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ABSTRACT

School location of microcomputers and its impact on use were examined using data from the National Survey of School Uses of Microcomputers. An analysis of the responses from 1,082 (68% of the sample) microcomputer-using, public and non-public, elementary and secondary schools surveyed between December 1982 and March 1983, suggests that where schools locate microcomputers does have an impact on how they are used. Keeping microcomputers solely in classrooms has largely negative consequences, although equity of use is improved for secondary schools, while putting computers into a laboratory situation has generally positive consequences, except for equity. Locating computers in libraries may improve equity in elementary schools and increase use by secondary teachers and students, but has little impact on learning or social and organizational outcomes. Rotating microcomputers from room to room is generally positive for secondary schools and improves equity and access at elementary schools, but allows insufficient time for student learning with the computer. Dispersing microcomputers among several locations has negative consequences for elementary schools, but provides increased microcomputer access to larger groups and a broader range of activities in secondary schools. A technical appendix describes the regression analysis of location effects. Five tables are included. (LMM)

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SCHOOL USES OF MICROCOMPUTERS:

Reports from a National Survey

Issue No. 5, June 1984

The Johns Hopkins University
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School Uses of Microcomputers

Reports from a National Survey

Issue No. 5, June 198

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Note for Readers New to this Series

This is the fifth interim report from the National Survey of School Uses of Microcomputers. The results presented are based on data from 1,082 microcomputer-using schools, representing 68% of a nationally representative sample of about 1,600 microcomputer-owning public and non-public elementary and secondary schools. These schools, having one or more microcomputers for use by teachers or students, were surveyed between December, 1982 and March, 1983.

Previous newsletters have described how schools use microcomputers in their instructional programs. We have shown that schools differ systematically in how they use micros according to such factors as the part of the country they are in, the kinds of students they serve, how long they have had micros, and whether an individual teacher, a group of teachers, or school administrators initially organized their use.

The analytic methods used so far have been limited to simple cross-tabulations and correlation coefficients. The statistical products of such analyses, although easily read and understood, are properly interpreted as indicating empirical associations between phenomena rather than strict cause and effect.

For example, in the previous newsletter we reported that where an individual teacher was responsible for an elementary school's acquiring and using a microcomputer, there was a tendency for the school to report less overall use of their microcomputers, use that was restricted to "above-average" students, use more to teach computer programming to students than to assist them in practicing traditionally-learned skills, and use which was felt by teachers to have had a more modest impact on student learning and social attitudes than in other micro-using schools. It may be that leaving acquisition and implementation decisions to an individual teacher--however interested and well-motivated that teacher may be--does more often result in more restricted and less efficacious use. Nevertheless, strictly speaking, the cross-tabular and correlational analyses are just an initial step in establishing a direct causal linkage between how microcomputers are implemented and how they are used.

In this issue, we examine another aspect of how schools organize the use of their microcomputers--specifically, where the micros are located within the school building. And, in order to provide somewhat stronger evidence regarding the actual impact of different organizational decisions on how schools use computers, we employ a more complex statistical tool--multiple regression analysis.

The Location of Microcomputers

Given a relatively small number of microcomputers and a much larger student body, schools have made a

variety of decisions about physically locating computers in their building. Some schools have located their few microcomputers in one or more regular classrooms, to be used by individual teachers with their own class; others have placed microcomputers in common spaces like libraries, where teachers may send individuals or groups of students to use micros under the supervision of a school librarian. Other schools have established "computer laboratories," often containing only two or three computers, supervised when staff time can be allocated, by a computer specialist, often drawn from the regular mathematics teaching faculty. A few schools have placed their microcomputer or microcomputers under the responsiblity of a department or office focusing on certain students like "gifted and talented" or "special education." Departmental rooms, like computer laboratories, are collectively privileged locations, where certain teachers and students "belong" quite clearly more than others.

These variations in locational arrangements are not random, and follow from several factors--for example the age and social background of the school's student body, the presence among the school faculty of computer enthusiasts, and the relative influence of teachers and administrators in initially acquiring and implementing microcomputers. It is also plausible that locational differences affect what schools do with their microcomputers and how successfully they are used: for example, how many of the school's teachers use microcomputers "regularly" with their students; how much time the computers are in use by students (as opposed to sitting idle, or in use by teachers or administrators); the breadth of computer use across different possible applications of using microcomputers; the proportion of the student body who use the computers; the relative access to microcomputers by "above-average" students in comparison to "average" or "below-average" students; and the emphasis on programming and "computer literacy", as opposed to instructional functions like "drill-and-practice." Location may also affect the amount of time that any one student user has during a given week to work at a microcomputer keyboard and the overall impact of microcomputers on student learning and on social aspects of instruction such as how independently students do their work, how individualized are the instructional tasks, and how much enthusiasm for schoolwork does having computers engender in the students.

Classroom locations are most common; but nearly half don't put micros in regular classrooms.

As of the survey date, January, 1983, microcomputers were placed in regular teacher classrooms in slightly more than half of all computer-using schools, both elementary and secondary (See Table 1). Libraries contained micros in more than one-third of computer-using elementary schools and in 20% of the secondary schools. Computer labs were formed in about a third of the elementary schools and nearly half of the secondary schools.

Putting micros in more than one location and rotating them from room to room are common--but each is done in less than half of the schools.

More than a third of the microcomputer-owning schools kept micros in more than one location at any one time. About one-quarter of the schools split their micros between classrooms and a more collective location such as a library or a computer lab. In addition, 17% of the elementary schools reported rotating their microcomputers among several classrooms, more than the number of elementary schools that kept micros solely in certain classrooms on a permanent basis. Counting all mentions of rotating microcomputers, about 38% of micro-owning elementary schools and 28% of secondary schools moved at least some micros from room to room.

Table 1: Location of Microcomputers in Elementary and Secondary School Buildings

Universe: Schools With 1 or More Microcomputers, January, 1983

	Elementary Schools		Secondary Schools	
	Any Micros In...	Micros Only in...	Any Micros In...	Micros Only in
Classrooms	52%	37%	58%	36%
Libraries	36%	17%	20%	8%
Laboratories	35%	25%	46%	32%
Special Rooms	5%		4%	
Total	128%	74%	128%	76%
Mixed Locations		26%		25%
		100%		101%

Schools with just one micro focus on the school library; those with more micros put them elsewhere.

Schools with exactly one microcomputer were more likely than other schools to put the micro in the school library. For example, among elementary schools, 47% of those with one micro kept it in the school library, but only 28% of schools with more than one micro kept any of them there. Laboratories were used by a majority of both elementary and secondary schools when they had 8 or more micros in the building, but even with as few as two microcomputers, nearly a third of the microcomputer-owning schools used what they called a "laboratory." About one-third of the schools in our sample, both elementary and secondary, resisted clustering or centralization of any kind and kept micros only in regular classrooms. For secondary schools, this declined with increasing numbers of micros, but for elementary schools, "micros only in classrooms" were just as common in schools with 3 or more micros as in those with only a single micro.

Five ways to measure 'location.'

To study the possible impact of location on microcomputer use, multiple regression equations were constructed for five measures of microcomputer location. Four are dichotomies--whether the school's microcomputers were located only in classrooms ("yes" or "no"); whether the school used a computer lab ("yes" or "no"); whether any microcomputers used for instruction were in the library ("yes" or "no"); and whether any microcomputers rotated from room to room or between classroom and library or lab. The fifth location variable examined is the number of rooms in which microcomputers were located at any one time. Elementary and secondary schools are treated separately in this analysis and are not themselves internally differentiated by grade levels.

In the analysis, other factors are statistically held constant.

In previous newsletters, we have shown how other factors also affect how a school uses microcomputers--for example, characteristics of the student body, how long the school

has had a microcomputer, and the influence of a single teacher on implementing a school's first microcomputer. Some of these factors also affect how a school chooses to locate microcomputers. If not taken into account, such factors might cause us to believe that locational factors influenced how schools used microcomputers when, in fact, these other determinants were the "causes" of different patterns of use--not location.

Multiple regression helps us statistically control on the importance of other factors like student body composition, leadership in implementation, and so on, and to attribute to "location" a more realistic degree of importance. Rather than present the multiple regression statistics in the context of this discussion, we have moved the statistical tables to an appendix, beginning on page 8. This appendix also contains an introduction to help the reader understand the tables. Here, we concentrate on the results of our analyses.

Impact of Micro Location on Use

Most of our analyses are summarized in Table 2. Each column in Table 2 presents results for one of the five ways of examining 'location.' Each row indicates results for one of the "outcomes" that we examined. Two entries are shown for each row-column intersection: the first is for elementary schools; the second, for secondary schools. A "+" indicates that there was substantially more of that outcome in those schools that located their micros in the way suggested by the column heading (e.g., in "classrooms only"); a "-" indicates substantially less of that outcome in comparison to other micro-using schools. A blank entry means that the difference was not statistically significant.

Micros only in classrooms: less use, but more equitable use.

The first column of Table 2 suggests that restriction of microcomputers to regular teacher classrooms may have the following consequences: fewer teachers using computers in their teaching, a narrower range of uses being made of the computers in elementary schools, greater use of microcomputers for drill-and-practice than programming instruction (in secondary schools, a less dominant use for programming instruction), more equity in use between below-average and above-average students in secondary schools, and a smaller amount of computer time for each of the students who do use a computer.

In quantitative terms--using some of the regression coefficients from the analysis--we find that restricting micros to elementary school classrooms rather than having at least some put in a library or laboratory may result in half as many teachers becoming regular users of the equipment with their classes. Also, limiting micros to secondary school classrooms means that they will be used for 1 1/2 or 2 hours less per week than putting them in labs or other centralized facilities. Actually, the real dif-

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Table 2: Summary: Impact of Micro Locations on Patterns of Use

Note: Each row-column combination has two entries. The format is...

ELEMENTARY ENTRY / SECONDARY ENTRY. The entries are:

\+ : Substantially More in These Schools Than in Other Schools
\- : Substantially Less in These Schools Than in Other Schools

	Classrooms Only	Computer Lab	Library	Rotate Micros Between Rooms	Dispersed Locations
Number of Regular Teacher Users.....	- / -	+ / +	/ +	/ +	/ +
Number of Hours Per Week of Student Use.	/	+ / +	/	/ +	- /
Breadth of Use Across 13 Applications.....	- /	/ +	/ -	/	/ +
Percent of Students Who Use Micro.....	/	+ /	/ +	+ / +	/ +
Dominance of Computer Programming Uses over Drill-and-Practice..	- / -	+ / +	/ -	- /	+ / -
Equity Between Above-Average and Below-Average Students' Use.. ..	/ +	- / -	+ /	+ /	/
Computer Time Per Student User.....	- / -	/ +	/	- /	- /
Academic Learning Attributed To Micro Presence...	/	/	- /	- /	/
Social and Organizational Outcomes Attributed to Microcomputer....	/	/	- /	- / -	- /

ferences deriving from these and other statistically significant relationships are likely to be much greater. Because of the imprecision with which most variables like this are measured, true relationships are most often understated by multiple regression procedures.

Impact of having a computer lab: more use; heavy on programming.

The second column of Table 2 suggests that putting some or all computers into a room used solely for computer-related activities--that is, a computer lab--may have these consequences: regular use of the computer by a larger number of teachers; student use of the micros for more hours of the week; a broader range of uses being made of secondary school computers; a higher proportion of elementary school students using the computers at all; in secondary schools, longer turns at the computer by those who do use the computers, particularly for program-

ming assignments; greater dominance of computer use by "above-average" students in both elementary and secondary schools; more intensive use of secondary school computers for programming activities; and more programming use than drill-and-practice use in elementary schools. In addition, elementary schools with computer laboratories reported much greater student enthusiasm for school, after controlling for the background variables.

Although most of these differences suggest that laboratory placement of microcomputers has positive consequences at both the elementary and secondary levels, one result of such organization is a tendency to restrict computer use to better-prepared students. This is, no doubt, partly because the emphasis in these lab situations is usually on computer programming. Schools concerned about equity of access to microcomputers, but desirous of taking advantage of laboratory arrangements, may want to provide a different supervisor for the computer laboratory than a teacher apt to use the equipment with only the most advanced mathematics classes. The survey data show no compelling reasons for limiting computer use to the "above-average" students, although teachers clearly perceive that above-average students have so far profited from having microcomputers much more than have other students.

Putting micros in the school library: elementary and secondary effects differ.

Placing microcomputers in the school library also has consequences for their use, as the summary data in the third column of Table 2 show. In particular, computers in secondary school libraries encourage computer use by more teachers, even more so than do computer labs. Also, at that level, having computers in the library means that more students will use them than when they are located elsewhere. However, student use is more restricted: there are fewer different uses made of micros in secondary schools where they are in the school library; and there is less intensive programming instruction, resulting in more equivalence between programming use and drill-and-practice use. Overall, in secondary schools with micros in the library, the machines are in use somewhat less of the time than schools with computer labs, but more than schools that keep their micros only in classrooms.

Elementary schools with a computer in the school library had more balance in use of the equipment between above-average and below-average students (other factors controlled); but the schools reported less positive learning outcomes and less positive social outcomes. ("Enthusiasm" was particularly low among elementary schools with computers in their library.)

Rotating micros: more access, but less impact on students and schooling.

The consequences of rotating microcomputers from room to room in elementary schools appear to be much the same as those of locating micros in the school library--more equity of use between above-average and below-average students, and poor reported outcomes for student learning and social aspects of computer use. (These analyses also control for the particular locations of the microcomputers, in order to see the effect of rotation per se.) Rotating microcomputers also results in access by a higher proportion of the school's students, but, elementary schools that rotate micros provide less computer time for each student user. There is also a tilt towards using microcomputers for drill-and-practice rather than programming instruction in the elementary schools that rotate equipment.

Elementary schools that rotate microcomputers do not have more teachers who use the microcomputer regularly than elementary schools that do not rotate micros; in contrast, this is the largest conse-

quence of rotating micros at the secondary level. It is by involving more teachers with micros on a regular basis that secondary schools that rotate micros use them for more hours of the week and with a higher proportion of the school's students than do secondary schools that do not rotate their micro equipment.

Dispersing micros around the school: more beneficial for secondary schools.

Finally, we have the question of whether schools should put all their microcomputers in one location, or spread them among several rooms (whether or not they rotate them to different rooms at different times). The regression results show different consequences for elementary and for secondary schools. Dispersion of micros at elementary schools may produce less overall use of micros, less computer time for each student who does use the computer, and possibly less beneficial impact, overall (as suggested by less effective academic and social outcomes, as reported in our survey). Dispersion is also associated with use for programming instruction rather than drill-and-practice.

Secondary schools that have dispersed their microcomputers to different locations, in contrast, have more regular computer-using teachers, a wider range of use of micros, a higher proportion of students using micros, and less of a dominance of programming activities as against drill-and-practice. (These results, of course, control on the number of micros at the school, the size of the student body, and the other background variables, as well as whether rotation of equipment is involved.) Thus, dispersion does not appear to be a good idea for elementary schools, but it has certain benefits for secondary schools.

Summary

These analyses suggest that where schools locate microcomputers has an impact on how they are used. Keeping microcomputers solely in classrooms has largely negative consequences, although equity of use is improved for secondary schools. Putting computers into a laboratory situation, in contrast, has generally positive consequences, except for equity. Neither pattern, though, classrooms or laboratories, is related to respondent judgment regarding the academic or social and organizational consequences of having computers in schools.

Locating computers in libraries has a mixed impact. It may improve equity in elementary schools and increase use by teachers and students in secondary schools, but not much consequence appears to follow, in terms of learning or improving social organizational outcomes. Rotating microcomputers from room to room is generally positive for secondary schools and improves equity and access at elementary schools, but at the expense of computer-using students getting an insufficient amount of computer time to accomplish much learning. Dispersing microcomputers among several locations at any one time appears to have only negative consequences for elementary schools, but has the benefits for secondary schools of increasing micro access to larger groups and for a broader range of activities.

Considerations such as these are certainly not the last word in deciding how schools should use the relatively small number of microcomputers they have with their comparatively large student bodies. However, when considering the educational value of school expenditures on such expensive instructional equipment--equipment that in contrast to movie projectors, television sets, photocopiers, and so forth, must generally be used for the benefit of a relatively few students during the course of a day--it is important to think, not only of the instructional value of computers for an individual student, but of how schools might most effectively organize use of computers so that they would best assist classrooms of students.

Technical Appendix: Multiple Regression Analysis of Location Effects

An Introduction to Tables A1 - A5.

The analysis of location's impact on patterns of micro use "holds constant" other factors. The relationship between where schools put their micros and how they use them was examined by statistically holding constant several "background" variables which also affect "where" and "how" schools use computers: the number of students enrolled, the number of micros at the school, race and socioeconomic status of the student body (measured by two dichotomies--whether the school was a "high SES, predominantly white school" and whether it was a "predominantly minority school"), the year the school first obtained a microcomputer, the influence that a single teacher had on the school's first acquisition and implementation of a microcomputer, and the presence of computer enthusiasts on the teaching staff. In addition, the number of regular computer-using teachers--itself one of the outcomes of locating equipment in different places--could be considered an independent determinant of how well schools use microcomputers; therefore a second regression equation was calculated with this variable held constant as well, and results are shown separately in the tables whereever it made a difference in how important "location" itself seemed to be.

Results are shown only if at least a modest relationship was found. Each of the Tables A1 through A5 shows descriptive statistics and statistics from the multiple regression analyses for one of the five location variables. Results are shown only for those outcomes where the location variable was at least marginally significant in the regression model used (beta=.08 or higher; approximately equivalent to $p<.20$, elementary; $p<.10$, secondary).

Columns 1 and 2 show simple average values for two groups of schools. The first two columns of numbers in each table show the average values on the outcome variable (for example, the average "number of regular micro-using teachers") for those schools that had the characteristic in question (e.g., "micros only in classrooms") and for the remaining schools (i.e., "micros not 'only in classrooms'"). Some outcome measures (for example, "breadth of use across 13 applications") are built from indices of several questionnaire items. In these cases, "average values" do not have a concrete meaning, so the computed averages are omitted from the table. The "Units" column in the table is shown as "(index)" for these situations.

Columns 3 and 4 show how closely location and outcome are linked. The correlation coefficient (r) and the standardized regression coefficient (beta) are shown in columns three and four. The correlation coefficient is a descriptive measure of how much an outcome variable differs according to where schools put microcomputers. A "zero" means it does not differ at all; a "1" or a "-1" would mean that the outcome is totally determined by the locational contrast--not a very likely occurrence!

"Beta" is similar to the correlation coefficient except that it shows how much "outcome" and "location" are associated after taking into account that different types of schools locate microcomputers differently and these other factors also affect the outcome. It can be used as a rough guide for determining which outcomes are most affected by the contrast in locational arrangements highlighted in that particular table.

Column 5 shows the impact of location according to the statistical model. The last column, labeled "b," also comes from the multiple regression analysis. It is equivalent to the difference between the two "average values" (columns one and two) after controlling on other background factors. Again, for those outcomes built from indices for which "average" values have no concrete meaning, the "b" value is omitted from the table. The "beta" coefficient, compared with other "beta" coefficients for that locational contrast can give the reader a sense of the impact of location on that outcome variable.

An example: The first row of entries in Table A1. Table A1 shows several ways that limiting microcomputers only to classroom locations affect school and student outcomes. The top half of the table shows outcomes affected in elementary schools. The first of these is the number of teachers who regularly use microcomputers.

Columns one and two give the average number of teachers who use micros regularly in two groups of elementary schools: those that keep micros only in classrooms, and those who have micros elsewhere (whether or not they also have any in classrooms). On the average, there are 3 more micro-using teachers in schools that do not limit their micros to classrooms (6.1 vs. 3.1).

But the "not only in classroom" schools also may have more micros altogther, may have had micros longer, or may differ from "only in classroom" schools in other ways that also might affect how many teachers use micros. The multiple regression procedure accounts for these factors which otherwise could "confound" our understanding of the impact of location on teacher use.

The result of the analysis, shown in Column 5, is that there are still 2.6 more regular micro-using teachers in elementary

Table A1: Impact of Locating Micros ONLY IN CLASSROOMS on Patterns of Micro Use

Outcome Variable	Average for Schools... With Micros ONLY IN CLASSROOMS (mean)	With Micros NOT "Only in Classrooms" (mean)	(Units)	Measures of Association r	beta	Impact in Units b
Elementary						
Number of Regular Teacher Users.....	3.1	6.1	teachers	-.22	-.18	-2.6
Breadth of Use Across 13 Applications.....			(index)	-.15	-.12	
Dominance of Programming over Drill/Practice.			(index)	-.07	-.12 -.17	
Computer Time Per Student User.....	27.	35.	minutes	-.10	-.09 -.12	-7.2 -9.5
Secondary						
Number of Regular Teacher Users.....	2.4	4.1	teachers	-.25	-.18	-1.3
Number of Hours Per Week of Student Use.	13.5	16.5	hours	-.13	-.09 -.07	-2.1 -1.6
Equity Between Above- and Below-Average Students' Use.....			(index)	.08	.09	
Dominance of Programming over Drill/Practice.			(index)	-.08	-.07 -.10	
Computer Time Per Student User.....	68.	85.	minutes	-.11	-.09 -.11	-14. -17.

schools with micros located in places other than classrooms than in schools with micros only in classrooms, other factors accounted for.

Notice also that the beta coefficient is only slightly less than the correlation coefficient; this is true also because controlling on background factors, in this case, does not appreciably change our impression of the importance of location in determining teacher utilization of micros. As a matter of fact, because we have controlled on so many variables without the relationship appreciably changing, we have more confidence in the idea that location is actually responsible for differential use by teachers.

Table Notes

Where two successive rows of regression statistics are provided for a single outcome variable, the second set is for a regression equation that also holds constant "number of regular teacher-users." This second set of numbers are shown only when they make a difference in the magnitude of "beta" or "b" for the location variable. An entry "N.S." means that after holding "number of teacher-users" constant, location is not, independently, a determinant of the outcome variable (N.S.: "not significant").

Besides controlling on the various background factors mentioned in this "introduction," the regression equations for "rotate micros between rooms" control on where micros were placed (lab or library vs other), and the equations for "number of (simultaneous) locations" control on where they were placed and on whether any of the computers rotate among different locations.

Table A2: Impact of COMPUTER LABORATORIES on Patterns of Micro Use

Outcome Variable	Average for Schools... With MICROS IN COMPUTER LABS (mean)	Average for Schools... WITHOUT ANY Computer Labs (mean)	(Units)	Measures of Association r	beta	Impact in Units b
Elementary						
Number of Regular Teacher Users.....	6.2	4.5	teachers	.12	.08	1.2
Number of Hours Per Week of Student Use.	16.5	13.6	hours	.13	.15 .10	3.3 2.3
Percent of Students Who Use Micro.....	43.	30.	percent	.18	.13 .07	9. 5.
Equity Between Above- and Below-Average Students' Use.....			(index)	-.12	-.16 -.17	
Dominance of Programming over Drill/Practice.			(index)	.15	.17 .19	
Student Enthusiasm Because of Micros... ('social' outcome)			(index)	.19	.19	
Secondary						
Number of Regular Teacher Users.....	4.0	3.0	teachers	.15	.08	0.6
Number of Hours Per Week of Student Use	16.8	14.2	hours	.12	.09 .08	1.9 1.7
Breadth of Use Across 13 Applications.....			(index)	.18	.18 .16	
Dominance of Programming over Drill/Practice.			(index)	.11	.08 .10	
Equity Between Above- and Below-Average Students' Use.....			(index)	-.09	-.10	
Computer Time Per Student User.....	90.	69.	minutes	.14	.11 .12	15. 17.

Table A3: Impact of Locating Micros IN THE LIBRARY on Patterns of Micro Use

Outcome Variable	Average for Schools... With MICROS IN THE LIBRARY (mean)	WITHOUT ANY Micros in the Library (mean)	(Units)	Measures of Association r	beta	Impact in Units b
Elementary						
Equity Between Above- and Below-Average Students' Use.....			(index)	.17	.17	
Learning Attributed To Micro Presence...			(index)	-.11	-.12	
Social, Org'l. Benefits Attributed to Micros			(index)	-.21	-.20	
Secondary						
Number of Regular Teacher Users.....	4.8	3.1	teachers	.21	.20	1.7
Breadth of Use Across 13 Applications.....			(index)	-.08	-.08 -.12	
Percent of Students Who Use Micro.....	24.	18.	percent	.13	.12 N.S.	6.
Dominance of Programming over Drill/Practice.			(index)	-.11	-.09	
Computer Time Per Student User.....	54.	41.	minutes	.11	.13 .15	16. 19.

Table A4: Impact of Microcomputers ROTATING AMONG ROOMS on their Patterns of Use

Outcome Variable	Average for Schools... Where SOME OR ALL MICROS ROTATE (mean)	Where NO Micros Rotate (mean)	(Units)	Measures of Association r	beta	Impact in Units b
Elementary						
Percent of Students Who Use Micro.....	43.	29.	percent	.20	.23	16.
Dominance of Programming over Drill/Practice.			(index)	-.12	-.14 -.10	
Equity Between Above- and Below-Average Students' Use.....			(index)	.26	.27	
Computer Time Per Student User.....	25.	35.	minutes	-.13	-.12 -.11	-9. -8.
Academic Learning Attributed To Micro Presence...			(index)	-.14	-.12	
Social, Org'l. Benefits Attributed to Micros			(index)	-.11	-.09	
Secondary						
Number of Regular Teacher Users.....	4.7	2.9	teachers	.24	.20	1.5
Number of Hours Per Week of Student Use.	16.8	14.8	hours	.	.07 N.S.	1.6
Percent of Students Who Use Micro.....	25.	17	percent	.18	.14 N.S.	6.
Social, Org'l. Benefits Attributed to Micros			(index)	-.11	-.11	

Table A5: Impact of NUMBER OF SIMULTANEOUS LOCATIONS on Patterns of Micro Use

Outcome Variable	Average for Schools... With MICROS IN 3+ LOCATIONS (mean)	With MICROS IN 1 LOCATION (mean)	(Units)	Measures of Association r	beta	Impact in Units b
Elementary						
Number of Hours Per Week of Student Use.	10.3	15.8	hours	-.16	-.25 -.24	-4.2 -4.0
Dominance of Programming over Drill/Practice.			(index)	.17	.14 .15	
Computer Time Per Student User.....	23.	37.	minutes	-.13	-.13 -.12	-7.4 -6.9
Social, Org'l. Benefits Attributed to Micros			(index)	-.13	-.15	
Secondary						
Number of Regular Teacher Users.....	5.0	2.9	teachers	.23	.16	0.9
Breadth of Use Across 13 Applications.....			(index)	.17	.15 .13	
Percent of Students Who Use Micros.....	27.	17.	percent	.13	.08 N.S.	3.
Dominance of Programming over Drill/Practice.			(index)	-.12	-.13 -.12	

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SCHOOL USES OF MICROCOMPUTERS:

Reports from a National Survey

Issue No. 5, June 1984

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School Uses of Microcomputers

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Note for Readers New to this Series

This is the fifth interim report from the National Survey of School Uses of Microcomputers. The results presented are based on data from 1,082 microcomputer-using schools, representing 68% of a nationally representative sample of about 1,600 microcomputer-owning public and non-public elementary and secondary schools. These schools, having one or more microcomputers for use by teachers or students, were surveyed between December, 1982 and March, 1983.

Previous newsletters have described how schools use microcomputers in their instructional programs. We have shown that schools differ systematically in how they use micros according to such factors as the part of the country they are in, the kinds of students they serve, how long they have had micros, and whether an individual teacher, a group of teachers, or school administrators initially organized their use.

The analytic methods used so far have been limited to simple cross-tabulations and correlation coefficients. The statistical products of such analyses, although easily read and understood, are properly interpreted as indicating empirical associations between phenomena rather than strict cause and effect.

For example, in the previous newsletter we reported that where an individual teacher was responsible for an elementary school's acquiring and using a microcomputer, there was a tendency for the school to report less overall use of their microcomputers, use that was restricted to "above-average" students, use more to teach computer programming to students than to assist them in practicing traditionally-learned skills, and use which was felt by teachers to have had a more modest impact on student learning and social attitudes than in other micro-using schools. It may be that leaving acquisition and implementation decisions to an individual teacher--however interested and well-motivated that teacher may be--does more often result in more restricted and less efficacious use. Nevertheless, strictly speaking, the cross-tabular and correlational analyses are just an initial step in establishing a direct causal linkage between how microcomputers are implemented and how they are used.

In this issue, we examine another aspect of how schools organize the use of their microcomputers--specifically, where the micros are located within the school building. And, in order to provide somewhat stronger evidence regarding the actual impact of different organizational decisions on how schools use computers, we employ a more complex statistical tool--multiple regression analysis.

The Location of Microcomputers

Given a relatively small number of microcomputers and a much larger student body, schools have made a

variety of decisions about physically locating computers in their building. Some schools have located their few microcomputers in one or more regular classrooms, to be used by individual teachers with their own class; others have placed microcomputers in common spaces like libraries, where teachers may send individuals or groups of students to use micros under the supervision of a school librarian. Other schools have established "computer laboratories," often containing only two or three computers, supervised when staff time can be allocated, by a computer specialist, often drawn from the regular mathematics teaching faculty. A few schools have placed their microcomputer or microcomputers under the responsiblity of a department or office focusing on certain students like "gifted and talented" or "special education." Departmental rooms, like computer laboratories, are collectively privileged locations, where certain teachers and students "belong" quite clearly more than others.

These variations in locational arrangements are not random, and follow from several factors--for example the age and social background of the school's student body, the presence among the school faculty of computer enthusiasts, and the relative influence of teachers and administrators in initially acquiring and implementing microcomputers. It is also plausible that locational differences affect what schools do with their microcomputers and how successfully they are used: for example, how many of the school's teachers use microcomputers "regularly" with their students; how much time the computers are in use by students (as opposed to sitting idle, or in use by teachers or administrators); the breadth of computer use across different possible applications of using microcomputers; the proportion of the student body who use the computers; the relative access to microcomputers by "above-average" students in comparison to "average" or "below-average" students; and the emphasis on programming and "computer literacy", as opposed to instructional functions like "drill-and-practice." Location may also affect the amount of time that any one student user has during a given week to work at a microcomputer keyboard and the overall impact of microcomputers on student learning and on social aspects of instruction such as how independently students do their work, how individualized are the instructional tasks, and how much enthusiasm for schoolwork does having computers engender in the students.

Classroom locations are most common; but nearly half don't put micros in regular classrooms.

As of the survey date, January, 1983, microcomputers were placed in regular teacher classrooms in slightly more than half of all computer-using schools, both elementary and secondary (See Table 1). Libraries contained micros in more than one-third of computer-using elementary schools and in 20% of the secondary schools. Computer labs were formed in about a third of the elementary schools and nearly half of the secondary schools.

Putting micros in more than one location and rotating them from room to room are common--but each is done in less than half of the schools.

More than a third of the microcomputer-owning schools kept micros in more than one location at any one time. About one-quarter of the schools split their micros between classrooms and a more collective location such as a library or a computer lab. In addition, 17% of the elementary schools reported rotating their microcomputers among several classrooms, more than the number of elementary schools that kept micros solely in certain classrooms on a permanent basis. Counting all mentions of rotating microcomputers, about 38% of micro-owning elementary schools and 28% of secondary schools moved at least some micros from room to room.

Table 1: Location of Microcomputers in Elementary and Secondary School Buildings

Universe: Schools With 1 or More Microcomputers, January, 1983

	Elementary Schools		Secondary Schools	
	Any Micros In...	Micros Only in...	Any Micros In...	Micros Only in
Classrooms	52%	32%	58%	36%
Libraries	36%	17%	20%	8%
Laboratories	35%	25%	46%	32%
Special Rooms	5%		4%	
Total	128%	74%	128%	76%
Mixed Locations		26%		25%
		100%		101%

Schools with just one micro focus on the school library; those with more micros put them elsewhere.

Schools with exactly one microcomputer were more likely than other schools to put the micrc in the school library. For example, among elementary schools, 47% of those with one micro kept it in the school library, but only 28% of schools with more than one micro kept any of them there. Laboratories were used by a majority of both elementary and secondary schools when they had 8 or more micros in the building, but even with as few as two microcomputers, nearly a third of the microcomputer-owning schools used what they called a "laboratory." About one-third of the schools in our sample, both elementary and secondary, resisted clustering or centralization of any kind and kept micros only in regular classrooms. For secondary schools, this declined with increasing numbers of micros, but for elementary schools, "micros only in classrooms" were just as common in schools with 3 or more micros as in those with only a single micro.

Five ways to measure 'location.'

To study the possible impact of location on microcomputer use, multiple regression equations were constructed for five measures of microcomputer location. Four are dichotomies--whether the school's microcomputers were located only in classrooms ("yes" or "no"); whether the school used a computer lab ("yes" or "no"); whether any microcomputers used for instruction were in the library ("yes" or "no"); and whether any microcomputers rotated from room to room or between classroom and library or lab. The fifth location variable examined is the number of rooms in which microcomputers were located at any one time. Elementary and secondary schools are treated separately in this analysis and are not themselves internally differentiated by grade levels.

In the analysis, other factors are statistically held constant.

In previous newsletters, we have shown how other factors also affect how a school uses microcomputers--for example, characteristics of the student body, how long the school

has had a microcomputer, and the influence of a single teacher on implementing a school's first microcomputer. Some of these factors also affect how a school chooses to locate microcomputers. If not taken into account, such factors might cause us to believe that locational factors influenced how schools used microcomputers when, in fact, these other determinants were the "causes" of different patterns of use--not location.

Multiple regression helps us statistically control on the importance of other factors like student body composition, leadership in implementation, and so on, and to attribute to "location" a more realistic degree of importance. Rather than present the multiple regression statistics in the context of this discussion, we have moved the statistical tables to an appendix, beginning on page 8. This appendix also contains an introduction to help the reader understand the tables. Here, we concentrate on the results of our analyses.

Impact of Micro Location on Use

Most of our analyses are summarized in Table 2. Each column in Table 2 presents results for one of the five ways of examining 'location.' Each row indicates results for one of the "outcomes" that we examined. Two entries are shown for each row-column intersection: the first is for elementary schools; the second, for secondary schools. A "+" indicates that there was substantially more of that outcome in those schools that located their micros in the way suggested by the column heading (e.g., in "classrooms only"); a "-" indicates substantially less of that outcome in comparison to other micro-using schools. A blank entry means that the difference was not statistically significant.

Micros only in classrooms: less use, but more equitable use.

The first column of Table 2 suggests that restriction of microcomputers to regular teacher classrooms may have the following consequences: fewer teachers using computers in their teaching, a narrower range of uses being made of the computers in elementary schools, greater use of microcomputers for drill-and-practice than programming instruction (in secondary schools, a less dominant use for programming instruction), more equity in use between below-average and above-average students in secondary schools, and a smaller amount of computer time for each of the students who do use a computer.

In quantitative terms--using some of the regression coefficients from the analysis--we find that restricting micros to elementary school classrooms rather than having at least some put in a library or laboratory may result in half as many teachers becoming regular users of the equipment with their classes. Also, limiting micros to secondary school classrooms means that they will be used for 1 1/2 or 2 hours less per week than putting them in labs or other centralized facilities. Actually, the real dif-

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Table 2: Summary: Impact of Micro Locations on Patterns of Use

Note: Each row-column combination has two entries. The format is...

ELEMENTARY ENTRY / SECONDARY ENTRY. The entries are:

\+ : Substantially More in These Schools Than in Other Schools
\- : Substantially Less in These Schools Than in Other Schools

	Classrooms Only	Computer Lab	Library	Rotate Micros Between Rooms	Dispersed Locations
Number of Regular Teacher Users.....	- / -	+ / +	/ +	/ +	/ +
Number of Hours Per Week of Student Use.	/	+ / +	/	/ +	- /
Breadth of Use Across 13 Applications.....	- /	/ +	/ -	/	/ +
Percent of Students Who Use Micro.....	/	+ /	/ +	+ / +	/ +
Dominance of Computer Programming Uses over Drill-and-Practice..	- / -	+ / +	/ -	- /	+ / -
Equity Between Above-Average and Below-Average Students' Use.. ..	/ +	- / -	+ /	+ /	/
Computer Time Per Student User.....	- / -	/ +	/	- /	- /
Academic Learning Attributed To Micro Presence...	/	/	- /	- /	/
Social and Organizational Outcomes Attributed to Microcomputer....	/	/	- /	- / -	- /

ferences deriving from these and other statistically significant relationships are likely to be much greater. Because of the imprecision with which most variables like this are measured, true relationships are most often understated by multiple regression procedures.

Impact of having a computer lab: more use; heavy on programming.

The second column of Table 2 suggests that putting some or all computers into a room used solely for computer-related activities--that is, a computer lab--may have these consequences: regular use of the computer by a larger number of teachers; student use of the micros for more hours of the week; a broader range of uses being made of secondary school computers; a higher proportion of elementary school students using the computers at all; in secondary schools, longer turns at the computer by those who do use the computers, particularly for program-

ming assignments; greater dominance of computer use by "above-average" students in both elementary and secondary schools; more intensive use of secondary school computers for programming activities; and more programming use than drill-and-practice use in elementary schools. In addition, elementary schools with computer laboratories reported much greater student enthusiasm for school, after controlling for the background variables.

Although most of these differences suggest that laboratory placement of microcomputers has positive consequences at both the elementary and secondary levels, one result of such organization is a tendency to restrict computer use to better-prepared students. This is, no doubt, partly because the emphasis in these lab situations is usually on computer programming. Schools concerned about equity of access to microcomputers, but desirous of taking advantage of laboratory arrangements, may want to provide a different supervisor for the computer laboratory than a teacher apt to use the equipment with only the most advanced mathematics classes. The survey data show no compelling reasons for limiting computer use to the "above-average" students, although teachers clearly perceive that above-average students have so far profited from having microcomputers much more than have other students.

Putting micros in the school library: elementary and secondary effects differ.

Placing microcomputers in the school library also has consequences for their use, as the summary data in the third column of Table 2 show. In particular, computers in secondary school libraries encourage computer use by more teachers, even more so than do computer labs. Also, at that level, having computers in the library means that more students will use them than when they are located elsewhere. However, student use is more restricted: there are fewer different uses made of micros in secondary schools where they are in the school library; and there is less intensive programming instruction, resulting in more equivalence between programming use and drill-and-practice use. Overall, in secondary schools with micros in the library, the machines are in use somewhat less of the time than schools with computer labs, but more than schools that keep their micros only in classrooms.

Elementary schools with a computer in the school library had more balance in use of the equipment between above-average and below-average students (other factors controlled); but the schools reported less positive learning outcomes and less positive social outcomes. ("Enthusiasm" was particularly low among elementary schools with computers in their library.)

Rotating micros: more access, but less impact on students and schooling.

The consequences of rotating microcomputers from room to room in elementary schools appear to be much the same as those of locating micros in the school library--more equity of use between above-average and below-average students, and poor reported outcomes for student learning and social aspects of computer use. (These analyses also control for the particular locations of the microcomputers, in order to see the effect of rotation per se.) Rotating microcomputers also results in access by a higher proportion of the school's students, but, elementary schools that rotate micros provide less computer time for each student user. There is also a tilt towards using microcomputers for drill-and-practice rather than programming instruction in the elementary schools that rotate equipment.

Elementary schools that rotate microcomputers do not have more teachers who use the microcomputer regularly than elementary schools that do not rotate micros; in contrast, this is the largest conse-

quence of rotating micros at the secondary level. It is by involving more teachers with micros on a regular basis that secondary schools that rotate micros use them for more hours of the week and with a higher proportion of the school's students than do secondary schools that do not rotate their micro equipment.

Dispersing micros around the school: more beneficial for secondary schools.

Finally, we have the question of whether schools should put all their microcomputers in one location, or spread them among several rooms (whether or not they rotate them to different rooms at different times). The regression results show different consequences for elementary and for secondary schools. Dispersion of micros at elementary schools may produce less overall use of micros, less computer time for each student who does use the computer, and possibly less beneficial impact, overall (as suggested by less effective academic and social outcomes, as reported in our survey). Dispersion is also associated with use for programming instruction rather than drill-and-practice.

Secondary schools that have dispersed their microcomputers to different locations, in contrast, have more regular computer-using teachers, a wider range of use of micros, a higher proportion of students using micros, and less of a dominance of programming activities as against drill-and-practice. (These results, of course, control on the number of micros at the school, the size of the student body, and the other background variables, as well as whether rotation of equipment is involved.) Thus, dispersion does not appear to be a good idea for elementary schools, but it has certain benefits for secondary schools.

Summary

These analyses suggest that where schools locate microcomputers has an impact on how they are used. Keeping microcomputers solely in classrooms has largely negative consequences, although equity of use is improved for secondary schools. Putting computers into a laboratory situation, in contrast, has generally positive consequences, except for equity. Neither pattern, though, classrooms or laboratories, is related to respondent judgment regarding the academic or social and organizational consequences of having computers in schools.

Locating computers in libraries has a mixed impact. It may improve equity in elementary schools and increase use by teachers and students in secondary schools, but not much consequence appears to follow, in terms of learning or improving social organizational outcomes. Rotating microcomputers from room to room is generally positive for secondary schools and improves equity and access at elementary schools, but at the expense of computer-using students getting an insufficient amount of computer time to accomplish much learning. Dispersing microcomputers among several locations at any one time appears to have only negative consequences for elementary schools, but has the benefits for secondary schools of increasing micro access to larger groups and for a broader range of activities.

Considerations such as these are certainly not the last word in deciding how schools should use the relatively small number of microcomputers they have with their comparatively large student bodies. However, when considering the educational value of school expenditures on such expensive instructional equipment--equipment that in contrast to movie projectors, television sets, photocopiers, and so forth, must generally be used for the benefit of a relatively few students during the course of a day--it is important to think, not only of the instructional value of computers for an individual student, but of how schools might most effectively organize use of computers so that they would best assist classrooms of students.

Technical Appendix: Multiple Regression Analysis of Location Effects

An Introduction to Tables A1 - A5

The analysis of location's impact on patterns of micro use "holds constant" other factors. The relationship between where schools put their micros and how they use them was examined by statistically holding constant several "background" variables which also affect "where" and "how" schools use computers: the number of students enrolled, the number of micros at the school, race and socioeconomic status of the student body (measured by two dichotomies--whether the school was a "high SES, predominantly white school" and whether it was a "predominantly minority school"), the year the school first obtained a microcomputer, the influence that a single teacher had on the school's first acquisition and implementation of a microcomputer, and the presence of computer enthusiasts on the teaching staff. In addition, the number of regular computer-using teachers--itself one of the outcomes of locating equipment in different places--could be considered an independent determinant of how well schools use microcomputers; therefore a second regression equation was calculated with this variable held constant as well, and results are shown separately in the tables whereever it made a difference in how important "location" itself seemed to be.

Results are shown only if at least a modest relationship was found. Each of the Tables A1 through A5 shows descriptive statistics and statistics from the multiple regression analyses for one of the five location variables. Results are shown only for those outcomes where the location variable was at least marginally significant in the regression model used (beta=.08 or higher; approximately equivalent to $p<.20$, elementary; $p<.10$, secondary).

Columns 1 and 2 show simple average values for two groups of schools. The first two columns of numbers in each table show the average values on the outcome variable (for example, the average "number of regular micro-using teachers") for those schools that had the characteristic in question (e.g., "micros only in classrooms") and for the remaining schools (i.e., "micros not 'only in classrooms'"). Some outcome measures (for example, "breadth of use across 13 applications") are built from indices of several questionnaire items. In these cases, "average values" do not have a concrete meaning, so the computed averages are omitted from the table. The "Units" column in the table is shown as "(index)" for these situations.

Columns 3 and 4 show how closely location and outcome are linked. The correlation coefficient (r) and the standardized regression coefficient (beta) are shown in columns three and four. The correlation coefficient is a descriptive measure of how much an outcome variable differs according to where schools put microcomputers. A "zero" means it does not differ at all; a "1" or a "-1" would mean that the outcome is totally determined by the locational contrast--not a very likely occurrence!

"Beta" is similar to the correlation coefficient except that it shows how much "outcome" and "location" are associated after taking into account that different types of schools locate microcomputers differently and these other factors also affect the outcome. It can be used as a rough guide for determining which outcomes are most affected by the contrast in locational arrangements highlighted in that particular table.

Column 5 shows the impact of location according to the statistical model. The last column, labeled "b," also comes from the multiple regression analysis. It is equivalent to the difference between the two "average values" (columns one and two) after controlling on other background factors. Again, for those outcomes built from indices for which "average" values have no concrete meaning, the "b" value is omitted from the table. The "beta" coefficient, compared with other "beta" coefficients for that locational contrast can give the reader a sense of the impact of location on that outcome variable.

An example: The first row of entries in Table A1. Table A1 shows several ways that limiting microcomputers only to classroom locations affect school and student outcomes. The top half of the table shows outcomes affected in elementary schools. The first of these is the number of teachers who regularly use microcomputers.

Columns one and two give the average number of teachers who use micros regularly in two groups of elementary schools: those that keep micros only in classrooms, and those who have micros elsewhere (whether or not they also have any in classrooms). On the average, there are 3 more micro-using teachers in schools that do not limit their micros to classrooms (6.1 vs. 3.1).

But the "not only in classroom" schools also may have more micros altogther, may have had micros longer, or may differ from "only in classroom" schools in other ways that also might affect how many teachers use micros. The multiple regression procedure accounts for these factors which otherwise could "confound" our understanding of the impact of location on teacher use.

The result of the analysis, shown in Column 5, is that there are still 2.6 more regular micro-using teachers in elementary

Table A1: Impact of Locating Micros ONLY IN CLASSROOMS on Patterns of Micro Use

Outcome Variable	Average for Schools... With Micros ONLY IN CLASSROOMS (mean)	Average for Schools... With Micros NOT "Only in Classrooms" (mean)	(Units)	Measures of Association r	beta	Impact in Units b
Elementary						
Number of Regular Teacher Users.....	3.1	6.1	teachers	-.22	-.18	-2.6
Breadth of Use Across 13 Applications.....			(index)	-.15	-.12	
Dominance of Programming over Drill/Practice.			(index)	-.07	-.12 -.17	
Computer Time Per Student User.....	27.	35.	minutes	-.10	-.09 -.12	-7.2 -9.5
Secondary						
Number of Regular Teacher Users.....	2.4	4.1	teachers	-.25	-.18	-1.3
Number of Hours Per Week of Student Use.	13.5	16.5	hours	-.13	-.09 -.07	-2.1 -1.6
Equity Between Above- and Below-Average Students' Use.....			(index)	.08	.09	
Dominance of Programming over Drill/Practice.			(index)	-.08	-.07 -.10	
Computer Time Per Student User.....	68.	85.	minutes	-.11	-.09 -.11	-14. -17.

schools with micros located in places other than classrooms than in schools with micros only in classrooms, other factors accounted for.

Notice also that the beta coefficient is only slightly less than the correlation coefficient; this is true also because controlling on background factors, in this case, does not appreciably change our impression of the importance of location in determining teacher utilization of micros. As a matter of fact, because we have controlled on so many variables without the relationship appreciably changing, we have more confidence in the idea that location is actually responsible for differential use by teachers.

Table Notes

Where two successive rows of regression statistics are provided for a single outcome variable, the second set is for a regression equation that also holds constant "number of regular teacher-users." This second set of numbers are shown only when they make a difference in the magnitude of "beta" or "b" for the location variable. An entry "N.S." means that after holding "number of teacher-users" constant, location is not, independently, a determinant of the outcome variable (N.S.: "not significant").

Besides controlling on the various background factors mentioned in this "introduction," the regression equations for "rotate micros between rooms" control on <u>where</u> micros were placed (lab or library vs other), and the equations for "number of (simultaneous) locations" control on where they were placed and on whether any of the computers rotate among different locations.

Table A2: Impact of COMPUTER LABORATORIES on Patterns of Micro Use

Outcome Variable	Average for Schools... With MICROS IN COMPUTER LABS (mean)	WITHOUT ANY Computer Labs (mean)	(Units)	Measures of Association r	beta	Impact in Units b
<u>Elementary</u>						
Number of Regular Teacher Users.....	6.2	4.5	teachers	.12	.08	1.2
Number of Hours Per Week of Student Use.	16.5	13.6	hours	.13	.15 .10	3.3 2.3
Percent of Students Who Use Micro.....	43.	30.	percent	.18	.13 .07	9. 5.
Equity Between Above- and Below-Average Students' Use.....			(index)	-.12	-.16 -.17	
Dominance of Programming over Drill/Practice.			(index)	.15	.17 .19	
Student Enthusiasm Because of Micros... ('social' outcome)			(index)	.19	.19	
<u>Secondary</u>						
Number of Regular Teacher Users.....	4.0	3.0	teachers	.15	.08	0.6
Number of Hours Per Week of Student Use	16.8	14.2	hours	.12	.09 .08	1.9 1.7
Breadth of Use Across 13 Applications.....			(index)	.18	.18 .16	
Dominance of Programming over Drill/Practice.			(index)	.11	.08 .10	
Equity Between Above- and Below-Average Students' Use.....			(index)	-.09	-.10	
Computer Time Per Student User.....	90.	69.	minutes	.14	.11 .12	15. 17.