

Computer equity is broader than mere access. . . . Computer inequity is the unequal access to computer learning as consequences of a student's social and economic position . . . or willingness of schools to provide computer experiences.

Computer Equity: Implications for Educational Policy and School Leadership

by Dr. Richard King

The pressure to move schools into the information age has been felt for several years throughout the nation. Educators, board members, and legislators are striving to define appropriate roles for technology in education, to identify the most effective ways to use computers in instruction and in classroom and office management, and to ensure that pupils of all backgrounds have opportunities for computer education. They are finding the resources needed to acquire hardware and software and are retraining present school personnel to use technology in instruction and management.

These challenges are critical in framing decisions made at all levels of the education policymaking hierarchy. The research study* discussed in this article addresses many of these issues in the context of microcomputer access and use in schools of North Carolina. Following a discussion of findings related to computer equity, implications for finance policy and for educational leadership are presented.

Equity in Computer Education

The computer's role in our increasingly information-oriented society will influence its role in schools. An important purpose of schooling is the preparation of individuals who are able to function productively in society. The ability to use and understand the potential and limitations of technology may someday be as essential in formal education as the traditional three Rs. Indeed, computer science is one of the "five new basics" according to the report of the National Commission on Excellence in Education (1983). A future so-

ciety which demands abilities to engage in information exchange compels opportunities for all pupils to use technologies in public schooling.

If we accept the fact that there are educational and economic benefits for students who are exposed to or can master the capabilities of computers, then we must face questions related to equity. Computer inequity is the unequal access to computer learning as consequences of students' social and economic positions (Anderson, et al., 1984) or as outcomes of differential abilities or willingness of schools to provide computer experiences. For Winkle and Matthews (1982, p. 315), equity is also closely tied to what teachers do within classrooms: "Computer equity means individualizing instruction in computer literacy, since students approach this new technology with varying experiences and expectations and interact with microcomputers in different ways."

Computer equity is broader than mere access to computers as might be expressed by a ratio of pupils to computers. It is also related to how they are used in the curriculum. Equity is concerned with identifying which students have opportunities for learning *about* (i.e., gaining literacy and programming skills) as well as *with* (i.e., using them as tools for learning and problem solving) computers. Yet, because computers are not being introduced into all schools, grade levels, and classrooms at the same time, differing access to hardware is itself a critical concern in reaching computer education goals.

Recent national surveys show that microcomputer availability varies greatly among schools. Students in less affluent communities receive very different opportunities for gaining computer literacy than do pupils in more affluent school districts (Market Data Retrieval, 1982; Quality Education Data, 1984; Anderson, et al., 1984; Center for Social Organization of Schools, 1983; and Becker, 1985). These studies focus more upon which schools have computers than on what these computers are used for, but relationships between uses made of computers and community wealth also emerge in analyses. The Quality Education Data survey, for example, found that fewer students in Title I schools take computer programming classes (Anderson, et al., 1984). Watt (1982) and Campbell (1984) report similar differences in instructional uses, noting that suburban schools introduce computers in the context of awareness, creative inquiry, and programming, while less affluent schools' use is primarily computer-assisted instruction of the drill and practice variety. Watt concludes, "Affluent students are thus learning to tell the computer what to do while less affluent students are learning to do what the computer tells them."

Lipkin (1984, p. 21) suggests that computer use can help disadvantaged pupils overcome many obstacles which often interfere with schooling: unfavorable dispositions toward learning, low levels of information processing skills, and little contact outside their own subcultures. He observes that the computer can provide positive reinforcement and motivation, serve as the instrument for developing skills to process information, and provide needed two-way communications with the outside world. But in fact, in about half of the schools reporting data in Becker's (1985) study, it is not the disadvantaged students with unfavorable attitudes who are using the computer. Rather, it is the higher achieving pupils who use computers in both ele-

Dr. Richard King is an associate professor and chair of the Program in Educational Administration at the University of North Carolina at Chapel Hill.

*This study was financed by a Spencer Foundation Young Scholar's Research Grant. The author appreciates the assistance of Anne S. Presnell in gathering and analyzing interview data.

mentary and secondary schools. In only a small minority of schools (perhaps 15 percent), computer use is intentionally and disproportionately allocated to lower achieving students.

Equity in computer education is a critical policy concern. Substantial social and economic gaps may result in the future between the "haves" and "have nots" (Nathan, 1983) of society, those who have and do not have access to and abilities to use information systems. The cumulative impact of decisions made at legislative, school district, and classroom levels about the purchase and use of computers can result in serious inequities. Economic factors may play a primary role in computer equity, just as they affect the distribution of many other educational resources. As several of these national surveys indicate, wealthy school districts are better able to purchase more computers within their larger overall budgets derived through a combination of state and local funds. The greater the amount of discretionary funds available to schools, the greater the ability of educators to procure instructional materials generally. But, unlike most other educational resources, computer hardware and software are not being funded exclusively through these traditional revenue sources.

In the early stages of microcomputers in public schools, funds were largely in the form of industry gifts, foundation grants, Federal programs, and school and PTA fund raising activities. Computers purchased through Federal categorical grants often restricted pupil access to those who were educationally disadvantaged or enrolled in vocational or special education classes. Many of these other sources enhanced instruction with computers in wealthier communities. State and local funds which have been increasingly devoted to computer education have also contributed to inequities in access among school systems.

As restrictions tied to Federal assistance ease under the block grant approach, and as proportions of Federal funds for education decline, poorer districts are losing their source of discretionary funds for such purchases. In contrast, wealthy districts find increasing support through these per pupil federal grants and through the growing commitments of local boards of education, businesses, and parent organizations. The Market Data Retrieval and Johns Hopkins University surveys indicate not only a strong advantage for wealthier schools, but also an ever widening gap between poor and wealthy schools.

State allocations for computer education often contribute to these inequities by showing little regard for differing abilities of school districts to provide funds for computers. In North Carolina, for example, an appropriation of over \$26 million between 1984-85 and 1986-87 finances hardware, software, supplies, repairs, and staff development through equal per pupil allotments. The General Assembly adopted a flat grant approach so that districts which had already spent funds on computer education would not be penalized. Equal allotments do not, however, take into account such factors as current microcomputer availability, districts' abilities to secure other sources of revenue, or students' needs.

States which finance needed equipment and staff development acknowledge the importance of computers in public education; they must also recognize potential inequities in access and use. This research explores various attributes of school systems which account for discrepancies in pupils' opportunities to learn about and with computers in North Carolina.

The Study Design

Analyses of relationships between microcomputer

availability and primary uses and financial and demographic data for all 141 school districts explored dimensions of equity in computer education. Interviews with school personnel in 16 selected districts supplemented this statewide analysis. Discussions of problems faced by educators as they plan programs, secure resources, provide staff development, and so on added "richness" to the macro level data.

Profile of Participating Districts. The selection of school systems deliberately included relatively wealthy and poor districts which provide relatively high and low pupil access to microcomputers. In order to reflect the diversity present in the state, the sample included both county and special chartered units, urban and rural districts, large and small units, wealthy and poor systems, and at least one district served by each of the eight regional offices of the State Department of Education. A primary criterion in their selection was access to microcomputers, defined as the ratio of pupils to computers as reported annually to the State Department.

A second criterion for selection was district financial condition, defined by assessed valuations and expenditure levels. Of the eight high access districts, four were located in relatively high wealth and four were in relatively low wealth communities. A similar division obtained with regard to the eight low access districts. Thus, four districts in various geographic areas of the state fell within one of four groups: high access-high wealth, high access-low wealth, low access-high wealth, and low access-low wealth.

In 1985, access to computers in those districts labeled high access was higher than the statewide average of 48 pupils to each computer. Ratios were 39 students to one in the four high wealth and 38 to one computer in the four low wealth districts. In contrast, pupils in the eight low access districts had much lower computer availability than did students in the state as a whole. The four high wealth districts classed as low access had one micro for each 66 pupils, and the four low wealth districts provided one computer for each 70 students.

In terms of relative financial condition, districts in the high wealth groups were above, and those in the low wealth groups were below, the state average property valuation. High wealth districts' per pupil valuations were \$345,695 and \$277,621 in the four high and low access districts, respectively. These figures were well above the state average (\$196,782) as well as being above valuations of the low wealth school systems (\$167,205 in high and \$136,460 in low access districts). Property tax rates and total (including state, federal, and local) funds expended followed similar patterns.

While it was not a consideration in the selection of participating districts, one additional attribute of these high and low access groups is worthy of attention. The eight high access districts had lower percentages of minority pupils (23 percent in high wealth and 30 percent in low wealth groups) than the percentage of minority students enrolled in the state as a whole (35 percent). In contrast, lower access districts enrolled 51 and 48 percent minorities in high and low wealth districts, respectively. This observation about the 16 districts is quite consistent with a highly significant ($p < .01$) negative correlation between access and minority enrollment in schools statewide.

The Statewide Analysis. The 141 North Carolina school districts range in size from under 600 to over 71,000 pupils. As with most other states, these districts vary greatly in measures of community socioeconomic status, school system wealth and effort, and revenue and expenditure levels.

Correlation coefficients identified several of the demographic and financial characteristics included in the original data set which were so highly related that they would explain much of the same variance in microcomputer access, use, and location. The following underlined ten school district characteristics were thus chosen as relatively independent variables for analysis.

Curricular innovations very often begin in large urban or suburban schools which are located near colleges or universities. The **average daily membership (ADM)** in the 1984-85 school year entered analyses to determine if district size had any bearing on the degree to which computers were available. The **density** of school districts, defined as the number of pupils per square mile, is an indicator of the urbanization of the system. **Distance metro/university** is the number of miles between central administrative offices and metropolitan centers larger than 30,000 which have a graduate level education degree program.

Many studies since the middle 1960s demonstrate that the socioeconomic status of a community has as large an influence upon educational opportunities as do factors present within schools. Two indicators of school districts' socioeconomic status, **median family income**, and the percent of **minority pupils**, thus entered analyses.

The wealth of local communities has long been recognized as influencing abilities of schools to finance educational programs. In North Carolina, varying amounts of locally raised funds supplement allotments granted by the General Assembly. Discretionary funds for enhancing computer education have often been found in this local revenue. Measures of district financial conditions included the **adjusted property valuation** per pupil which takes into account differing numbers of years since reevaluation. As an indicator of tax effort, the **total tax rate**, which includes the countywide levy and any additional local supplement in the district, entered analyses.

The largest source of money, about 64 percent of the total, is provided through the General Assembly. These funds are closely tied to personnel allotments, and leave little discretionary funds for computer purchases. The state has, however, financed computer education through the special appropriation discussed earlier. Federal funds acquired through categorical programs for disadvantaged, vocational, and special education pupils and through more recent general purpose block grants amount to about 10 percent of the total operating revenue available to districts in North Carolina.

Levels of expenditures derived through these various sources entered analyses. The **state expenditure** varied from \$1,345 to \$1,761; the mean of \$1,472 and standard deviation of \$75.50 indicate little variation among the majority of school systems (from about \$1,397 to \$1,548). **Federal expenditure** levels appear to have varied more than these state amounts, with a range from \$67 to \$319 per pupil. **Local expenditure** amounts varied substantially from \$195 to \$1,159; the mean and standard deviation reveal that the majority of districts were between \$265 and \$601. As with the demographic variables, we anticipated that differences in these financial measures would explain some of the variation in computer access and uses among school districts of the state.

Determinants of Computer Access, Use, and Location

School district media coordinators responded to surveys in both 1984 and 1985, indicating the number of microcomputers available in their schools, and their primary uses and locations. The **ratio of pupils to micros** in 1985 and the

percent change in the ratio in the two-year period are dependent variables in analyses as indicators of access (see Table 1).

Table 1. Microcomputer Access, Primary Use, and Location—Dependent Variables in Analyses (N = 141*)

VARIABLE	MINI-MUM	MAXI-MUM	STANDARD MEAN	DEVIATION
Access				
Ratio of pupils to micros—1984*	14.22	335.15	98.39	50.82
Ratio of pupils to micros—1985	12.96	109.86	48.12	16.41
Percent change in ratio—1984 to 1985*	2.86	476.67	103.67	70.41
Primary use (percent of total)				
Literacy	0.00	100.00	47.62	20.22
CAI/CMI	0.00	90.27	18.36	17.08
Programming	0.00	62.96	13.97	13.04
Administrative	0.00	18.29	5.35	3.95
Location (percent of total)				
Computer lab	0.00	100.00	33.30	17.48
Classroom	0.00	100.00	32.50	19.55
Media center	0.00	55.81	14.17	9.98
Mobile	0.00	38.37	8.50	7.46
Office	0.00	22.88	4.46	3.62

*N = 141 for all variables except Ratio of Pupils to Micros in 1984 and Change in Ratio from 1984 to 1985, as three districts did not respond to the survey in 1984.

The range in ratios in 1984 of one microcomputer to 14 pupils (relatively high access) to one computer to 335 pupils (relatively low access) diminished to a range in 1985 from one to 13 and one to 110 pupils. This large constriction in the range in access among districts is evident also in the means of the ratios. Access improved dramatically from one microcomputer to 98 pupils to one to 48 pupils on the average in the state. The percent change in these ratios ranged from 3 percent improvement to 477 percent improvement. Clearly, districts made great strides in one year in increasing students' access to computers, largely in response to the infusion of funds from the General Assembly.

The overall difference in ratios among districts and the variation evidenced by the standard deviation is of continuing concern. In 1985, the large majority of districts provided one computer for between 32 and 65 pupils, a relatively large range in ratios about the mean. Furthermore, the nature of computer education curriculum which can occur in lower access districts with ratios approaching one computer to 110 pupils is very different from curriculum in those districts having very high access ratios of nearly one microcomputer to 13 pupils.

The reported "primary use" entered analyses to determine if district characteristics would explain variations among districts in uses made of computer technology. The percent of the total microcomputers available which were reported to be used primarily for **literacy**, computer assisted/managed instruction (**CAI/CMI**), **programming**, and **administrative** applications were dependent variables in subsequent analyses. Computer literacy was clearly the primary use in 1985, with an average of 48 percent of micros in districts devoted to this purpose (see Table 1). While at least one district reported that 90 percent of the microcomputers were used primarily for CAI/CMI, the mean percent-

age was quite low (18 percent) and was closely followed by programming as a primary use (14 percent). Very few of the micros were reported to be used primarily for administrative tasks.

The nature of access and uses made of computers depends in part upon their location in schools (Becker, 1983). The percentages of the total microcomputers which were located in **computer labs**, in **classrooms**, in **media centers**, on **mobile carts**, and in **offices** were dependent variables in analyses. Ranges in reported locations indicate that between zero and 100 percent of a district's computers were in labs and classrooms (see Table 1). Fewer were in the other locations: zero to 56 percent were in media centers, zero to 38 percent were on mobile carts, and zero to 23 percent were in offices. Overall, one-third of the microcomputers in the state were located in computer labs, and one-third were in classrooms, with the remaining computers divided among other locations.

Statistical models select combinations of independent variables which predict dependent variables. When variables were permitted to enter regression equations only if they met a test of significance (i.e., probability of F less than .10), several of the district characteristics entered equations. This requirement was imposed so that variables which individually or collectively did not explain a significant amount of variance did not enter equations. The results of these analyses are presented as "best" possible equations in Table 2. The order of entry of variables and levels of significance of individual variables and of the combination of variables (R^2) is indicated for each equation.

Four of the independent variables explained significant amounts of the variance in the ratio of pupils to microcomputers in 1985 (see Equation 1). This ratio was higher (i.e., lower access) in districts with large enrollments, higher concentrations of minority pupils, and lower proportions of their expenditures from state and local sources. Conversely, higher access was afforded in smaller districts with lower minority enrollments and in districts which were more dependent upon state and local funds.

It must be noted that the adjusted property valuation of school units first entered this equation, but its capacity to uniquely explain variance in access was mitigated by the entry of the variables indicated in Equation 1. This effect is best explained by the correlation between valuation and percent of minority pupils (-.33) and local (.38) sources of funds. Despite its absence from the "best" equation, the power of property valuation to explain variation in access has implications for equity in computer education.

The percentage change in ratios from 1984 to 1985 is best explained by the median family income of district residents (see Equation 2). The greatest improvement in access occurred in districts with the lowest family income. Nevertheless, this one variable accounts for less than one percent of the variance in the change in ratios among districts of the state. It appears that greater improvements in access occurred in districts which may be least able to provide them through such sources as community fund-raising activities and donations from parents or other residents. Each of these has been a source of computer related funds in many of the higher access districts. The equal per pupil grants for computer purchases from the General Assembly may have greatly improved the relative condition of computer education opportunities in school districts which most needed them.

District demographic and financial characteristics predicted only three of the four primary uses of microcomputers. The percent of computers used for teaching literacy

Table 2. Best Regression Equations for Microcomputer Access, Primary Use, and Location

Dependent Variable	Independent Variables	Regression Coefficient	F	Significance Level (P<)
EQUATION 1				
Ratio of pupils to micros (1985)	ADM	0.0005	10.37	0.01
	Minority pupils	0.2273	18.02	0.01
	State expen.	-0.0342	3.81	0.06
	Local expen.	-0.0289	14.55	0.01
	Intercept	99.6534		
R^2		0.2376	10.60	0.01
EQUATION 2				
Change in ratio (1984 to 1985)	Family income	-0.0050	3.97	0.05
	Intercept	182.2177		
R^2		0.0283	3.97	0.05
EQUATION 3				
Literacy	State expen.	-0.0645	5.59	0.02
	Federal expen.	0.0660	2.92	0.09
	Intercept	132.7746		
R^2		0.0402	2.89	0.06
EQUATION 4				
CAI/CMI	Total tax rate	-12.1646	2.62	0.10
	Distance metro	-0.1117	2.81	0.10
	Intercept	30.8581		
R^2		0.0343	2.45	0.09
EQUATION 5				
Administrative	Family income	0.0004	6.03	0.02
	Distance metro	0.0303	3.01	0.09
	Intercept	-1.6952		
R^2		0.0443	3.20	0.05
EQUATION 6				
Media center	Minority pupils	0.0762	4.50	0.04
	Intercept	11.6162		
R^2		0.0314	4.50	0.04
EQUATION 7				
Mobile	Family income	0.0005	2.79	0.10
	Federal expen.	-0.0336	5.17	0.03
	Intercept	5.0747		
R^2		0.1445	11.65	0.01
EQUATION 8				
Office	State expen.	-0.0069	2.93	0.09
	Intercept	14.6332		
R^2		0.0206	2.93	0.09

was best determined knowing the proportion of total funds derived from state and federal sources (see Equation 3). Higher literacy use was associated with lower state but higher federal expenditures. These variables explained little (.04 percent) of the variance in literacy use, but suggest that literacy was the primary concern of districts most dependent upon federal revenue.

The proportion of computers used for computer assisted or computer managed instruction was best explained by the total tax rate and the distance from a metro center with a college (Equation 4). The direction of each relationship indicates that CAI/CMI was more likely to be happening in districts which had lower tax rates and were closest to metropolitan areas. Administrative uses were likely to be found in districts with higher family incomes which were farthest from metropolitan centers as indicated in Equation 5. It appears that the leaders in using microcomputers to ease administrative tasks are located in higher socioeconomic areas of the state, perhaps in smaller districts which are away from urban centers.

None of the district characteristics entered equations to predict the location of computers in laboratories or classrooms. The proportion of minority pupils explained a significant amount of the variance in the percent of computers located in media centers (Equation 6). Districts with more minority pupils were more likely to house computers in media centers, while districts with higher family incomes and lower proportions of funds from federal sources were more likely to locate computers on mobile carts (Equation 7). Districts with lower proportions of expenditures derived through state sources also located more computers in office settings (Equation 8).

These relationships suggest that computers are likely to be located in media centers in school districts serving more minority pupils. Computers in wealthier school districts are more likely to be available for use within classrooms since they are on rolling carts. Classroom use may enhance access for more pupils and broaden the range of potential uses; educators should examine implications of media centers and mobile computers on computer education opportunities, particularly for minority pupils.

A large percentage of variance in computer access, use, and location is unexplained by traditional predictors of school conditions. It is only in the equation for the ratio of pupils to microcomputers that a relatively high percentage of variance is accounted for by district demography. Computers are more accessible in small, wealthy districts which enroll fewer minority pupils and which are more dependent upon state and local sources of income. Conversely, there is lower access to computers in large, poor districts with more minorities and a heavier reliance upon federal resources.

Leadership and Computer Access and Use

Several questions from this analysis of state level data prompted interviews** and on-site visits: What are superintendents' and computer coordinators' perceptions of computer access and use in wealthier and poorer communities? To what degree are students learning *about* and learning *with* computers in elementary, middle, and high schools? What factors appear to be associated with relatively high computer access in those four low wealth districts, and, conversely, with low access to computers in those four high wealth districts in which one might expect different levels of access?

As superintendents, computer coordinators, business managers, and others discussed instructional issues and sources of funds, it became apparent that leadership and

personnel commitment are vital. Leadership was particularly evident, for example, in descriptions of progress made in the low wealth-high access districts. Differences in wealth may be mitigated by the presence of strong leaders who inspire others to commit energy and resources.

Recent research identified leadership as one of the five correlates of effective schools. Lezotte (1983) stated, "Appropriate and effective leadership is essential in any successful organization. More often than not, the attitudes conveyed by the individual in the leadership position present themselves throughout the entire organization." Someone, whether from the central administrative office, individual schools, or the community, planted the seeds from which a movement grew to involve technology in curriculum. High access districts were characterized by actively involved superintendents, principals, board members, or community leaders. Crucial leadership came primarily from *within* the local school system. When an individual or small group took the initiative, and perhaps risk, subsequent funding and personnel training followed.

It also became clear that involving personnel in planning activities for computer acquisition and use ensured personnel commitment and subsequent higher general access for pupils. Hershey and Blanchard (1982) explained that when a participative change cycle is implemented, "new knowledge is made available to the individual or group." (1982, p. 273) Furthermore, they contended that if participation is effective, changes in attitudes and behavior result. From the initial leadership in higher access districts, a general commitment on the part of school personnel and board members improved both levels of pupil access and the integration of technology with curriculum. Perhaps these findings are over-generalizations from our interviews, yet it was clear that strong leadership and commitment to technologies were quite evident in higher access districts—regardless of their financial condition.

In contrast, in many of the lower access school systems, leadership came from *outside* the local schools and community. The stimulus for change was the General Assembly's appropriation for computer education. Funding depended upon the development of school system computer plans. This situation is descriptive of a second cycle for change defined by Hershey and Blanchard. Directive change "begins by change being imposed on the total organization by some external force." (p. 273) Computer coordinators in these low access districts relied more heavily upon state directives as they developed computer education plans. There appeared to be more dependency upon the state for leadership, direction, and resources in low access districts, even in those with higher than average levels of local property value and total expenditure levels.

High access districts were leaders in the movement to involve technology in many subject areas; yet computer access and use varied widely within these systems. Furthermore, there were many examples of very effective uses of computers within some schools of those districts where pupils had generally lower access. Potential opportunities for pupils to have contact with computers, and the nature of educational experiences which can be planned for computers, were quite different in schools and classrooms providing relatively high and low access. Uses of technology in instruction varied with the number of pupils sharing equipment. Unlike instructional uses of one blackboard or movie

**A full discussion of the interview data is beyond the scope of this article and has been reported previously (King and Presnell, 1986).

projector, having one computer for a classroom of thirty pupils or sharing few computers among several classes seemed to have limited each pupil's opportunity to learn with computers. Low access districts thus focused attention in uses on literacy and programming, while higher access districts provided more opportunities for integrating technology with curriculum.

Districts were at very different stages of development (Cory, 1983) of computer use. Low access districts had "jumped on the bandwagon" of computer implementation and were in a stage of "confused activity" which was characterized by mixed feelings among teachers, administrators, and board members toward the role of the new technologies. Many schools in the high access districts had moved beyond these initial stages, and school staff found themselves engaged in coordinated planning and comfortable use of computers. The final stage, that of full implementation, is likely to be reached only if leadership and commitment, as well as funds for computer equipment and associated supplies and staffing, are present. Funds are a necessary, but not sufficient condition for reaching the goal of full implementation. This research suggests that leadership and commitment do contribute to the "sufficient" condition in the equation.

Conclusions and Implications

It is clear from our analyses of statewide data and discussions with educators in selected districts that there are extreme variations in pupils' access to microcomputers *within* and *among* school districts of North Carolina. The General Assembly's special appropriation for computers and staff development has improved access, and the goal of one computer to each 50 pupils has been reached in many districts. This goal has not, however, been attained in all districts or schools of the state.

This study began with an anticipation that school system demographic and financial characteristics would explain the extreme variance in computer access and use. While district attributes are related to inequities in computer education, these factors explain no more than 24 percent of the variance in access, primary use, and location. The remaining variance in pupils' opportunities for computer education is in part reflective of leadership and personnel commitment.

Several testable hypotheses emerge from interviews, site visits, and statewide analysis of data. Studies which focus on roles of various individuals within and outside school districts should confirm that leadership and commitment are the crucial missing variables which predict levels of access to computers.

Hypothesis 1: *Leadership and commitment at all levels in the educational hierarchy are more important for providing computer access for pupils than are demographic and financial characteristics of school districts.*

Furthermore, the development of appropriate uses of computers in instruction depends upon leadership, commitment, and direction from state and local agencies. It is school district level leadership, however, which appears to make the difference between stages of implementation observed in otherwise similar school systems. State directives provide guidelines for change; local officials determine the speed at which actual change occurs.

Hypothesis 2: *Appropriate uses of computers, especially in the form of integration within many diverse subject areas, are guided more by*

leadership abilities and the commitment of local school personnel than from state directives.

To the degree that the above theses are accurate statements about computer access and use, it is imperative for educators and policymakers to recognize and nurture leadership, prepare teachers to use computers effectively in varied subject areas, provide incentives for local development of programs, and promote the exchange of information and software applications. The following specific recommendations for school district operation and state policy should improve computer equity in both access and use:

Engage in systemwide planning. Much hardware has already been purchased by school systems and many teachers and administrators now have a better idea of directions for the future. There is continuing need for serious and participatory planning for appropriate uses of technology within the curriculum. It is essential for district personnel and board members to make a commitment to the development of systemwide plans, the acquisition of computers and instructional materials above those provided by state allocations, and the preparation of teachers and administrators.

The lack of local funds for computer education should not be the excuse for poor planning. Many districts provide higher than expected access to computers and make effective use of technology in classrooms despite low property valuations and expenditure levels. The contrast between two of the districts visited illustrates the potential which leadership and commitment can unlock.

One low wealth district, which shifted funds within budget categories and delayed other equipment purchases, now has a systemwide program in place and affords all pupils access to computers nearly daily. A high wealth district, on the other hand, despite its capacity to finance an extensive and well integrated program, is just beginning programs for high school students and will expand to elementary schools as funds flow from the General Assembly. Like many others, this district waited for state direction and funds, and pupils do not have the same levels of access nor the same quality of programs as are available in other districts of even less wealth.

In many low access districts, control over equipment is largely in the hands of a few teachers or subject area specialists, perhaps due initially to restrictions imposed by funding sources (e.g., federal categorical programs). The implementation of computer education plans is at best "disjointed," as was expressed by one coordinator. Other educators voiced a similar concern that the movement is taking off in all directions and urged policymakers to channel their energy and money. There is need for district level coordination by individuals who have a general curricular view and who understand the role of technology in strengthening school programs.

Clarify roles of computer coordinators. District level computer coordinators are a primary source of leadership and commitment. Systemwide planning for computer uses within curricula is enhanced in the high access districts by coordinators who were formerly teachers, but who are able to divorce themselves from other teaching or administrative responsibilities. Continuity in this position also appears to further the transition through successive stages of development from first jumping on the bandwagon to full implementation of a well integrated systemwide approach to computer education. Their leadership and commitment and the support of other administrative and teaching personnel

help assure the development of effective computer education plans which move school systems toward full implementation.

Coordinators are often caught between administrative and instructional specialization as they are asked to direct purchasing of equipment, coordinate the implementation of statewide networks, assist secretaries with word processing, guide administrative development of applications for recordkeeping and financial management, maintain their schedule of rotation among buildings, and even teach one or more classes. Many coordinators are expected to perform as administrators but continue to be paid for ten months on the teacher scale. The difficulty of learning administrative software and developing applications for local district financial and inventory management, while also attempting to teach several classes and help teachers in diverse subject areas, suggest that expectations for coordinators in many districts may be unrealistic.

Coordinators' perspectives are critical in districtwide planning. It was clear in many interviews that school administrators do not have a complete understanding state goals, of the degree of flexibility afforded within state appropriations, or of directions for local computer education plans. Coordinators are generally more aware of these goals and of the latitude permitted in use of state funds for computer education, and yet they are not always involved in planning. Many computer coordinators commented that they are isolated from the administration, particularly as district's priorities are defined and as decisions regarding purchases and curricular applications are made. Clarification of job descriptions and role expectations and involvement in policy development may be the incentives needed to retain these specialists who in turn can strengthen instructional access and use.

Employ building level computer specialists. Use of hardware and software and the integration of technology with curricula appear to be maximized when a computer resource teacher assists classroom teachers and communicates regularly with the district coordinator. Having full time specialists (either resource teachers or lab monitors) within schools communicates districts' commitments to technology as an important instructional tool.

Particularly in the first stages of computer implementation, resource teachers make a difference in schools' uses of computers. If teachers become skillful in integrating computers with daily instruction, resource teachers may someday be replaced by lab monitors within schools and by technicians who serve many schools. If funding is not available to employ a part or full time resource teacher, then schools should arrange for partial release of an individual from teaching responsibilities to coordinate instructional applications and to participate in training sessions within and beyond the district.

Reduce inequities in computer use within the district. Data analyses indicate that pupils in small, wealthy districts with fewer minority pupils and with expenditures derived primarily through state and local sources have greater access to computers. The relationship between access and minority enrollment is also apparent in demographic data on the sixteen districts participating in the study. The eight high access districts (in both wealthy and poor communities) evidence very low percentages of minority pupils. On the other hand, lower access districts, whether wealthy or poor, enroll much higher proportions of minorities.

In addition to inequities among districts, computer coordinators described extreme ranges in pupil use within schools and districts. Differences often reflect teachers'

abilities and willingness to employ computers, locations of computers, and decisions about which grade levels or ability groups have access. Policymakers and educators must be aware that district policies and individual teachers' actions may promote unequal opportunities for various student groups to use computers.

With the prevalence of computers in homes of more affluent families, schools should take care to balance opportunities for less advantaged and minority pupils. Teachers should ensure that computers are not restricted to high achievers, as often happens when computers become an extra activity for pupils who complete their work quickly. Indeed, computers must not be classified with recess time as a reward for good behavior or completion of assignments. Systemwide curriculum plans may have been developed to provide equal exposure for pupils, but all teachers may not have adequate training or commitment to ensure that computers are properly integrated and used by all pupils.

Procedures for signing up for computer courses or for extra time with computers in media centers and labs should not discourage use by less aggressive female and minority students (see, for example, Boss, 1982, and Anderson, et al., 1984). Career awareness programs should include discussions with minorities who make use of technologies in their businesses and professions. Minority student organizations might be encouraged to adopt computer exploration as one of their activities.

Continuing education classes in school facilities or the use of school-owned computers at home might reduce inequities among parents' abilities to provide computer experiences. Employing school level computer resource teachers may also promote community uses of schools' computers during the evening, summers, and on weekends. One superintendent envisioned the day schools will have computers available for students to sign out, much like library books. Offering short parent-child awareness sessions prior to initial use may encourage more parental involvement in school programs while enabling more pre-school and school-aged children to learn with computers.

Relate computer locations to instructional goals. North Carolina districts with higher proportions of minority pupils are more likely to locate computers in media centers. Those with higher family incomes and lower proportions of expenditures derived through federal sources have more mobile computers. These findings suggest potential equity issues associated with computer uses dictated by their locations.

Decisions about where to house computers often reflect a school's philosophy about the role of computers in instruction. There are distinct advantages and disadvantages of classroom, mobile, and laboratory locations. Consistent with the review of other studies of arrangements (see, for example, Becker, 1983, and Lipkin, 1984), interviews in the sixteen districts indicate that no one approach has sufficient advantage over the others to argue for its exclusive adoption in schools.

These findings stress the importance of involving many users in discussions about locations, as these decisions can influence pupils' opportunities to learn with computers. Curricular planning is an essential first step, to be followed by decisions about locations. Planning, leadership, and commitment play important roles in the effectiveness of various arrangements for achieving instructional goals and ensuring that all pupils have access. If programs are well planned and managed, the particular location does not appear to matter.

Prepare teachers for computer use in the curriculum.

Ensuring that all pupils have access to computers depends upon having teachers who are comfortable with and prepared to use computers. School systems should emphasize curricular applications (the computer as an instructional tool) in inservice training. Well planned sessions which include time to experiment with new software and ready access to software for later use in classrooms enhance effective transfer of new ideas to teaching. Computer resource teachers within schools will further assist classroom teachers to plan curricular applications, secure courseware, troubleshoot problems with hardware, and address equity issues.

Curricular integration is encouraged if supervisors recognize its importance. Informal feedback and more formal recognition of efforts in annual reviews and personnel decision (e.g., merit or career ladder advancement) may be incentives for teachers to participate actively in planning sessions and to use technologies in classrooms. Planning activities which occur outside normal school hours, as in the case of summer employment, permit teachers to concentrate energy on curricular development and provide recognition of the importance of their involvement.

Acquire financial resources and seek state-level leadership. Sources of revenue which finance computer education represent a broader range of partnerships and commitments than many other educational priorities. Traditional local, state, and federal funds are complimented in many districts by gifts from individuals, grants from industry, donations from parent-teacher and community organizations, and so on. These so called "creative" financing approaches include the establishment of school foundations to encourage community and industry support. In the future, it may be feasible to redirect funds from other instructional materials (e.g., hard copy texts) to phase in computers, laser disks, and other electronic media.

Special legislative appropriations like the North Carolina funds for computer hardware, software, supplies, repairs, and staff development are often viewed as an "add on" whose future is uncertain. One superintendent expressed a fear that the state may turn away from computer education and remarked, "If there is a mandate, the General Assembly should pay for it." States must express clear sustaining commitment to computer education through annual allocations to districts. Computers will become a critical part of learning in diverse subject areas in all schools in the future. By including substantial levels of funding for technology within funding formulas, districts will be better able to plan, to retain computer specialists who often are unsure of the duration of their positions, to replace and maintain hardware as it deteriorates, and to make technology a priority in instructional programs.

Great strides have been made in improving access in North Carolina, but the fact is that inequities remain. The current policy of allocating equal computer education funds per pupil was adopted to avoid punishing districts which had already purchased computers and begun staff development activities. However, continuing to purchase hardware in those districts whose ratios of pupils to computers approach 13 to one may be an inefficient use of resources when over 100 pupils share each computer in other systems. From a fiscal equity perspective, it might be advantageous to require local districts to provide a percentage of funds based on property valuations, such that wealthier districts contribute larger proportions of computer education revenue.

At some point, a "saturation" level is reached in terms

of computers to pupils. What is considered saturation will of course shift in the future as the stage of full implementation is attained. The following funding approach might yield greater latitude in the use of allotments once a "saturation point" is reached. If, for example, a ratio of 15 pupils to one computer (or 15 computers per school, whichever is greater) is desirable, flexibility in districts with saturation level access should encourage contributions to statewide program development and training efforts. State funds might pay computer specialists and classroom teachers to develop computer related curriculum to be shared with, or to sponsor training sessions in, neighboring schools and districts. Rewards and recognition for such responsibilities, rather than additional hardware purchases, might be the incentive needed to retain their skills in public education. Moreover, sharing their abilities and programs would improve computer education in other schools and districts.

There are continuing concerns with acquiring, maintaining, and replacing adequate hardware and software, attracting and holding teachers and coordinators who are skilled in computer uses for schools, preparing personnel to make appropriate uses of technology in instruction and management, and remodeling facilities and maintaining security. School personnel expressed their desire for an expanded commitment for the state in financing programs and computer coordinators' positions through continuing annual allotments.

In this arena, state departments can play critical roles as leaders in planning for computer education and as disseminators of information. Their personnel should strive to strengthen curriculum guides with references to teaching with computers to enhance pupils' problem solving and higher order thinking skills. Planning and program development efforts should encourage the movement in all districts from teaching about computers to using computers as tools of instruction.

Computer coordinators speak highly of statewide meetings and regional conferences as opportunities for learning about new software and curricular applications. State and regional information exchanges serve important functions as software clearinghouses and sponsors of workshops which feature teachers and curriculum specialists. Personnel in one district might be referred through these exchanges to persons in another district, to state agencies or to universities with expertise in integrating particular software with curricula. Rapid exchange of information and calls for help among districts and state agencies should justify the creation of expanded electronic networks and telecommunications. Clearinghouses might also coordinate corporate investments to encourage industries to assist computer education efforts in diverse school systems.

Include computers in school improvement efforts. Educators recognize the importance of computers in schools, but they are currently burdened with multiple demands for school improvements. Rather than competing for resources and planning time, involving computers in curricula can and should be important aspects of schools' responses to states' career development and curricular revision plans. Attitudes of school personnel must reflect a belief that the total school program is enhanced by opportunities for students to learn with computers.

This research suggests that actions of policy makers and educators must merge technologies and school improvement efforts to enable all pupils to reach beyond literacy goals. From their leadership and long term commitment to technologies will come planning for appropriate roles of computers in schools, necessary financial and human re-

sources, programs for the preparation of personnel, and, most importantly, greatly enhanced education for *all* pupils.

References

Anderson, Ronald E., Wayne W. Welch and Linda J. Harris. (1984). Inequities in opportunities for computer literacy. *The Computing Teacher*, 10-12.

Becker, Henry J. (1985) **The Second National Survey of Instructional Uses of School Computers: A Preliminary Report**. Norfolk, VA: World Conference on Computers in Education.

Boss, J. A. (1982). Sexism among the micros. *The Computing Teacher*, 9, 55-57.

Center for Social Organization of Schools. (1983). **School Uses of Microcomputers: Reports from a National Survey**, Issue No. 3. Baltimore: The Johns Hopkins University.

Cory, Sheila. (1983). A 4-stage model of development for full implementation of computers for instruction in a school system. *The Computing Teacher*, 11-16.

Hershey, Paul and Kenneth Blanchard. (1982). **Management of Organizational Behavior**. Englewood Cliffs, New Jersey: Prentice-Hall.

King, Richard A. and Anne S. Presnell. (1986) Equity in computer education: Determinants of access and use. San Francisco: American Educational Research Association.

Lezotte, Larry, ed. (1983) **The Effective School Report, 1**. New York: KELWYNN, Inc.

Lipkin, John. (1984). Computer equity and computer educators (you). *The Computing Teacher*. 19-21.

Market Data Retrieval. (1982). **Update on the School Market for Microcomputers**. Connecticut: Market Data Retrieval, Inc.

Nathan, J. (1983). **Free to Teach—Achieving Equity and Excellence in Schools**. New York: Pilgrim Press.

The National Commission on Excellence in Education. (1983). **A Nation at Risk: The Imperative for Educational Reform**.

Quality Education Data. (1984). **1983-84 Microcomputer Usage in Schools**. Denver: Quality Education Data, Inc.

Watt, D. (1982) Education for citizenship in a computer-based society. R. Seidel, et al., eds. **Computer Literacy**. New York: Academic Press.

Winkle, Linda W. and W. M. Mathews. (1982). Computer equity comes of age. *Phi Delta Kappan*, 63, 314-315.