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COMPUTER USE BY SCHOOL-AGE CHILDREN: TRENDS, PATTERNS, AND PREDICTORS*

BRUCE ROCHELEAU
Northern Illinois University

ABSTRACT

Patterns of computer use are studied based on analysis of data from the Longitudinal Study of American Youth (LSAY) in which a cohort of students and their parents were surveyed for five consecutive years. Special attention is given to students who were heavier users of computers. Heavier use is associated with high SES as well as superiority in grades. Heavier use declined as this cohort progressed from the seventh grade to high school despite increasing access to computers at home. Parents with computers at home reported that their children used computers mostly for educational purposes. Males were significantly more likely to be heavier users until the 1992 survey when the gap with females narrowed. A substantial proportion but less than half (42%) of heavier users remained more frequent users from 1988 to 1992. Analysis suggests that computer ownership and parental interest in their children using computers exerted the biggest impacts on the likelihood of being a heavier user.

The rapid proliferation of microcomputers in schools and the homes of school-age children has resulted in many studies exploring computer ownership and use by students. Many believe that students with better access to computers will have a substantial advantage in education, and that consequently there are serious issues of inequity concerning those with less access due to low income [1].

Much of the early research concentrated on ownership of computers, the implicit assumption being made that ownership would lead to use and ultimately to educational benefits. A review and meta-analytical study by Dutton, Rogers and Jun brought together the results of many studies of computer ownership and use [2]. They reported that variables positively associated with ownership included education and use of a computer at work. They found an association between early

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adoption of home computers and spending less time with tv and outdoor sports. Early home computer users also were more likely to spend time alone. But, Dutton, Rogers and Jun noted that only one of the studies reviewed was based on a national probability sample [2]. They pointed to a need for multivariate and longitudinal studies.

A 1989 Bureau of the Census report found that about 24 percent of children had a computer available at home in which 71 percent made use of it [3]. Serious racial/ethnic inequities were found with more than 26 percent of whites having a computer at home compared to only about 10 percent of blacks and Hispanics. The education of the head of the household was strongly associated with computer ownership: Nearly 50 percent (48.6) of those with four or more years of college owned a computer compared to less than four percent (3.6) of those with less than a high school education. Income too was important with more than half of those with over $75,000 owning computers compared to about 7 percent of those with less than $10,000 of income.

Becker and Sterling used a national probability sample to study use of computers in schools. They found that favorable student-computer ratios were more likely to occur in classes and schools with high concentrations of students with high socioeconomic (SES) status and superior ability. Ironically, they found that computer-using students in high use schools received less time for use of school computers due to competition for the resource. In another article, Becker reported that there were still not enough computers in schools in 1989 for simultaneous use by many students [4].

Our study concentrates on students who are more frequent users of computers. We believe that concentration on heavier users is theoretically important if we are to analyze the impacts of computing on education. McQuarrie and Iwamoto's research suggests that exposure has a cumulative effect leading toward more positive attitudes toward computers [5]. Our study complements those of Becker [1, 4, 6] in that we focus on use of computers at home and in-school use that is outside of classes. Also, in the above articles, Becker's data are based on interviews with teachers and principals and thus limited to making generalizations at the classroom and school level. Our data are drawn from interviews with individual students and their parents. Thus we can examine the impact of many potentially important individual characteristics of students, their parents, and the students' peers that have not yet been analyzed based on a national probability sample.

METHOD

This study draws from data collected in the National Science Foundation's Longitudinal Study of American Youth (LSAY). The focus of LSAY is students' attitudes toward science and mathematics [7]. The range of student variables is extensive. A two-stage stratified probability sample was used. Schools were

stratified on the basis of region and urban development. The sample included fifty-one schools; within each school, a random sample of sixty students per cohort was selected. Two cohorts were surveyed in the LSAY—seventh and tenth grade students during the 1987/88 academic year. The data reported here concern only Cohort 2, for example, 1987-88 seventh graders. These same students and their parents have been interviewed each year since the 1987-88 school year. Thus our research draws on five years of data.

Variables Potentially Influencing Student Computer Use

In studying the use of computers and their relationship to education, we investigated several variables that could influence computer use:

Parental Background Variables

The research cited previously suggests that parental background variables are important in encouraging computer ownership and use such as income, education, age, and use of computers at work:

1. Socioeconomic Status (SES): The LSAY did not ask parents directly about income. Instead a composite SES equally-weighted variable was constructed by considering parental education, occupational status, and a household possessions index.
2. Other parental background variables: Parents were questioned about whether they used a computer at work and whether they had a computer in their home, and parental age was also used since Dutton et al. report this as a significant variable in predicting computer ownership [2].

Parental Attitudinal and Interest Variables

There is much less research in the computer field concerning parental attitudes and their impact on children's use of computers. However, there is good reason to expect that parental attitudes are important. A recent qualitative account of the home ownership of a computer illustrates the importance that some parents attach to computers:

> . . . parents hoped the computer would somehow catalyze or induce positive attributes in their children, particularly those related to learning or greater appreciation of computing [8, p. 305].

Moreover, microcomputers are now inexpensive enough that parents with a wide range of incomes can afford them. If parents are strongly interested in their children's education and believe that microcomputers will make a difference, then it is quite possible that parents with modest incomes will purchase microcomputers. Also, we hypothesized that parents who are interested in science would be more likely to purchase computers as well as encourage their use by

their children. The LSAY contains many indicators of parental attitudes. In our study, we have included the following:

1. Parental educational expectations concerning the highest level of education they would like to see for their children. It was measured by an 8-point scale ranging from less than high school to doctorate.
2. Parental interest in science as measured by how frequently they talked about science/technology with their children. It used a three-point scale: often, sometimes, never.
3. Whether the parents were interested in their children learning computers. This information was a yes-no question.

Although these variables are moderately associated with SES (ranging from .13 for parents wanting their children to use computers to .34 for educational expectations), a preliminary analysis (not shown) of partial correlations showed that they remained significantly associated with heavier use of computers after controlling for SES.

Student-related Variables

There are several student variables potentially related to computer use that may be independent of parental influence that we included:

1. Gender of the Student: Gender has been found significant in many studies of computer attitudes and use, although some recent work has found fewer differences concerning females and males. For example, Reece, in a small scale sample, found parents as likely to provide home computers for daughters as sons and found no relationship between sex and computer use attitudes among elementary school children [9].
2. Student Attitude toward Science: Students may become fascinated with science independently of their parents. One question asked them if they enjoyed science (5-point scale ranging from strongly disagree to strongly agree concerning whether they like science).
3. Student Peer Relationships: Chen's work shows that a student's interest in science and computers may be sustained and strengthened if her/his peers have a similar interest [10]. One question asked if their friends liked science.
4. Student Personality: There has developed a stereotype about children who are frequent users of computers based on the popular media as well as qualitative accounts of such individuals [11, 12]. In particular, Turkle's research provides case studies of children who became intensive computer users due, in part she argues, as a method for coping with self-doubts [11]. Another study found that those most interested in computing were likely to have intellectual interests and be less drawn to activities like watching television [13]. Yet, until now, we know of no empirical study based on a

national probability sample that has explored personality factors that may encourage frequent usage. Consequently, we included a variable concerning whether the students were satisfied with themselves, to attempt to get at this dimension (5-point scale ranging from strongly agree to strongly disagree).

Computer Use Variables

Students were asked whether they used a computer for ten or more hours (other than in a class) during this school year. Thus we define a heavier user as a student who used the computer ten plus hours outside class during a school year. Although this usage may not seem "heavy" in an absolute sense, Becker's 1985 report found that only one student in fifty had more than an hour of time on a microcomputer in school during any given week [6]. Thus, in relative terms, ten or more hours outside class is significant and the only measure available concerning frequency of use of computers for all students—whether they have a computer at home. In addition, for those students with access to a home computer, we studied the number of hours that their parents reported that students used their home computers in general and for educational purposes specifically.

Educational Outcome and Other Variables

The LSAY includes yearly test scores for science and mathematical knowledge. It also asks questions concerning student grades in mathematics and English. We also studied variables such as the number of hours students watch tv and do homework since some research suggests that heavier users of computers are more intellectual and spend less time with tv [13].

Missing Data and Other Methodological Notes

Please note that in all cases where we have reported on trends, our sample consists of only those respondents who had no missing data for those years. Note that, since the study surveyed students and their parents over a five year period, many variables can be analyzed for several years. In certain tables following, due to limitations of space, we have chosen to present data drawn from interviews conducted during initial school year of the survey (1987-1988). In each case where we rely on only one year's data, we found similar results for other school years.

RESULTS

Computer Ownership: Rich Get Richer

Since computer ownership is expected to be such an important variable in explaining use, we begin by studying reports on ownership trends. In Figure 1, we show that there is, as we would expect, a slow but consistent trend toward

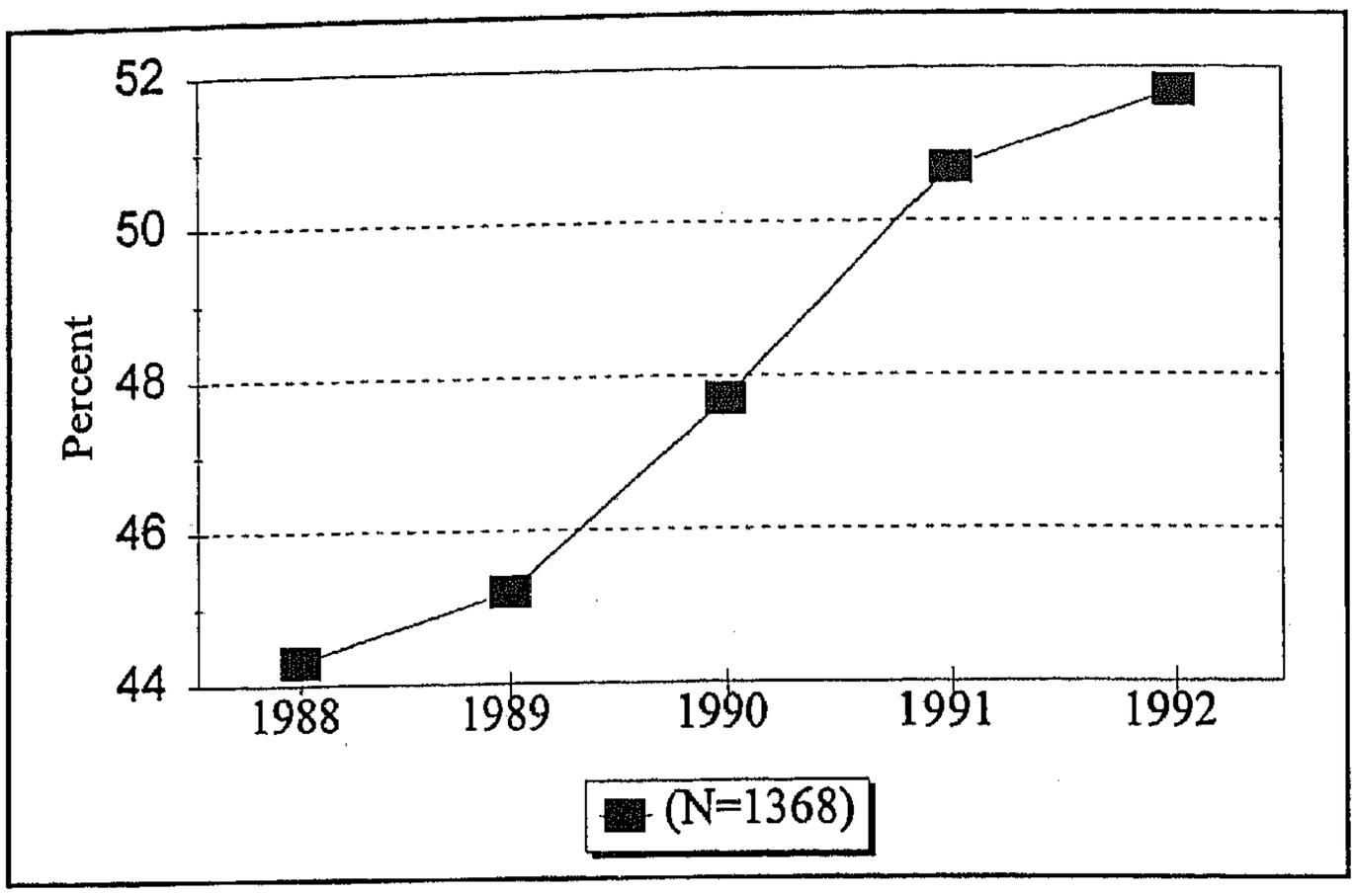

Figure 1. Percent students in homes with computers, 1988-1992.

ownership of computers, so that more than half the students lived in households with computers in 1992.

We conducted *t*-tests comparing students with and without computers at home. Students with computers at home consistently differed from the others on several variables (see Table 1). Computer-owner students reported better overall grades and also better grades in English and mathematics. However, the hours owners and nonowners spent on watching TV and doing homework did not differ significantly. These results emphasize the serious degree of inequity concerning computer ownership—those who are socioeconomically and educationally better off are much more likely to have a computer at home.

Heavier Computer Users: Capable and Confident

As noted previously, there are some stereotypes about students who are heavier users of computers that we wished to test. Consequently, we examined the differences between heavier users (i.e., those students who reported using the computer for ten or more hours unrelated to a class) and other students. However, since such students are likely to be members of families with computers at home and ownership is likely to be associated with several variables such as SES, we restricted the comparison to families with computer at home. Table 2 shows that the heavier computer users appear to excel consistently in various academic areas (better overall grades and grades in math and English), as well as in a test of

Table 1. *T*-Tests of Differences between Students with Computer at Home versus Those Without, 1987-1988

Variable	Group	Mean	2-Tail Probability	Degrees of Freedom
Socioeconomic status[a]	No computers	−.14	<.001	2479
	Computers	.30		
Hours on homework[b]	No computers	6.00	.15	2442
	Computers	6.40		
Average grades[c]	No computers	3.05	<.001	2377
	Computers	2.48		
English grades[c]	No computers	3.02	<.001	2043
	Computers	2.53		
Math grades[c]	No computers	2.81	<.001	2034
	Computers	2.47		
Parental educational expectations[d]	No computers	5.70	<.001	2421
	Computers	6.28		
Hours watching TV per week[b]	No computers	12.71	.24	2446
	Computers	12.02		

[a]Socioeconomic (SES) status is a composite variable based on parental educational, parental occupational status, and a household possessions index. It is measured as a z-score ranging from −2 (low SES) to +2 (high SES).
[b]This is the student's estimate for a typical week.
[c]All the grade variables are measured on a scale ranging from "Mostly A" (1) to "Mostly Less than D" (6).
[d]Based on response to question "What is the highest level of education you would like to see (student name) complete?" It ranges from 1 (less than high school) to 8 (doctorate).

scientific knowledge. Their friends are more likely to like science. They are more satisfied with themselves. However, there are no statistically significant differences concerning the groups in their number of hours of homework per week, and time spent watching tv. The general picture of the heavier user is a student who is proficient academically and self-confident but similar to other students in social activities. These comparisons are significant in that we are comparing them here only to other students who have computers in their homes and, as noted above, are themselves academically advantaged. This picture differs significantly from the stereotype that has developed of student hackers as ridden with self-doubt.

Heavier Usage Down

Figure 2 shows that the percentage of all students who use the computer ten plus hours per school year outside of class actually trended downward from about

Table 2. *T*-Tests of Differences between Students Who are Heavier Users of Computers versus Those Who Are Not (in Computer Owner Homes Only), 1987-1988[a]

Variable	Group	Mean	2-Tail Probability	Degrees of Freedom
Socioeconomic status[b]	Not heavy user	.22	<.001	928
	Heavier user	.38		
Hours on homework[c]	Not heavy user	6.06	.19	888
	Heavier user	6.57		
Math grades[d]	Not heavy user	2.67	<.001	793
	Heavier user	2.26		
Parents want students to use computer[e]	Not heavy user	.27	<.001	926
	Heavier user	.52		
Hours watching TV per week[c]	Not heavy user	11.93	.98	921
	Heavier user	11.91		
Friends like science[f]	Not heavy user	.24	<.01	926
	Heavier user	.33		
Satisfaction with self[g]	Not heavy user	2.21	<.05	888
	Heavier user	2.07		

[a]Heavier use is defined as using a computer 10+ hours for the school year other than in a class. Note that the differences between the figures in this table and Table 1 are due to exclusion of students with missing data on the heavier use question.
[b]Socioeconomic (SES) status is a composite variable based on parental educational, parental occupational status, and a household possessions index. It is measured as a z-score ranging from –2 (low SES) to +2 (high SES).
[c]This is the student's estimate for a typical week.
[d]All the grade variables are measured on a scale ranging from "Mostly A" (1) to "Mostly Less than D" (6).
[e]Based on response to statement, "My parents want me to use computers," (0 = No, 1 = Yes).
[f]This is based on student's response to statement, "My friends like science," (0 = No, 1 = Yes).
[g]This item is based on student's response to statement, "On the whole, I am satisfied with mysef," (1 = Strongly Agree, 6 = Strongly Disagree).

27 percent (Spring 1988) to about 19 percent (Spring 1991) with an uptick in the 1992 survey to about 26 percent. This finding is surprising in the sense that home computer ownership expanded during this period, thus creating new opportunities for access.

Students who are in love with computers but lack any at home, may find access to them during free time, after-school, at a friend's house. However, Figure 2 shows that computer ownership does have a big impact on the heavier use of a computer. When we look at just those students whose reported ownership of a

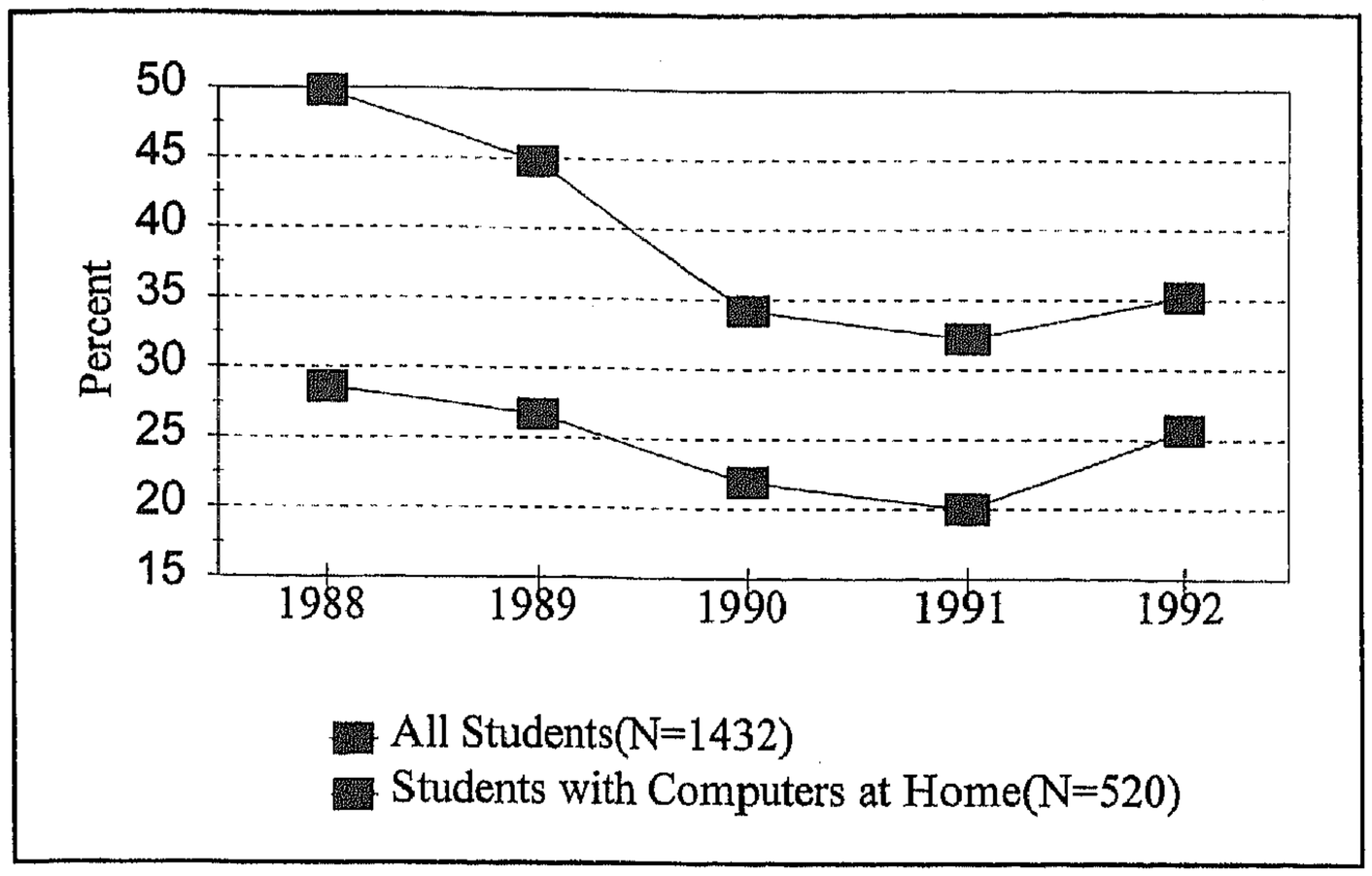

Figure 2. Percent students using computer 10+ hours outside of classes, 1988-1992.

computer (during 87/88), we find that more than half the students in computer-owned families used the computer for ten plus hours during 1988. However, there is a decline through time in this group so that during the spring of 1992, only about 35 percent report heavy use.

These declines in heavier use could reflect the effects of entering high school where other activities compete for their time. Another explanation could be a loss in the novelty of computers for students as computers lose their "halo effect" [14]. Figure 3 shows that parental interest in their children learning computers increased from 29 percent to about 36 percent. Thus, the decrease in heavier use did not appear to result from changing parental attitudes.

Computers Heavily Used for Educational Purposes

It is possible that many heavier users spend much of their computer time in playing video games and they do not receive any educational benefit. Figure 4 shows the number of hours and percent (of total hours of use) spent on educational purposes by the student in computer-owner families. According to their parents, they spent a large and growing portion of their computer usage time for educational purposes, increasing from 51 percent in 1988 to 84 percent in 1992. Watkins and Brim argue that parents overestimate educational use due to fuzzy conceptions of educational use as well as the need to justify the money spent on

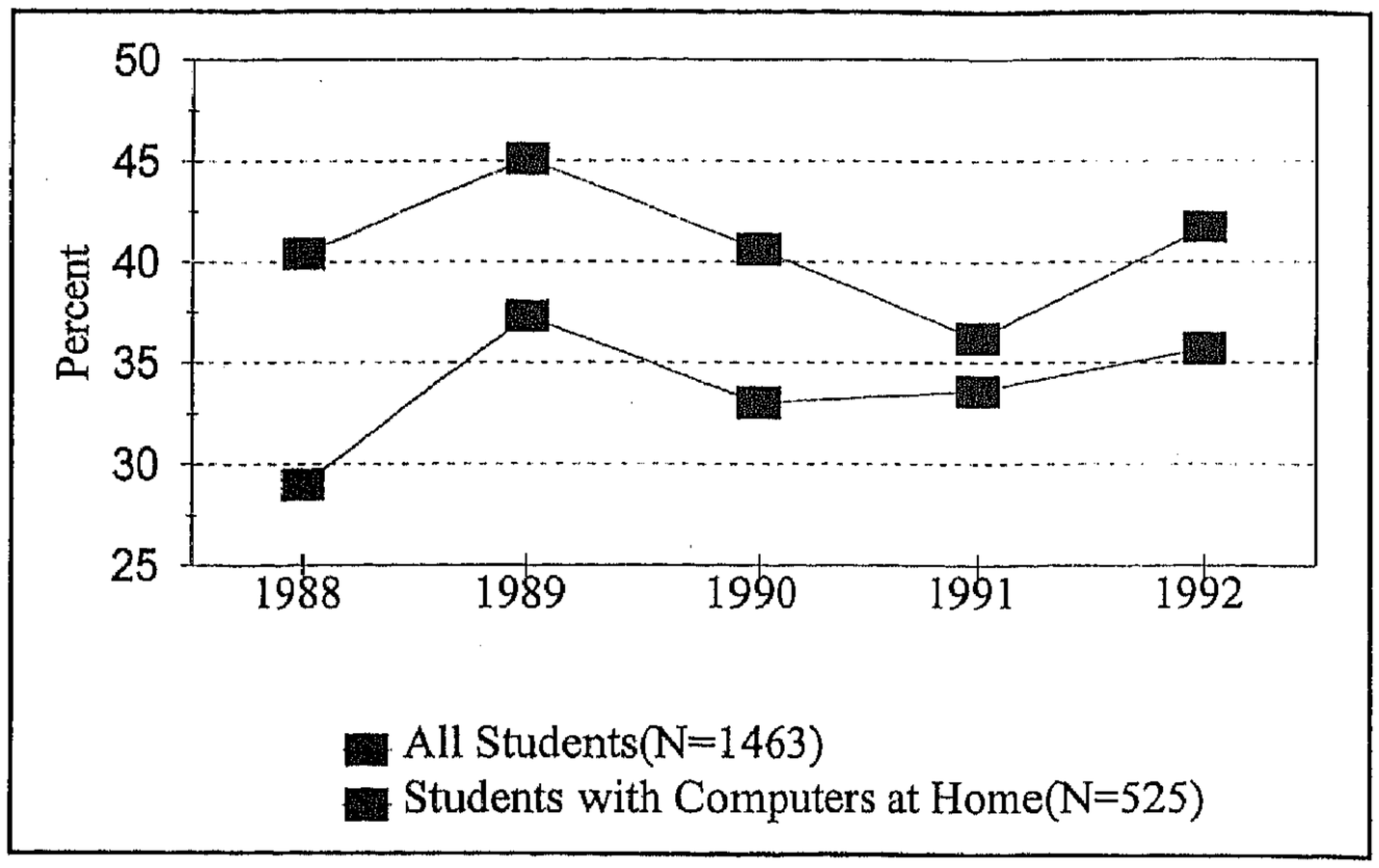

Figure 3. Percent of parents who want students to use computers, 1988-1992.

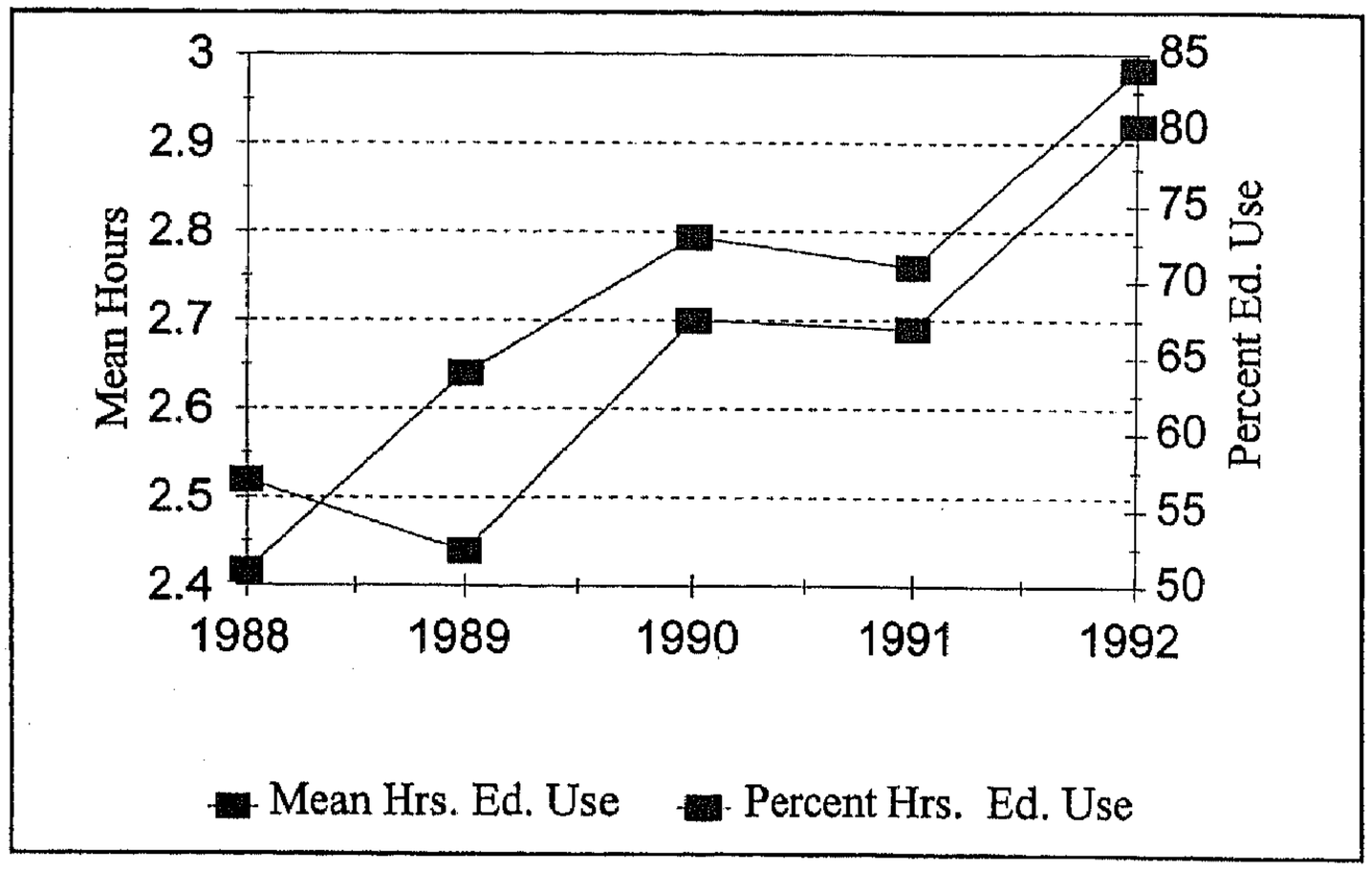

Figure 4. Educational (Ed.) use of computers, 1988-1992.

computers [15]. However, this argument would not explain why the tendency to overestimate such use would increase through time.

The Gender Gap in Usage

We expected to find that males would dominate the heavier user group by a large margin. Figure 5 shows that gender is associated with heavier-use throughout the first four years of the survey. The percentages of heavier users declined for both groups—from nearly 36 percent and 21 percent for males and females respectively in 1987 to about 28 and 24 percent in 1991. Until the final year, differences between males and females remained in the 10 to 15 percent range and were statistically significant ($p < .001$). However, in 1992, the difference was only 4 percent and not statistically significant. We need to be cautious in jumping to conclusions based on the 1992 data alone. However, if these latest figures prove to be predictive of the future, then the gender gap problem in usage has been lowered.

Heavier Usage: Change and Stability

Until now, there has been little information on whether heavier usage is a stable or transitory phenomenon. Do most of the people who are more frequent users one year continue to be heavier users for succeeding years? Table 3 reveals a considerable amount of change with more than half the heavier users in 1988 falling into the "not heavier user" category in 1992. Nevertheless, a substantial proportion (about 43%) of those who were heavier users in 1988 were still heavier users

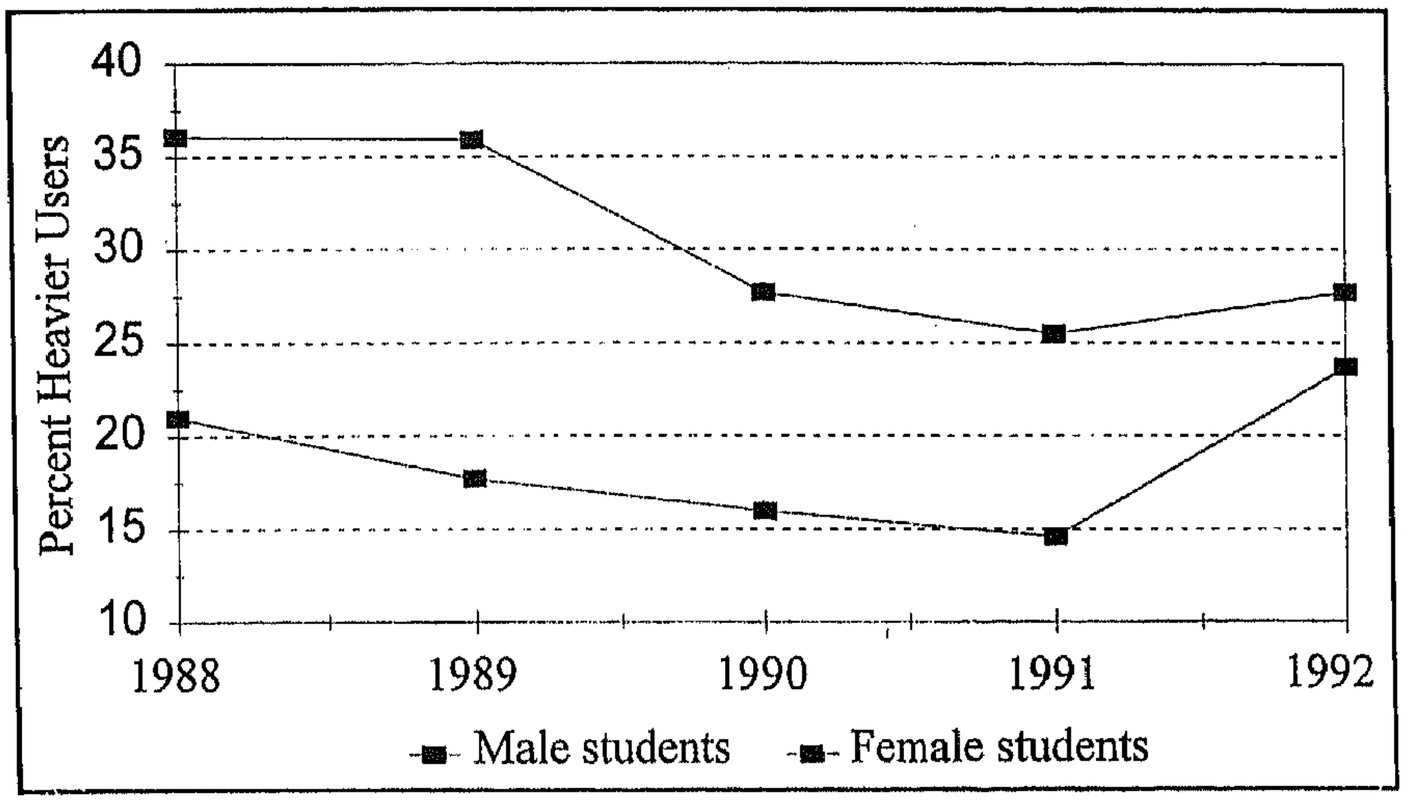

Figure 5. Gender and heavier use of computers, 1988-1992.

Table 3. Consistency of Usage:
Heavier Use in 1992 by Heavier Use in 1988[a]

Heavier User	Heavier User in 1988		
in 1992	No	Yes	Totals
No	79.9%	57.1%	73.5% (1259)
Yes	20.1%	42.9%	26.5% (454)
Totals	100% (1230)	100% (483)	100% (1713)

[a]Heavier use is defined as 10+ hours this school year other than in a class.
Note: Statistics: Cramer's V: .22 ($p < .001$), Gamma: .50 ($p < .05$).

four years later. This finding is significant for future studies of impacts of computers (and their usage) since it makes it more likely that there would be enduring impacts of computing on these students who are consistently, heavier users.

Predictors of Heavier Usage

Table 4 reports on the results of stepwise logistic regressions with heavier use of the computer as the dependent variable. Logistic regression is an appropriate multivariate method for examining dichotomous dependent variables (heavier usage in our case). According to Hosmer and Lemeshow, the stepwise selection method is appropriate for our situation where the outcome being studied is relatively new and the important covariates are not well known [16]. The logistic coefficient can be interpreted as the change in the log odds associated with a one-unit change in the independent variable [17]. The R value shows the contribution (and direction) of the impact of each variable to the model controlling for the other independent variables. The odds ratio tell us by what factor the odds ratio changes with a unit change in the independent variable. An odds ratio of greater than one shows that the independent variable increases the likelihood of the dependent variable (i.e., heavier use).

As we would expect, the data suggest that computer ownership has by far the greatest impact on heavier use. After ownership, the students' perception of their parent's desire for them to learn computers and student gender are the most influential. Although they enter the model, the SES variable and parental educational expectations are less influential. Parental age, parental discussion of science/technology and most of the student and peer-related variables were not found to be useful to predicting heavier use and thus not entered into the model. The model's predictive capabilities are modest. It can predict correctly who is a heavier and less heavy user in just over 76 percent of the cases compared with

Table 4. Results of Stepwise Logistic Regression with Heavier Use of Computer as Dependent Variable, 1987-1988[a]

Variables in Model[b]	B Value[c]	Significance	R[d]	Odds Ratio[e]
Computer at home[f]	1.66	<.001	.29	5.26
Parents want students to use computer[g]	.78	<.001	.13	2.18
Student gender[h]	.63	<.001	.11	1.87
Socioeconomic status[i]	.34	<.001	.07	1.40
Parental educational expectations[j]	.15	<.001	.05	1.16
Constant	–3.31	<.001		

Classification Table for Predicting Heavier Use:

		Predicted	
		No	**Yes**
Observed	**No**	1084	139
	Yes	273	234

Overall 76.18% correct

[a]Heavier use is defined as using computer for 10+ hours this school year other than in a class.

[b]Variables not entered in the model included the following: whether the student likes science, how satisfied the student is with self, whether friends like science, parental age, how often parents talk about science, and parental use of computer at work.

[c]The B value is the logistic coefficient that represents the change in the log odds associated with a one-unit change in the independent variable.

[d]The R statistic shows the partial contribution of the variable to the model. It can range from –1 to +1.

[e]The odds ratio shows the effect of a unit increase in the independent variable on the odds of the event (heavier use) occurring. A value >1 means that the variable has a positive effect on the probability of heavier use.

[f]0 = No computer, 1 = Computer.

[g]0 = Parents not interested in students using computer, 1 = Parents interested.

[h]0 = Female, 1 = Male.

[i]Socioeconomic status was measured as a composite variable based on parental education, parental job status, and a household possessions index. It was constructed as a z-score ranging from –2 to +2.

[j]Parental educational expectations for their children ranged from 1 (less than high school) to 8 (doctorate).

about 71 percent correct that could be predicted by always guessing the modal category (i.e., less heavy use).

In logistic regression, the probability is based on a nonlinear curve and depends on the particular configuration of values in the variables. We constructed a base model in which all of the values of the variables entered into the logistic regression equation were set to zero (0) except parental educational expectations that is set at two (2) (i.e., high school graduate expectation). The low value of one (1) for the educational expectations variable represented parents who had less than a high school graduate expectation for their children and was almost devoid of cases and thus not appropriate for use. With the configuration of the base model, there is only about a .05 chance of the student being a heavier user. In Table 5, we show the effects of changing each independent variable from zero to one. (For the educational expectations variable, we increased it from high school (2) to college (6) since this seems to be similar in importance to the other unit changes.) The biggest impact results from the ownership of a computer which increased the likelihood of heavier use about 15 percent from .05 to .20. An increase of one SES standard unit increased the probability of heavier use less than two percent (+1.5%). The impacts of the other variables included parents' wanting them to learn computers (+5%), changing gender from female to male (+3%), and changing educational expectations from high school to college (+3%).

Table 5. Logistic Regression Analysis: Percentage-Point Difference in the Predicted Probability of Heavier Use of Computers Due to Change in Each Explanatory Variable[a]

Explanatory Variable (Change in)	Percent Increase in Probability of Heavier Use
Computer-Ownership (Non-owner to Owner)	+15
Parental Interest in Children using Computers? (No to Yes)	+5
Gender Impact (Female to Male)	+3
Parental Educational Expectations:	
Change from High School (2) to College (6)[b]	+3
Socioeconomic Status (Change from 0 to +1)	+1.5

[a]Each increase is based on a comparison with a base model in which all variables are set to 0 except educational expectations which was set to 2 (high school level) since there were almost no cases on the lowest value for this variable (which was "less than high scool" = 1). Note that heavier use is defined as using computer 10+ hours this school year other than in a class.

[b]We used the change from high school (2) to college (6) for educational expectations because this would seem to be similar in importance to the other unit changes.

DISCUSSION

Although we hypothesized that "subjective" variables related to both students and parents would influence heavier use, the most important variables tended to be the non-perceptual (computer ownership and student gender) for heavy use. Student perception of their parents' desire to use computers was important—outweighing gender. These findings show the powerful influence that parents can exert on their children. By purchasing computers and communicating their desire for their children to use computers, they can create a higher probability that their children will be heavier computer users.

However, the next step in research must turn to the issue of whether inequities in computer access (and consequent use) result in educational inequities above and beyond what would exist without computers. Although analysis of computer ownership and use has some inherent interest attached to it, ultimately we are interested in the educational impacts, if any, of computing. Although the LSAY data set provides a large, probability-based, longitudinal sample, nevertheless it may be difficult to identify educational impacts. First, there are several powerful variables such as innate ability as well as parental socioeconomic status that influence educational outcomes. We would expect the general impacts of computers will be small compared to these underlying variables. By focusing on heavier computer users, the computer impacts could be maximized, thus making it more likely to identify them. However, as we have shown above, there are already large differences between heavier computer users and other students in the very first year of the study (1987). Since most of students who are heavier users at the beginning of the study were already educationally superior, it makes it difficult to identify subsequent educational impacts of usage. Phenomena such as ceiling effects might make it difficult to identify any long-term impacts given these initial differences.

One strategy we believe is to concentrate on certain subgroups of students who are most likely to reap positive benefits from microcomputer use. For example, we may find students who suffer from some combination of poor grades, poor test scores, and poor self-concept who, through heavier computer use, experience educational benefits such as greater love of science and consequently improved science test scores. Given the great investments by schools and parents due to high expectations concerning the educational benefits of microcomputers, it is important that such research be conducted.

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Direct reprint requests to:

Dr. Bruce Rocheleau
Division of Public Administration
Northern Illinois University
DeKalb, IL 60115