Computer Equity: Implications for Educational Policy and School Leadership

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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 the classroom, and to ensure that pupils of all backgrounds have opportunities for computer education. They are finding the resources needed to acquire or develop new 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 society 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 (1962, p. 316), 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., 1964; Center for Social Organization of Schools, 1983; and Becker, 1965). These studies focus more upon which schools have computers and on what the computers are used for; but relationships between use 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 into the context of awareness, creativity, learning, and programming, while less affluent schools use them primarily for 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 (1964, 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, as a result, failure to understand the potential of technology. 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 a recent survey of the schools reporting data in Becker's (1985) study, it is not the disadvantaged students who are using the computer. Rather, it is the higher achieving pupils who use computers in both elementary and secondary schools.

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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.

**Profiles 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 ($136,792) 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 49 percent minorities in high and low wealth districts, respectively. This observation about the 16 districts is quite consistent with a highly significant (p < 0.01) 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 16 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 $1,701; 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 use 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>
<thead>
<tr>
<th>Variable</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
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<tr>
<td>Access</td>
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<td></td>
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<tr>
<td>Ratio of pupils to micros—1984*</td>
<td>14.22</td>
<td>335.15</td>
<td>98.39</td>
<td>50.82</td>
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<tr>
<td>Ratio of pupils to micros—1985</td>
<td>12.96</td>
<td>109.86</td>
<td>48.12</td>
<td>16.41</td>
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<tr>
<td>Percent change in ratio—1984 to 1985*</td>
<td>2.26</td>
<td>476.07</td>
<td>103.67</td>
<td>70.41</td>
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<td>Primary use (percent of total)</td>
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</tr>
<tr>
<td>Literacy</td>
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<td>100.00</td>
<td>47.62</td>
<td>20.22</td>
</tr>
<tr>
<td>CAICMI</td>
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<td>90.27</td>
<td>18.36</td>
<td>17.08</td>
</tr>
<tr>
<td>Programming</td>
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<td>62.06</td>
<td>13.97</td>
<td>13.04</td>
</tr>
<tr>
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<td>18.29</td>
<td>5.35</td>
<td>3.95</td>
</tr>
<tr>
<td>Location (percent of total)</td>
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<td>Computer lab</td>
<td>0.00</td>
<td>100.00</td>
<td>33.30</td>
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<tr>
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<td>100.00</td>
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<tr>
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<td>8.50</td>
<td>7.46</td>
</tr>
<tr>
<td>Office</td>
<td>0.00</td>
<td>22.88</td>
<td>4.46</td>
<td>3.62</td>
</tr>
</tbody>
</table>

* N = 141 for all variables except Ratio of Pupils to Micros in 1984 and Change in Ratio from 1984 to 1985, as these 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 (CAICMI), 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 CAICMI, 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 de-
pends 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 be-
tween 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 indepen-
dent 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 signifi-
cant 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 lev-
els of significance of individual variables and of the combi-
nation of variables ($R^2$) is indicated for each equation.

Four of the independent variables explained signifi-
cant amounts of the variance in the ratio of pupils to micro-
computers 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 propor-
tions of their expenditures from state and local sources.
Conversely, higher access was afforded in smaller districts
with lower minority enrolments 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 resi-
dents (see Equation 2). The greatest improvement in access
occurred in districts with the lowest family income. Never-
thless, this one variable accounts for less than one per-
cent 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 ac-
tivities 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 com-
puter education opportunities in school districts which most
needed them.

District demographic and financial characteristics pre-
dicted only three of the four primary uses of microcompu-
ters. 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 | Significance Level (P<) |
| EQUATION 1 | Ratio of pupils to micros (1985) | ADM | 0.0005 | 0.37 | 0.01 |
| | | Minority pupils | 0.2273 | 18.02 | 0.01 |
| | | State expen. | -0.0342 | 3.81 | 0.06 |
| | | Local expen. | -0.0289 | 14.56 | 0.01 |
| | | Intercept | 99.6534 | | |
| | | $R^2$ | 0.2375 | 10.60 | 0.01 |
| EQUATION 2 | Change in ratio (1984 to 1985) | Family income | -0.0050 | 3.97 | 0.05 |
| | | Intercept | 182.2177 | | |
| | | $R^2$ | 0.0263 | 3.97 | 0.05 |
| EQUATION 3 | Literacy | State expen. | -0.0545 | 5.59 | 0.02 |
| | | Federal expen. | 0.0563 | 2.92 | 0.09 |
| | | Intercept | 132.7746 | | |
| | | $R^2$ | 0.0402 | 2.89 | 0.06 |
| EQUATION 4 |avity (1985) | Total tax rate | -12.1645 | 6.32 | 0.10 |
| | | Distance meter | -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 meter | 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 lit-
tle (94 per cent) of the variance in literacy use, but suggest
that literacy was the primary concern of districts most de-
pendent upon federal revenues.
The proportion of computers used for computer as-
isted or computer managed instruction was best ex-
plained by the total tax rate and the distance from a metro-
center with a college (Equation 4). The direction of each re-
lation suggests that CA/CMU was more likely to be hap-
pening 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 socio-
economic 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 class-
rooms. The proportion of minority pupils explained a signifi-
cant amount of the variance in the percent of computers lo-
caled in media centers (Equation 6). Districts with more
minority pupils were more likely to locate computers in me-
dia 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). Dis-
tricts with lower proportions of expenditures derived
through state sources also located more computers in offi-
cel 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 dis-
tricts are more likely to be available for use within class-
rooms 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 educa-
tion 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 percent-
ace of variance is accounted for by district demographic.
Computers were 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 superin-
tendents' and computer coordinators' perceptions of com-
puter 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 particu-
larly 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, "Approp-
rate and effective leadership is essential in any suc-
cessful 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 cur-
criculum. High access districts were characterized by ac-
tively involved superintendents, principals, board mem-
ers, or community leaders. Crucial leadership came
primarily from within the local school system. When an indi-
vidual or small group take 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 gen-
eral access for pupils. Hershey and Blanchard (1982) ex-
dained that when a participative change cycle is imple-
mented, "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
educational changes are quite evident in higher access dis-
tricts—regardless of their financial condition.

In contrast, in many of the lower access school sys-
tems, leadership came from outside the local schools and
community. The stimulus for change was the General As-
sembly's appropriation for computer education. Funding
depended upon the development of school system com-
puter plans. This situation is described in a second cycle
for change defined by Hershey and Blanchard. Directive
change "begins by change being imposed on the total or-
ganization by some external source." (p. 273) Computer coordi-
nators in these low access districts relied more heavily
upon state directives as they developed computer educa-
tion 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 lo-
cal 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. Fur-
thermore, there were many examples of very effective uses of
computers within some schools of those districts where
pupils had generally lower access. Potential opportuni-
ties for pupils to have contact with computers, and the nature
of educational experiences which can be planned for com-
puters, 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 equip-
ment. 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, 1988).
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 56 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 only 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 of 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 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 students 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 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 use 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 curriculum 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 complemented 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 phases 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 learning 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 1 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 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 curriculum. 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 and should be important aspects of schools’ responses to states’ career development and curriculum 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