING TO COMPUTER CLASS INTERRUPTED YOUR REGULAR CLASS? (DID IT CAUSE PROBLEMS FOR YOU WITH THE CLASSES YOU MISSED?)

NO A LITTLE YES, QUITE A BIT

11. DO YOU WANT TO HAVE COMPUTER CLASS AGAIN NEXT YEAR?

NO DON'T CARE YES

12. DO YOU FEEL COMFORTABLE WORKING WITH A COMPUTER NOW?

NO NOT SURE YES