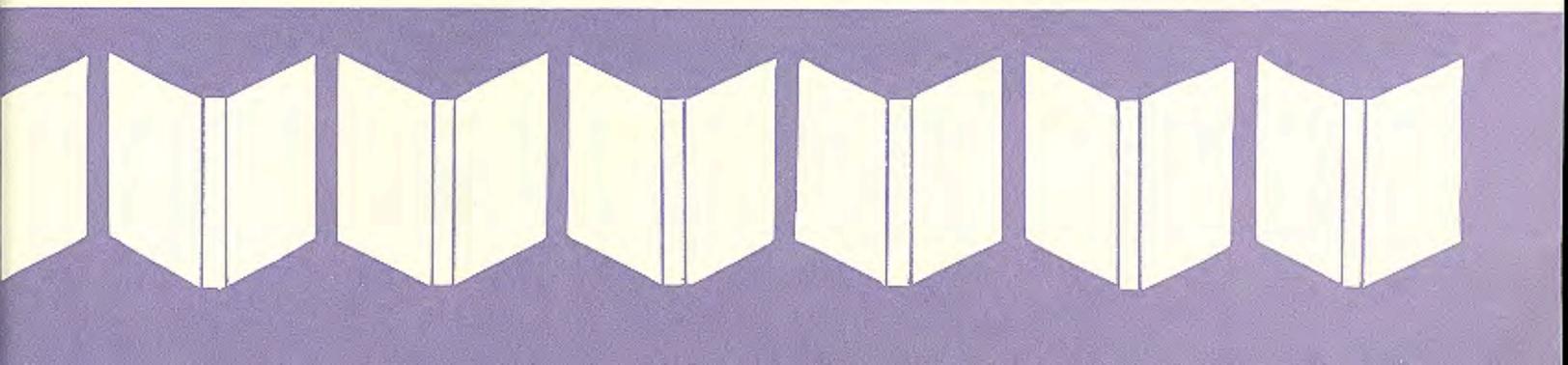


ISSN No.  
0146-9282

Fall  
1986

# educational considerations

published at kansas state university college of education



# Editorial

Slightly more than a decade has passed since the term microcomputer was introduced to the American public. During the early stages of microcomputer development there was a mystique which surrounded the use of this new and emerging technology. While advocates anticipated the limitless uses to which this new variation of existing technology could be applied, antagonists predicted its eventual demise. Yet the vast majority of the American public, whether intimidated or awed, waited to see what would evolve. It was not until the IBM Corporation introduced its "personal computer" in August of 1981 that the microcomputer was legitimized in the world of business and industry. In the five years since then, its rate of growth and development has accelerated at a staggering pace.

The rapid intrusion of computer technology upon American society has forced educators throughout this nation to assess the need to develop comprehensive, computer-based programs for students and teachers. Often there is little guidance available from state departments of education and institutions of higher education who are struggling with these issues themselves.

In the fall of 1984 a special task force was empowered by the United States Department of Education to investigate the use of technology "... to improve learning in our Nation's schools." Their report entitled "Transforming American Education: Reducing the Risk to the Nation," was delivered to the Secretary of Education in the spring of 1986. In Section 1 of this report the members of the task force ask five important questions:

1. Is the expenditure (on computer technology) justified;
2. Is the movement supported by careful planning;
3. Is the technology being applied appropriately;
4. Will it prove effective in the long term or is it merely a fad; and,
5. Where is all this activity leading education?

Following careful consideration of the issues and concerns surrounding the use of computer technology in schools, the task force detailed six areas considered important to the long-term successful integration of computer technology within education. The six areas of concern which were discussed include:

1. Planning;
2. Financing;
3. Teacher Education;
4. Curriculum and Instructional Practice;
5. Research, Development, Evaluation, and Dissemination; and,
6. Demonstration schools.

This special issue of **Educational Considerations** addresses many of the problems mentioned in the task force report. While there remains an overwhelming amount of work to be done, this is a start.

The theme of this edition focuses on the needs of school administrators and other educational policy makers for adequate information on the current issues on the uses of computers in our nation's schools. School administrators are charged with responsibility for making decisions. Usually, decisions are made based on a firm comprehension of a given situation which results from a thorough analysis of those conditions which may or may not influence anticipated outcomes. However, the base of information relevant to the issues concerning the implementation of computer-based programs at all levels of the educational spectrum changes almost daily, and most school administrators cannot stay current. In addition, it is only recently that a body of knowledge, pertinent to the implementation of computer technology in the education setting, is beginning to emerge.

This special issue of **Educational Considerations** brings together a variety of papers which are the results of recent research and writing in the area of computer technology in schools and the implications for administrative decision making—issues addressed by the task force report. The items contained in this issue have been divided into two sections: Section 1 contains articles which discuss the results of research analyses on the process of implementing computer based educational programs in various states; Section 2 includes a collection of articles in which the authors cover a range of current issues and concerns which should be considered by educators involved in the process of utilizing computer technology in their schools.

The authors who have contributed to this issue are educators from throughout the United States. All have worked with school districts in an attempt to evaluate computer-based programs for administrators, teachers, and students. While opinions may vary and personal preferences stated, it must be noted that each of these authors is committed to the study and reporting of educational practice, and I thank each of them for their contribution.

# educational considerations



Vol. XIII, Number 3, Fall 1986

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**Educational Considerations** is published three times yearly. Editorial offices are located at the College of Education, Blumont Hall, Kansas State University, Man-

hattan, Kansas 66506. Correspondence regarding manuscripts must be accompanied by a self-addressed stamped envelope. No remuneration is offered for accepted articles or other material submitted.

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Printed in the United States of America.

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-

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\*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
<b>Access</b>				
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
<b>Primary use (percent of total)</b>				
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
<b>Location (percent of total)</b>				
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 <)
<b>EQUATION 1</b>				
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
<b>EQUATION 2</b>				
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
<b>EQUATION 3</b>				
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
<b>EQUATION 4</b>				
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
<b>EQUATION 5</b>				
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
<b>EQUATION 6</b>				
Media center	Minority pupils	0.0762	4.50	0.04
	Intercept	11.6162		
.....				
$R^2$		0.0314	4.50	0.04
<b>EQUATION 7</b>				
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
<b>EQUATION 8</b>				
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.

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Student access to computer technology is a financial concern . . . the extent to which computers are used after purchase is determined by the enthusiasm of the staff and the support given to them by the administration.

# Factors which Influence the Effectiveness and Utilization of Computer-Based Programs: Implications for Decision-Making

by Dr. Dave Honeyman

The attitudes and perception of educators concerning instructional and management uses of the microcomputer have changed in recent times. Rapid technological advances have caused widespread proliferation of computer technology within many aspects of educational operation. A recent study by Talmis (1986) estimates that 1.4 million computers were in operation in public schools in 1986 and anticipates a 25 percent increase in that number during the 1987 school year. This situation has created problems for many public school systems. The computer can no longer be viewed simply as a teacher aid for instruction and programmed learning, or as a management tool for attendance and record keeping; rather, the computer has become the basis of a new, independent, instructional program which includes the studies of computer literacy, computer programming, computer science and technology, and computer applications (Bear, 1984 and Becker, 1983).

This rapid advance in technology and the development of new, instructional programs has forced many school systems to make major decisions on the establishment of microcomputer instructional programs. Frequently, these decisions are made by school personnel unprepared to make accurate and informed determinations about the costs and applications of the new technology. This lack of experience has often resulted in the development of ineffective and

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under-utilized computer projects (Honeyman and Honeyman, 1985).

Many school systems which have initiated microcomputer instructional programs have encountered great difficulties in measuring the effectiveness, and the utilization of microcomputer equipment used in these programs (Seidel, 1980). A lack of quantitative information on the effectiveness and use of existing programs has hampered the development of new programs and impeded the spread of comprehensive programs to other school systems. The answers to questions concerning costs, planning, staff commitment to the use of microcomputers, and the inservice training of employees are needed in order to provide information useful to school personnel making policy decisions about the development of computer-based programs (Gress, 1983).

## Purpose of Study

The purpose of this study was to determine whether or not relationships existed between the variables 1) effectiveness, and 2) utilization of microcomputer instructional programs and 14 selected factors which were believed to effect these variables. Of importance to this study were the following questions:

1. Is there a relationship among the demographic factors—size of the school division, income of the community, wealth of the community, and the total operating budget of the school division, taken independently and in combination, to: 1) the measures of effectiveness, and 2) the measures of utilization of microcomputers?

2. Is there a relationship among the organizational factors, willingness to pay, and planning time by administrators and teachers to: 1) the measures of effectiveness, and 2) the measures of utilization of microcomputers?

3. Is there a relationship among the inservice factors, total computer related inservice time offered, level of inservice training provided for principals and teachers to: 1) the measures of efficiency, 2) the measures of effectiveness, and 3) the measures of utilizations of microcomputers?

4. Is there a relationship among the degree of computerization factors, the number of units in service, and the number of years of the microcomputer program operation to: 1) the measures of effectiveness, and 2) the measures of utilizations of microcomputers?

The dependent variables used as measures of the effectiveness and the utilization of microcomputer instructional programs were described as follows:

**Effectiveness**—The percentage of students in average daily membership (ADM), participating in computer literacy and computer programming programs offered by school districts included in the sample.

**Utilization**—The average number of hours per week that microcomputers were in actual use for courses in computer literacy, and computer programming in the school systems surveyed.

The independent factors selected for this study included the following:

## Demographic Factors:

1. The student enrollment of the school system surveyed,
2. The per capita wealth (assessed valuation of real property) of their community,
3. The per capita income level of the community,
4. The total operating budget of the school system.

### Organization Factors:

5. A "willingness to pay" ratio for microcomputer programs,
6. Total time spent on planning the microcomputer program,
7. The percentage of that planning time organized for principals,
8. The percentage of that planning time organized for teachers.

### Inservice Factors:

9. Total inservice training time for all school personnel,
10. The percentage of inservice training time for principals,
11. The percentage of inservice training time for teachers.

### Degree of Computerization Factors:

12. The number of years of microcomputer program operation,
13. The number of microcomputers currently in use,
14. The original number of microcomputers in use the first year of the program.

The data on effectiveness, and utilization were gathered on two questionnaires addressed to 1) superintendents, and 2) building principals in 37 school districts which had been identified by the Virginia State Department of Education as having established instructional programs in computer literacy and computer programming. In addition to supplying these data, respondents were asked to comment on their perceptions of the success of microcomputer instructional programs in their schools. This anecdotal information was collected in order to develop profiles which would help explain the effectiveness of microcomputer instructional programs and levels of utilization of microcomputer equipment operating in their school systems.

### Derivation of Variables

The following dependent variables were measured in this study. The derivation of each factor is explained.

#### Effectiveness

The dependent variable, effectiveness of the microcomputer instructional program was defined as a measure of the ability of the school district to deliver microcomputer programs to its students (Barsby, 1972). This factor was determined by calculating the ratio of the number of students participating in computer literacy and computer programming to the average daily membership (ADM). No attempt was made to evaluate the "quality" of the programs being offered, and it was noted that double-counting of students, one student having taken both courses, was an acknowledged source of error. Most school districts could not differentiate course enrollments by student name or number.

#### Utilization

This variable was defined as the average number of hours per week per machine that microcomputers were in use in each school building during the school year surveyed (Seidel, 1980). Data relevant to this variable were recorded by each individual school and summed together and averaged for each school district.

### The Demographic Factors

As mentioned above, most of the data for this study were collected by survey questionnaires sent to Virginia School districts which operated microcomputer instructional programs during the 1983 school year. Additional data on the factors district size, wealth, income levels, and operating budgets were obtained from the Virginia State Department of Education financial report *Facing-up*.

### The Organizational Factors

The method for calculating "willingness to pay," was the ratio of the total, start-up costs including capital costs, incurred during the first year of the microcomputer program, divided by that year's total operating budget. This willingness to pay ratio, similar to an opportunity cost factor, was used as an indicator of the extent to which a district was financially committed to establishing computer based instructional programs. (For a detailed discussion on the derivation of this factor see Honeyman, 1983, pp. 29-33.) These calculations were not adjusted for inflation by constant dollar or current price indexing since the ratio of program costs to total budget was being calculated. Any adjustments for inflation or changing prices over time would effectively cancel each other. This factor was calculated from data reported in the questionnaire addressed to superintendents as follows:

$$\text{Willingness to pay ratio} = \frac{\text{Total start-up costs}}{\text{Total operating budget}}$$

The system level planning percentages for principals and teachers were calculated from data reported in the superintendent's questionnaire as follows:

$$\text{Planning time (percentage-principals)} = \frac{\text{Man-hours involved by principals}}{\text{Total time for all system personnel}}$$

$$\text{Planning time (percentage-teachers)} = \frac{\text{Man-hours involved by teachers}}{\text{Total time for all system personnel}}$$

### The Inservice Factors

The inservice factors percentage of inservice training provided to building principals and to teachers, and total inservice training time, were calculated from the data contained in the superintendent's questionnaire as follows:

$$\text{Inservice (percentage-principals)} = \frac{\text{Man-hours of participation by principals}}{\text{Total man-hours for all system personnel}}$$

$$\text{Inservice (percentage-teachers)} = \frac{\text{Man-hours of participation by teachers}}{\text{Total man-hours for all system personnel}}$$

### Degree of Computerization Factors

The data for the degree of computerization, years of the program, original number of microcomputers, and number of microcomputers as of June 1982 (the year that the State Department of Education began to keep data on computers in schools), were taken from the questionnaire addressed to superintendents and included in the analysis.

### Analysis of the Data

Descriptive Profile: a descriptive profile was developed and used to add detail to this study. This profile, see Table 1, includes the mean values for the responses to questions asked on the questionnaire addressed to superintendents.

**TABLE 1.**  
**Descriptive Profiles of School Systems**

DESCRIPTION	MEAN
1. Size of the district	16,562.65 students
2. Per capita wealth	\$17,092.91
3. Per capita income	\$6,387.60
4. Per pupil operating budget	\$2,003.04
5. Willingness to pay factor	0.085 (0.85%)
6. Total planning time	100-200 man-hrs.
7. Total inservice time	150-200 man-hrs.
8. Years in a microcomputer program	2.54
9. Number of microcomputers as of June 1982	11 to 20
10. Original number of microcomputers	6 to 10
11. Expenditure per pupil for computers	\$118.65
12. Percentage of students receiving instruction	9.81%
13. Average utilization of microcomputers per school building	3.27 hrs/week/machine

Step-wise, multiple regression analysis was selected to test for relationships between each dependent variable and the fourteen independent factors. Multiple correlation coefficients, R, were developed and used to determine the degree of dependence of the dependent variables on the independent factors. The goodness of fit of the regression equation was then observed by determining R<sup>2</sup>, the coefficient of determination.

All possible relationships were tested initially by Pearson product-moment correlation analysis, and then by step-wise multiple regression analysis and significance was set at the 0.05 level of confidence.

#### The Relationships Between Effectiveness and Selected Factors

The zero-order, correlation coefficient analysis of the relationships between effectiveness and the fourteen factors resulted in one (1) statistically significant relationship. This relationship between effectiveness and willingness to pay was significant at greater than 0.01 level ( $r = 0.4480$ ). (See Table 2.) As a result of this analysis it was determined that as the willingness to pay ratio increased the effectiveness of computer-based programs in the school districts surveyed would increase as well.

**TABLE 2.**  
**Summary of Zero-order Pearson Correlation Coefficients Among Selected Variables and Measures of Effectiveness (N = 31)**

FACTOR	EFFECTIVENESS CORRELATION	SIGNIFICANCE
Demographic Factors:		
1. The student enrollment	-.127	.260

2. The per capita wealth	.175	.186
3. The per capita income	.031	.438
4. The total operating budget	.0233	.453
Organization Factors:		
5. Willingness to pay ratio	.448	.008**
6. Total time planning	-.0023	.495
7. The percentage planning—principals	-.219	.141
8. The percentage planning—teachers	-.075	.357
Inservice Factors:		
9. Total inservice training time	.116	.282
10. The percentage inservice training—principals	-.248	.106
11. The percentage inservice training—teachers	-.076	.352
Degree of Computerization Factors:		
12. The number of years of operation	-.072	.358
13. The number of microcomputers currently in use	-.116	.279
14. The original number of microcomputers	-.081	.279

\*\*Significant  $\leq 0.01$

The step-wise multiple regression analysis was performed for effectiveness and the selected factors and the results of this analysis are included in Table 3. The factor willingness to pay was the only significant factor in this equation (0.037), and accounted for 19.2 percent of the variance. A second step-wise multiple regression equation, which analyzed effectiveness and the other factors excluding willingness to pay, produced no significant changes in either the levels of significance or the R<sup>2</sup> values of the remaining factors. Based on these findings the best predictor of the effectiveness of microcomputer instructional programs, was the willingness to pay ratio of the school system.

**TABLE 3.**  
**Step-wise Multiple Regression—Effectiveness**

STEP	FACTOR	SIGNIFICANCE	MULTIPLE R (CUMULATIVE)	R <sup>2</sup>
1	Willingness to pay	.037	.437	.192
2	Wealth of community	.126	.531	.282
3	Training—principals	.125	.607	.368
4	Training—teachers	.272	.604	.410
5	Original Number computers	.461	.655	.429
6	Size of district	.465	.670	.448

#### The Relationship Between Utilization and Selected Factors

The analysis of the relationships between Utilization and the factors selected for the study produced one (1) statistically significant relationship. (See Table 4.)

Utilization of microcomputers was shown to relate positively and significantly with total inservice planning time, ( $r = .3692$ ). As a result of this analysis, it was found that increases in the levels of inservice training for all personnel were reflected in increased utilization of microcomputers by schools in that school system.

An initial step-wise multiple regression analysis was

performed for the variable utilization with the selected factors. The results of this analysis are summarized in Table 5A. The factors inservice time, per capita income, per pupil operating budget, willingness to pay, and total number of microcomputers in operation, taken in combination explained 78 percent of the variance found in the variable utilization.

The order in which variables were loaded into the regression equation raised questions concerning the possible presence of a suppressor variable operating within the calculation. It was determined that this suppressor variable was closely related to one or more of the top five factors, and caused the factor inservice training for teachers to load first yet explain less variance than the factor entered at Step 2, income of community. A second step-wise multiple regression analysis was performed which excluded income, operating budget, willingness to pay, and the original number of computers from the calculation. The results of this analysis are summarized in Table 5B. The change in ordering of this second equation indicated that the per capita income of the community factor was sharing variance with other variables and when taken in combination with percentage of inservice training for teachers from the first analysis increased the amount of explained variance. As a result, it was determined that the factors, total inservice training time for all school personnel, the per capita income level of the school community, and the willingness to pay ratio were the best predictors of utilization.

**TABLE 4.**  
**Summary of Zero-order Pearson Correlation Coefficients**  
**Among Selected Variables and Measures of Utilization**  
**(N = 161)**

FACTOR	EFFECTIVENESS CORRE-	SIGNIFI-
	LATION	CANCE
<b>Demographic Factors:</b>		
1. The student enrollment	.037	.430
2. The per capita wealth	.131	.276
3. The per capita income	-.352	.056
4. The total operating budget	-.169	.219
<b>Organization Factors:</b>		
5. Willingness to pay ratio	-.144	.256
6. Total time planning	-.301	.082
7. The percentage planning—principals	.208	.170
8. The percentage planning—teachers	.008	.486
<b>Inservice Factors:</b>		
9. Total inservice training time	-.116	.300
10. The percentage inservice training—principals	-.104	.318
11. The percentage inservice training—teachers	.369	.041*
<b>Degree of Computerization Factors:</b>		
12. The number of years of operation	-.219	.096
13. The number of microcomputers currently in use	.071	.469
14. The original number of micro-computers	-.020	.463

\*\*Significant < = 0.05

### Survey Summaries

Respondents to the survey of superintendents were offered an opportunity to make personnel comments and recommendations concerning factors they perceived as important in the development of their microcomputer instructional programs. Their responses are summarized in Table 6 and described below.

Twenty-seven questionnaires (69 percent) were returned with comments explaining those factors superintendents considered crucial to the development of a microcomputer program, and suggestions for others to follow. As reported, 48 percent of the superintendents indicated teacher inservice, the need for intensive planning, and curriculum development were necessary prerequisites for developing a microcomputer instructional program. Forty-four percent of the superintendents also indicated the importance of sufficient levels of equipment, and the need for well-planned purchases of equipment. Thirty percent indicated they had hired a consultant or engaged a specialist, and 20 percent mentioned that enthusiastic teachers, community members, and school board members were important to the development of their microcomputer instructional program.

**TABLE 5A.**  
**Step-wise Multiple Regression—Utilization**

STEP	FACTOR	SIGNIFI-	MULTI-	R2
		CANCE	PLE R	(CUMULATIVE)
1	Training—teachers	.083	.369	.136
2	Income of community	.010	.620	.384
3	Operating budget	.030	.723	.522
4	Willingness to pay	.034	.794	.631
5	Planning time—total	.131	.823	.678
6	Original number computers	.018	.881	.776
7	Planning—teachers	.283	.890	.793
8	Years in operation	.358	.897	.806

**TABLE 5B.**  
**Step-wise Multiple Regression—Utilization**  
**(Excluding Income, Operating budget, Willingness to pay,**  
**and the Original number of computers)**

STEP	FACTOR	SIGNIFI-	MULTI-	R2
		CANCE	PLE R	(CUMULATIVE)
1	Training—teachers	.083	.369	.136
2	Planning time—total	.063	.525	.275
3	Current number of computers	.239	.573	.328
4	Wealth of community	.325	.603	.364
5	Planning—principals	.360	.629	.396
6	Size of school	.489	.643	.414

**TABLE 6.**  
**Summary of Comments from the Superintendent's Survey**

Number of written responses 27  
(Note: Respondents could refer to more than 1 category)

Comment Category	Percentages
1. Need for teacher inservice	48%

2. Need for intensive planning and curriculum development	48%
3. Need for adequate and well planned equipment purchases	44%
4. Need for specialists or consultant	30%
5. Need to generate staff enthusiasm	22%
6. Need to generate community and school toward enthusiasm	22%
7. Need for an overall commitment for funds	19%
8. Need to involve building administrators	15%
9. Need for central office and/or superintendent enthusiasm	11%

#### Summary of the Comments from the Survey of Building Principals

One hundred sixteen of the respondents to the questionnaire addressed to the building principals (72 percent) answered questions which asked for recommendations and suggestions for school administrators currently developing microcomputer instructional programs. Their responses are summarized in Table 7.

TABLE 7.

#### Summary of Comments from the Principal's Survey

Number of written responses 116

(Note: One respondent can refer to more than one category)

Comment Category	Percentages
1. Need for principal involvement	36%
2. Need for adequate and well-planned equipment purchases	30%
3. Need for enthusiastic staff	26%
4. Need for central office support	15%
5. Need for increased financial support	15%
6. Need for adequate planning of the program	13%
7. Need to provide specialists and adequate inservice	10%
8. Need to involve community and parents	10%

The need to involve staff members in the planning and development of such programs including building administrators, was mentioned by 36 percent of the respondents. Teacher enthusiasm and central office support staff was mentioned by 26 percent and 15 percent of the respondents respectively. Thirty percent indicated that adequate and well-planned equipment purchases were important, and 15 percent mentioned that increased financial support was needed in order to facilitate the delivery of microcomputer instructional programs.

#### Conclusions

##### Effectiveness

As the results of this study indicated, the most effective school systems, as defined above, were willing to pay more for the development of microcomputer programs than were the less effective school systems. These findings were consistent with the observation that willingness to pay was a contributing factor in the measured effectiveness of projects undertaken in the public sector and in business. If it is true that decision makers within the school system must perceive the value of these new programs in order to support their development, then the results of this study in-

dicade that effective microcomputer instructional programs result from a significant commitment of resources and effort at the beginning of the program. If the eventual ability to delivery computer-based instructional programs is reflected by the willingness to pay for such programs, school systems must plan from the beginning to spend sufficient financial resources to establish adequate programs and deliver them to the greatest number of students.

The willingness of school policy makers to expend adequate resources on microcomputer instructional programs is an important factor in determining the overall effectiveness of these projects. Although the need to commit funds was ranked high by only 19 percent of the school superintendents in this study, financial concerns, i.e., equipment costs, consultants, staff training, etc., consistently ranked higher. Likewise, 30 percent of the building principals noted the importance of financial concerns such as equipment purchases. They also indicated that generating support from community, central office staff, and teachers were equally important considerations.

Each of these factors are vital concerns in the development of any new instructional program. They are especially appropriate when considering programs which require a large financial commitment. In order to assure the effective access to equipment necessary for microcomputer instructional programs, school systems must plan to meet the needs of their entire student population. The following statement should be addressed during the process of developing such programs:

#### For the schools reporting in this study access to computer technology is a financial concern.

In states which have no programs to assist school districts purchase computer equipment serious equity questions must be addressed to determine the extent to which wealth, income, and community socioeconomic status influence a district's ability to deliver computer-based instructional programs.

School personnel must generate the support necessary to guarantee that adequate funds will be made available for the development of such programs. If reductions in available resources result in fragmentation of the implementation process the results will be higher long-term costs and lower participation. As the analysis of the data in this study indicated with an average willingness to pay ratio of 0.0085, responding school districts spent an average \$118.65 for each pupil receiving instruction on microcomputers that year, and delivered such programs to only 9.81 percent of their student population. Yet districts which reported higher-than-average effectiveness also reported willingness to pay ratios greater than .012 (1.2 percent of the general fund budget)—low levels of commitment and financial support prior to the implementation of the program resulted in lower participation and presumably in higher costs.

#### Utilization

The analysis of the data on utilization indicated that per capita income of the community, total microcomputer inservice training time for all personnel, and willingness to pay were the best predictors of utilization.

Perhaps the most important conclusion developed as a result of this study is derived from the correlation between utilization and total inservice time. As the best single predictor of utilization, the levels of inservice training offered to school personnel may be the most important indicator of the eventual use of computers in schools. The finding that high levels of microcomputer inservice training resulted in

increased utilization of microcomputers by teachers was in agreement with studies by Hersh (1981), and Joyce (1981) which indicated that teachers who participated in effective, inservice training programs had greater levels of commitment to the program. It is reasonable to assume that teachers who are committed to the use of microcomputers will utilize them more frequently and microcomputer inservice training programs should be offered to increase current levels of utilization.

**The extent to which computers are used after purchase is determined by the enthusiasm of the staff and the support given to them by the administration.**

It should be obvious that those teachers and building administrators who have been encouraged to participate in the planning process and have received inservice training will be more supportive of the program. The lack of a supportive, collegial attitude toward innovation and change can impede the successful introduction of computer based instructional programs. The success or failure of such programs is directly influenced by the leadership abilities of the decision makers within the school district. It is the ability to provide leadership in order to generate support and commitment at all levels of school operation during the planning and implementation of computer-based instructional programs which is a vital factor in the eventual success of these programs.

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The potential benefits of microcomputer use in the schools are gains in efficiency, equity, and quality of the instructional programs.

# Instructional Policy and the Development of Instructional Computing: Maintaining Adaptive Educational Programs

by Dr. Robert L. Blomeyer, Jr.

In the last five years, the instructional use of computers in American secondary and elementary schools has demonstrated remarkable growth. Thanks to survey work on the "Instructional Uses of School Computers" directed by Dr. Henry Jay Becker at Johns Hopkins University, the 1983-84 National Assessment of Educational Progress, and others, we now have a growing body of information concerning the penetration of microcomputers in American schools and the variety of strategies that are being used to incorporate applications of microcomputers into schooling.

In data collected between spring 1983 and spring 1985, the Becker survey indicates that the number of computers in use in schools quadrupled from about 250,000 to more than 1 million. The survey used a stratified probability sample of 2,361 public and non-public schools and had a 92 percent response rate overall. Raw results were "reweighed" so that the reported results may be interpreted as being from a representative sample of all the schools in the U.S. (Becker, 1986).

The survey also shows that the instructional use of these computers differs sharply between the elementary and secondary schools. In elementary schools, over 50 percent of student use involves using "drill and practice" or "tutorial" software and only about 12 percent of the time is

spent writing computer programs. These percentages are nearly reversed in secondary schools, where computers are used for programming over 50 percent of the time and Computer Assisted Instruction (CAI) only accounts for about 16 percent of computer use overall. This means about 35 percent of the total computer use is due to a variety of other instructional applications in both cases.

This new evidence presents a profile of computer use in the schools and illustrates broad patterns regarding hardware distribution and the existing range of computer activities in the curriculum. However, many questions remain unanswered regarding conditions in the schools that may influence the development of instructional computing programs and shape the impact of computer use on learning. Salomon and Gardner (1986) discuss the issue of the "effectiveness" of instructional computer use. They compare research on school computer use to prior research on the instructional uses of television. In the research on instructional television, many investigators pursued questions about the "effectiveness" of TV as a delivery medium, in comparison with other alternatives. Salomon and Gardner discuss the idea that comparative methodological research pursuing questions about the relative "effectiveness" may be unproductive.

They conclude that the overall lack of significant findings from this earlier research may not be because TV is in itself ineffective as a medium. Instead they suggest that the insignificant findings may be due to the lack of sensitivity of "experimental" studies to other changes in the schools and classrooms where TV was being used. Their central point is that research, on new technology in the schools, pursuing questions on relative "effectiveness" (measured by comparisons of gains through testing) may be asking the wrong or an inappropriate question. They recommend that for organizing research on instructional computer use, investigators should learn from the shortcomings of the existing studies on instructional television. For new research concerned with understanding the outcomes of instructional computer use in the schools, more productive findings may be possible by organizing and conducting heuristic research that describes the context of computer use and provides information useful for discovering specific questions that can be tested as hypotheses in subsequent research (Salomon and Gardner, 1986).

A few descriptive of "ethnographically oriented" studies from the 1970s provided valuable precedents for conducting contextually relevant research on instructional computing programs. This early research provided the basis for a stable core of "foreshadowed issues" that have great relevance for understanding our present situation. An issue raised by Smith and Pohland (1974) concerned the effects of a community's dominant cultural pattern on the implementation of instructional computer use in the schools. They found that the use of CAI in schools was not as simple as assigning the students time on computers to complete instructional tasks. Instead, CAI was found to be a complex mixture of "... physical, social, emotional and cognitive behaviors inextricably intertwined and shaped by both administrative routines and norms of the particular schools and classrooms" (Smith and Pohland, 1974, p. 36).

Other pioneering research on instructional computing (Stake, 1977) pointed out that there are particular attributes associated with the role of the teacher in classrooms where computers are present that have significant impact on whether students succeed or fail in adapting to the use of the new instructional medium. In a study of PLATO and fourth grade mathematics, students with a limited reper-

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toire of learning strategies encountered severe difficulty and tended to give up without the intervention of the teacher. In the reported findings it appears that the participating teachers had become well versed in the routines necessary for the effective use of computers in the classroom probably through immediate contact with the developers and designers involved in the PLATO implementation project. This suggests that productive attitudes and management protocols are best learned through direct contact with educational professionals who are by now experienced with integrating computers into the school setting. These findings are significant for teacher "computer literacy" and for teacher training.

Case studies and other descriptive research in the '80s usually focus on staff training, hardware and software distribution, school conditions affecting access to computers, software design issues, and a broader concern for an appropriate integration of instructional computing with prior curriculum content and objectives. Two studies of particular interest for their portrayal of school computer programs are Sheingold, Kane, and Endreweit's comparative study (1983) of instructional computing programs in three contrasting school districts and Meister's single case study (1984) of a "model" elementary school microcomputer program in the San Francisco area (also see Blomeyer, 1985, and Cline, Bennett, Kershaw, Schneiderman, Stecher, and Wilson, 1986). A similar constellation of issues is discussed in the ethnographically-oriented literature on instructional computing in both the 70s and the 80s. Enough information is provided in these studies that we can begin systematic discussion and analysis of policy at the federal, state, district, and local school levels. This analysis of instructional computing policy, and the examination of its relationship to teaching practice, can assist in the timely and appropriate integration of microcomputers in all areas of the elementary, secondary, and post-secondary curricula.

For example, the IBM/ETS Secondary School Computer Education Project suggests that a major component of instructional applications in secondary schools is the classroom use of applications software (word processors, database programs, and spreadsheets; Cline, et. al., 1986). Lockheed and Mandinach (1986) go on to suggest that while the comprehensive integration of computer tools into the full range of the subject areas is a worthy objective, current difficulties concerning logistics, available materials, and teacher training make the comprehensive approach difficult at present.

As an alternative, Lockheed and Mandinach describe an integration strategy that optimizes the "fit" or curricular appropriateness of generally available software tools. They suggest developing an "applications-based course" for students that would teach the use of generic software tools (like word processing, etc.). When students learn to control generic tools, subject matter courses can then draw on these abilities and allow development of linkages to the remainder of the curriculum. Meanwhile, the other problems blocking comprehensive integration of computers and curriculum (i.e. insufficient access to hardware, inappropriate software, and low levels of teacher training on technology) can be improved. They argue that adopting this approach on an interim basis will improve the equity of instructional computer use and ease the development and implementation of new programs while offering immediate benefits that will contribute to improving educational quality.

In a multiple site case study of microcomputer use in secondary school foreign language teaching, Blomeyer (1985) found the level of functional computer literacy for

both teachers and students was a major factor in the quality of the three programs that were studied. State, district, and local school policies influenced these "literacy levels." It appeared that a school district policy explicitly requiring each student to take a "computer literacy" course (or demonstrate equivalent competencies) had a positive influence on the equity of school computer use by enabling female and minority students to use microcomputers in other classes. It also appeared that curriculum-wide use of microcomputers as an instructional resource provided greater equity within a school than use limited to mathematics and vocational technology.

Teachers in all subject areas were given a systematic inservice introduction to the computer literacy curriculum before the class was first offered to the students. These initial levels of literacy were sufficient to sustain the teachers during the first two years of the program. However, the foreign language teachers who were developing CAI lessons found out that as student literacy in the school population increased, it was necessary for them to increase their technical sophistication as courseware developers. As the students became more sophisticated in computer programming skills, they often used their new skills to modify CAI programs instead of helping them study their Spanish or German. It seemed that increasing student computer literacy required an overall increase in staff technical abilities to reduce the probability of management and behavior problems affecting the use of microcomputer laboratories.

Another policy issue discussed in Blomeyer (1985) concerns district or school support of local software development. Observational data and interviews indicated that the successful integration of microcomputers as a supplemental delivery medium in foreign language teaching was substantially enhanced by teacher produced materials. These materials had close "fit" to the curriculum and saved class time that the teachers would ordinarily have spent in vocabulary and grammar drill and practice activities. This classroom time was apparently reallocated to other more complex in-class activities aimed at increasing student "oral proficiency" in the languages studied.

Not all the outcomes of teacher participation in software development activities were positive. In general, participation in lesson design and development was an extremely labor intensive activity that sometimes conflicted with the teachers' more traditional roles as foreign language teachers. Increased workloads, stress, and potential for "teacher burnout" were observed among teachers who participated in courseware development projects. One teacher studied voluntarily reduced her teaching appointment so she could continue to develop and publish lesson materials. Overall, it appeared unlikely that the teachers observed would be able to sustain the level of effort necessary to continue materials development efforts without significant changes in the level of incentives offered to support these activities. Summer salaries, support from highly proficient programmers and "computer aids" hired to assist with computer laboratories provided some relief from the added workload (Blomeyer, 1985). Another solution indicated is temporary reduction of teaching load for individuals participating in the initial development or pilot use of computer-based instructional materials.

The conclusions summarized above on the "human costs" of local software development activities are paralleled by a frequently quoted cost effectiveness analysis of computer assisted instruction (Levin, 1984). This analysis indicates that there is a predictable "resource/energy trade-off" related to the direct costs of hardware and the indirect

or "hidden" costs associated with personnel in a school where CAI is used as a regular part of instruction. According to Levin's calculations, for every dollar in direct costs that is spent on hardware, an expenditure of three dollars can be anticipated for other indirect costs; including software, fixtures, maintenance, and especially expenditures for training or hiring new staff to assist with the operations of the computers in education program (pp. 16-20). If the existing faculty and staff must absorb the majority of the "hidden costs" associated with implementing microcomputer programs in the schools, then low teacher morale and high teacher turnover may have a potentially negative effect on the educational program. In short, no programmatic, structural, or technological innovation is entirely without risks. These must be carefully weighed against possible benefits and decisions should be made according to the greatest potential for constructive change.

On the more positive side, my finding that classroom time can be reallocated from repetitive drill-related activities to tasks of a more challenging nature is paralleled by a body of earlier research on the use of "drill and practice" programs and has been called "the CAI phenomenon" (Bright, 1983). A frequent assertion regarding the instructional use of computers as an integrated component of schooling is that the use of computer-based instruction (CBI) or computer-assisted instruction (CAI) results in equivalent learning outcomes which take less time than more traditional methods.

Although the majority of studies reporting this time-compression effect were conducted on the use of programs designed to teach math facts (Jamison, Suppes, and Wells, 1974; Kulik, Kulik, and Cohen, 1980; and Bracey, 1982) my research on computer-based language learning presents a slightly different interpretation of related findings. Foreign language teachers reported that the use of computer-based drill and practice of vocabulary and grammar exercises allowed the teachers to spend more classroom time on increasing the students' "oral proficiency" or ability to use the foreign language for spoken communication (Blomeyer, 1984 and 1985). While the same amount of time was used for teaching each content objective, students had the opportunity to practice their language skills in more diverse contexts.

Two relevant conceptions of educational improvement are the "functionalist" perspective and the "inquiry" perspective (Greenstone and Peterson, 1983). The functionalist view of educational improvement assumes that schools and school administrators have an obligation to provide services and social functions that are mandated by the larger community. Improvement of education is accomplished by changing the allocation of resources to reshape student and teacher behavior. In contrast the inquiry perspective stresses that educational improvement is an outcome of changes in teacher motivation, insight, and flexibility which are supported by school administrators and the local community.

The individual classroom teacher is the lead element in the inquiry approach to educational improvement. Teachers serve as models who transmit intellectual skills and broad cultural traditions. The inquiry orientation stresses the development of every person's intelligence in accord with accepted standards for competence and excellence. In these terms, good teaching is being adaptive to students' individual areas of academic and interpersonal strength and weakness. According to Greenstone and Peterson, the inquiry perspective emphasizes the teacher's need for freedom and autonomy within the classroom.

If the "inquiry perspective" on policy concerning educational improvement is accepted, then the additional flexibility that is a possible outcome from the instructional use of computers may provide a significant positive influence on teaching and learning. Rather than viewing computer technology as a system of technical artifacts and skills that have intrinsic value in pursuing high status technical employment, computer use in the schools can be seen as a valuable delivery system that can potentially become and integrated part of the traditional American school curriculum.

Another result of adopting the viewpoint of the "inquiry perspective" is to regard instructional computer use in the schools as a powerful force for maintaining and supporting the centrality of the traditional subject matter curriculum. Individual needs and differences within the student population can be addressed effectively by using the flexibility that is possible through the integration of microcomputer-based instruction as a component of educational programs which adapt instructional levels and methods to meet the needs of each individual student.

Planning for school computing programs that can provide increased instructional flexibility requires a comprehensive approach. Just as Stake (1977) found that significant aspects of the computer-using teacher's role need to be learned through contact with more experienced peers, administrators can also gain insights from their colleagues who have experience developing comprehensive computers in education programs. A model for program planning suggested by one such plan is proposed by Vakos (1986). He presents a planning and development model with four stages: (a) initial discussions, (b) development and adoption of a formal district implementation plan, (c) implementation, and (d) program evaluation. Ten steps are considered to be critical for the success or failure of the program development efforts:

1. local needs assessment,
2. a clear statement of a program philosophy,
3. establishment of school board policies addressing local needs and program philosophy,
4. development of administrative procedures,
5. specification of learner goals,
6. establishment of learner priorities,
7. specification of equipment needs,
8. preparation of bid specifications,
9. integration of microcomputer use into the comprehensive subject matter curriculum, and
10. design of an appropriate program evaluation measuring the success or failure of the program in meeting its programmatic and instructional objectives.

(Vakos, 1986, pp. 56-58).

An important feature of Vakos' approach to program planning and development is the degree to which policy issues dominate the ten steps summarized above. While the article apparently describes the personal experiences of the author, many of its conclusions are paralleled by the general recommendations of Cline, et. al. in the summary chapter of their volume on the IBM/ETS project. Their principal recommendations are:

1. Develop a written plan for integrating the computer into the learning process,
2. Make a multiple-year commitment to establishing a comprehensive program,

3. Use a shared planning approach to ensure a broad base of participation and support,
4. Teach all students to use microcomputers as tools to facilitate learning in many subject matter areas and extracurricular activities,
5. Ensure that computing programs do not reinforce economic, racial, or gender disparities,
6. Recognize that using computers in the instructional process will create additional work for teachers.

(Cline, et. al., 1986, pp. 133-134).

These recommendations summarize the findings of the IBM/ETS project, but they also have been echoed in many of the other contextually grounded studies of instructional computing programs discussed here.

The potential benefits of microcomputer use in the schools are gains in the efficiency, equity, and quality of the instructional programs in our schools where there is no "zero sum choice" in which any one initiative might negate gains in the other two areas. To realize maximum gains, administrative decisions on the selection, distribution, and disposition of instructional computing resource should support increased flexibility at the classroom level. Teachers must have the training, resources, and adaptability to integrate the use of computers as instructional resources which support the central elements of the comprehensive curriculum. By providing teachers with adequate technological resources and instructional flexibility, American education can use computers to increase the adaptability of classroom instruction to individual students' needs and to improve the effectiveness of schooling.

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Administrators must also be sensitive to the potential dangers inherent in a thoughtless rush to incorporate computing in schools.

# Educational Computing: Some Policy Implications for Administrators

by Dr. William D. McInerney

Few technological innovations have entered schools with the speed and inevitability of computers. Driven by public demand for a skill that is seen as critical for success in professional life, and by osmosis from a computer-impregnated society, educational computing is increasingly a fact of school life. The power of the computer to alter the ways in which the traditional tasks of education are performed, and the intense pressure to adopt computing in schools, make it imperative that we understand the unintended as well as the intended effects of our practices and policies. The uses of computing to teach various types of subject matter have received considerable treatment in the literature. Less well studied, but no less important, are the social and structural impacts of computing on the dynamics of the organization itself.

## Instructional and curricular impacts

The impact of academic computing on teachers has been widely thought to be salutary, freeing the teacher from the drudgery of teaching, facilitating individualized attention to students, and allowing the teacher to concentrate on the creative aspects of teaching (Lindelow, 1983). There has, however, been some suggestion that the nature of the teaching role may change from a focus on content where instruction is delivered in a group setting to an emphasis on diagnosing student instructional needs, monitoring student progress, and designing appropriate enrichment or remediation (Duttweiler, 1983; Podemski, 1984).

Administrators will find that computing has greatly complicated the tasks of managing instruction and curriculum. Staff may resist computing, particularly if it is forced, and thus integration of computing into the curriculum is a key task, although it is not yet clear where computing can supplement instruction and where it may supplant it (Podemski, 1984; Rockman, White, and Rampy, 1983). Software is improving in quality, but the high cost of quality software means that schools will have only one or two packages for any given instructional application, potentially leading to a standardization and uniformity of curricula (Dede, 1985).

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There is also fear that computing may force teaching, testing, and curricula into modes that are amenable to computerized monitoring, but not amenable to good teaching and learning. Studies in other organizations suggest, however, that the impacts of computing on organizational processes tend to be less dramatic than predicted, as computing is generally made to adapt to existing behavior and practice (Bank and Williams, 1986; Danziger, 1985), which appears frequently to be the case with education as well.

As computing becomes more significant in instruction, the intellectual skills most important to possess will center on those which promote abstract thought, particularly analysis, synthesis, and evaluation. The life-long learning required by the information age will demand independent, critical thinkers who can apply and develop their learning and thinking skills to both pose and solve problems (Dede, 1985; Lowi, 1981; Pea, 1985). Unfortunately, the major application of computing in instruction is currently drill-and-practice (Becker, 1986; Protheroe, Carroll, and Zoetis, 1982), which has not been found to convey any sense of control over the uses to which the machine can be put (Trumbull, 1986).

Administrators must also be sensitive to potential dangers inherent in a thoughtless rush to incorporate computing into schools. Computing has been found to isolate individuals, reducing their interaction with others (Danziger, 1985). The computer models the notion of pure rationality, which becomes man's ideal model of his own intelligence. Cognition, however, involves a rationality much deeper and capacious than simple technical rationality, and the humanistic aspects of the curriculum must not be sacrificed to a misplaced emphasis on instrumental rationality (Shallis, 1984; Sloan, 1984).

Educational computing may offer significant improvement in the efficiency with which school tasks are carried out. Protheroe, et al. (1982) maintained that educational computing would allow time and resources previously spent on administrative and recordkeeping functions to be allocated to the needs of individual students. Other studies (Danziger, 1985) have shown, however, that while computing has been a major source of productivity gains for individuals and organizations, the greatest benefits have been realized on more structured, repetitive tasks. Still, the idea that machines train and people educate is attractive from a cost-benefit perspective, as presumably machine-based training would be more efficient by avoiding some of the constraints of the cost of information. The one-time cost outlay for the development of a piece of quality instructional courseware, which could be used throughout the country, would be much more cost-efficient than the labor-intensive instructional technology which we employ now (Dede, 1983; Podemski, 1984). Lessinger (1985) has warned that technology must support tasks currently important within the school. If technology creates new jobs to be done, it will be resisted by the people managing the school. While it might be argued that this severely limits the prospect of technology creating desirable options that do not currently exist, certainly people will resist unnecessary jobs done simply because the machine is available. A more pressing danger to efficiency is the solitary, isolated nature of much work done with computers, which could injure morale and working relationships in an enterprise as much concerned with the human factor as is education (Brod, 1984). Another possible danger is the marked standardization caused by the nature of computing processes and the sorts of tasks given over to computers to do (Sherman, 1985). Finally, much hardware has been purchased prior to

effective planning, creating a mishmash of incompatible machines and software. In order for major gains in efficiency to occur, serious participatory planning is essential (King, 1986).

Educational computing is expected to have deep and profound impacts on the role and nature of administration. A recent survey (Protheroe, et al., 1982) found the major benefits of computing to administration to be a decrease in time spent on routine matters, an increase in the amount and quality of information available for planning, and new functions being performed that previously were not possible within budgetary constraints. Time for adequate planning in the face of community pressures to take action was however found to be a major problem for administrators (Moskowitz and Birman, 1985). Podemski (1984) has identified issues which the full incorporation of computer technology would impact to include the governance structure of education, the role of the teacher, the nature of parental involvement in their children's education, and the financing of education. Podemski suggested that the ultimate role of administrators could become that of instructional support and systems design, since such organizational artifacts as scheduling, budgeting, course selection, advisement, and student evaluation systems will need to be reworked in order to take advantage of the flexibility made possible by the new technology. Also affected will be such administrative prerogatives as staff selection, development, and evaluation. Other issues of concern to administrators include how resources can be allocated to ensure equal access to computing on the part of all students, how the technology can most effectively be acquired, introduced, and managed, and how computing can most effectively be utilized in classrooms (Rampy, White, and Rockman, 1983).

Railsback (1983), looking at the implementation of education computing, has cited as common administrative mistakes overselling the idea, rushing to gain publicity, changing by administrative fiat, and purchasing equipment without knowing how it is going to be used. His keys to success include creating a board policy, developing administrative procedures, and establishing a plan to evaluate the computer program. Moskowitz and Birman (1985) cited a lack of clearly presented goals for computer activities, a lack of implementation plans, and the problem of assuring access for all students as the most common problems in the ten districts they studied. It is incumbent on the administrator, therefore, to become sufficiently computer literate to be able to ask the correct questions, and to plan for computer use. Clearly, the most important administrative skill in an era of computer technology may well be the ability to manage change (Estes and Watkins, 1983; Sturdivant, 1986). It is nonetheless true that the danger of depersonalization is always present. As computers enter into our way of thinking about the jobs we do, they similarly enter into our way of thinking about ourselves (Turkle, 1984). Already we are prone to think of the administrator less as the intellectual leader of a school and more as the manager of a system (Sardello, 1984). The uses a principal puts technology to will depend on his vision of what is possible both for technology and for education. What is required is not automation but renovation, not so much computerization as revitalization (Mojkowski, 1986). Indeed, King (1986) found leadership in all levels more important than either demographic or financial characteristics of districts in providing computing for students.

The computer is not, however, a magical panacea. Nelbauer (1985) has characterized the machine as a new toy for teachers seeking new experiences in the classroom and

as a public relations gimmick for administrators. Today's microcomputers are severely limited for use in education. They are hard to use, and few teachers are expert in their use. Long-term planning is nearly impossible since there is so little standardization of hardware and software. We are only beginning to learn to use microcomputers in education, so many mistakes are being made. Educational outcomes that involve judgment and intuition are difficult to teach through computers. Finally, microcomputers only aggravate such serious educational problems as equity, school finance, and divergent public expectations (Walker, 1983).

The issues are serious, since the movement of society into the information age holds the potential for a stratification of people related to intellectual preparation and functional responsibility. However, policy decisions regarding educational technology are frequently being made by default and inaction, without a policy planning process suitable for decisions of such importance (Lowi, 1981; Rampy, White, and Rockman, 1983). Much will be lost if we allow machine-mediated learning to replace egalitarian policies. If human interaction and interpersonal skills are not stressed in the curriculum, students' affective growth may be stunted by spending so much time with machines (Dede, 1983). Sloan (1984, p. 545) has noted that "It is in the imaging capacity of the mind that we find the moral element at the heart of all thinking." By letting the computer create images for children, the imagination is stilled, the senses blunted. The risk is that the child may form a relationship with the computer that closes off opportunities for personal development. We prize the computer's qualities of speed and accuracy, but there is a danger that we may come to expect similar qualities of speed and perfection from people. We have worried that the computer may replace the teacher; a more profound worry may be that the computer could replace the growing child (Brod, 1984; Turkle, 1984; Zajonc, 1984).

#### **Organizational and structural implications**

Research indicates that aspects of organizational structure, such as control relationships, patterns of authority, and hierarchy, tend to be contingent of the organization's technology (Danziger, 1985). Computer systems affect organization in at least three areas: content of jobs, patterns of communication, and skill requirements for individuals in the organization. We can expect that as computing becomes increasingly important in schools, the traditional distinction between line and staff will blur, since in many schools teachers will be far more computer adept than the administrators who ostensibly manage them. The manager's job will place greater emphasis on environmental scanning, goal setting, and motivation of employees, and less on recordkeeping, evaluation, and task-associated communication (Whisler, 1970). Studies in the insurance industry indicate that when computer-based decision systems are implemented, choice making and goal setting are pushed to higher organizational levels (Whisler, 1970). The shift in decision making tends to affect middle managers in departments first, then interdepartmental consolidation of decision making takes the locus of decisions higher in the organization. If this same pattern holds for school systems, we may expect computer-based management information systems to augment the principal's decision making in the short run, but to shift to an emphasis on central office decision making in the long run.

The successful implementation of technology may well be dependent on the support, motivation, and skill of

staff to utilize the technology, implying that training or otherwise changing the way users relate to the technology is the best way to address computing problems (Kraemer, Dutton, and Northrop, 1981). King (1986) found the computer coordinator to be the key to effecting the transition from initial applications of computing to a full implementation. Clearly the disjointed nature of many (if not most) school district implementations of educational computing indicates a strong need for district level coordination by individuals who understand both technology and curriculum. It is equally clear that such coordinators must not be isolated from such policy issues as the definition of district priorities and decisions about equipment and applications. If funding is not available for a full-time position, it is likely that a school district already employs people who could be given some release time from teaching or other duties to serve a coordinating role.

Computing does not of course enter schools in a vacuum, but in the context of ongoing activities and processes. The key questions for educators are to attempt to determine for whom, where, and how computing can be most helpful (Sloan, 1984). In the typical school, the principal computer-using teacher is a classroom teacher, and the major application, particularly in elementary school, is CAI (Becker, 1986; Protheroe, et al., 1982). For meaningful integration of technology into curriculum, the teacher must be modeled as a facilitator of instruction rather than as a lecturer. This is difficult to do when such traditional organizational artifacts as curricula, schedules, and classroom organization have remained largely intact for several generations. Thus the successful integration of technology will call for a revitalization of roles and activities, not more of the same. Successful management in the computing era will be effected by technologically sophisticated administrators, adept at the self-conscious manipulation of the information environment (Duttweiler, 1983; Lowi, 1981; Mojkowski, 1986; Sturdivant, 1986).

There is reason to believe that administrative decisions could improve in a computer-based decision system, from the availability of comparative, trend, and outlier information (Klein, 1986). It is also true that computers, relying on explicit sets of rules, tend to rationalize and quantify decision making, reducing the importance of the judgmental and intuitive elements in decisions (Whisler, 1970). Danziger (1985, p. 14) has found a tendency toward overestimation of the reliability, validity, and significance of quantifiable data: "From this perspective, narrow, technical considerations tend to override a richer assessment of crucial goals and the most appropriate means for achieving them." Computers magnify errors in two ways: first, the fact that a datum has emerged from a computer gives it an aura of accuracy that may be quite misleading; second, data are often swapped back and forth from one decision system to another, compounding the error each time they undergo analysis. Thus the qualitative factors are squeezed out by the false sense of objectivity engendered by computer analysis. Finally, it is important to remember that a decision system defines the boundaries of authority and responsibility of a decision maker, and thus sets limits to the search for information, and the range of decision variables and factors that will be considered (Shallis, 1984; Sherman, 1985; Whisler, 1970).

The question of performance documentation regarding educational computing is of particular interest to administrators. Lessinger (1985) has noted the need to set standards and measure performance objectively even as we attempt to understand the place of technology in our hu-

manistic school systems. The capability currently exists to place all of the various parameters of teacher or administrator evaluation, based on district, school-level, or classroom objectives, in a computerized data base. Such information as grades, test scores, IQ scores, demographic information, teacher sick days, and referrals to the office are readily subject to computer analysis, and would permit comparisons both between different personnel and between expected and observed performance on a variety of measures. Once comprehensive data bases are built, the data may be easily analyzed in a variety of ways. These matters are of course hardly value-neutral. The mechanisms of information gathering, processing, and disseminating reveal the functional value orientation of the school system. How various organizational stakeholders receive and reveal information from and about each other says a good deal about the assumptions and power relationships that shape the school system (Molnar, 1986).

It is important to realize that a technology is not centralized or decentralized simply because it has a computer attached; it must be designed to be so. Current information from other industries suggests that computing tends to reinforce existing power distributions, providing a relative increase in influence for those higher in the hierarchy who perform more discretionary information processing tasks, as computing increases their capabilities for accessing, analyzing, and utilizing data relevant to organizational decision making. The current interest in cross-state comparisons of educational achievement was to some degree occasioned by the increased availability of data in computer-based information systems. Such systems are already making possible cross-district, cross-school, and cross-teacher comparisons. We may expect this use of computer-generated information to be increasingly a feature of the educational landscape. Further, the ability of the computer to conduct analyses on multi-variate aggregate data enables central decision makers to monitor and control actions on a much wider basis than was possible before computer-based information systems. Already we see numerous districts that have in essence removed financial decision making from the principal's job description, and similar developments are occurring in other decision areas, particularly with respect to the allocation and control of various resources, such as equipment, maintenance, and to some extent curriculum and personnel. The movement toward centralization of decision making is naturally most pronounced in districts that have opted for centralized computing services. The widespread use of microcomputers as independent, unmonitored systems, as is the case with a considerable amount of public school computing, should significantly reduce the impacts of computing on organizational control and on power concentration (Danziger, 1985; Kraemer and Danziger, 1984).

Clearly the critical organizational issue is who controls. "The impacts of a technology are fundamentally determined by the actions of those groups who control its development and use" (Danziger, 1985, p. 5). At least three potential loci of control seem possible in education. The most obvious is the administrative staff, who already dominate access to the policy formation process. Another is the group of computer "champions," those enthusiasts who by dint of their specialized knowledge and by simply beginning to use computers in what they do have seized control by default. The third possibility is that no one is in control—an anarchy of decision responsibility brought about by everyone riding off in all directions in the absence of policy planning. Current indications (Becker, 1986; King, 1986) are that

all are true in one district or another. Probably the most common pattern, particularly in smaller districts which have not instituted centralized computing, is that anarchy prevails, and into that vacuum have come the computer champions. Not willing to wait for central administration, the computing enthusiasts among teachers and administrators have begun to use computers in their work on an ad hoc basis, almost always leading to problems of machine and software incompatibility when policy planning and centralized coordination attempt to catch up.

Another important dimension of control is whether computing has altered the educator's control over the work of teaching or administering. Control in this context takes on a variety of meanings (Kraemer and Danziger, 1984). First, control can mean supervision—control of the educator's work by others. In many cases, academic applications of computing are unsupervised to a degree that is not true of more traditional academic processes, because administrators feel inadequate to evaluate computing. Second, control can mean influence—the educator's control over what others do. The computer can be such a mysterious, intimidating object to many people that the computer enthusiast on the staff acquires considerable influence in various applications of computing. Third, control can mean control by the machine—through specification of procedures, through coordination, through initiating action (such as supplying data for someone else's MIS), through the tighter monitoring of accuracy, and through the imposition of deadlines (Whisler, 1970). We may posit a law of organizational computing, that reports will expand to consume the data available. In the context of academic computing, machine control is manifested in the availability of software for specific machines and in the likelihood of one or very few software packages for any given application. Fourth, control can refer to the educator's overall sense of control over his/her work life, as indicated by a sense of accomplishment and the belief that computing is enabling the educator to do a better job. Clearly computing enthusiasts believe that computing is efficacious in their work. Equally clear is the need for continuing research and development activities to advance the potential of academic and administrative computing, particularly for those educators not intrinsically enthusiastic about computers.

Perhaps the most interesting aspect of the issue on control is the rise of the information elite, a phenomenon first noted in other organizations, but apparent in schools as well. These persons, who combine some sophistication in the use of computers with technical expertise in teaching or administration, gain access to the policy process by their ability to provide the computing experiences which educator peer pressure and the public demand. In the absence of managers who are comfortable with computer technology, the information elite gains influence over others and avoids control by others through a combination of the force of what is seen as specialized, somewhat arcane knowledge and their ability and usefulness in serving as information brokers for decision makers. The teacher who can incorporate academic computing into the curriculum becomes a powerful public relations as well as educational resource for the school. This writer is familiar with a district where one principal has emerged as first among equals by his ability to craft various budgetary spreadsheets for use by the superintendent. In the long run, as principals and superintendents become more computer sophisticated, the power of the teachers and staff who now constitute the information elite may diminish, but in the short run their influence is apt to remain considerable (Kraemer and Danziger, 1984).

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The level of training necessary for administrators to gain personal familiarity with computers will approximate the level of training that is generally received in many of the other specialized tasks of administration.

# Attitudes and Knowledge Perspectives of Administrators Necessary for Fostering the Adoption of Computer Technology in School Systems

by Dr. Maynard J. Bratlien

The phenomenal changes which were brought about in the world of technology due to the microchip have virtually revolutionized our thinking and our approaches to the tasks facing us in the workplace as well as in our personal lives. Microcomputers became available to us barely a decade ago, and at that entry point utilization potential seemed profound. Now, 10 years later, we find that very industry has gone through four or five "generations" of development and refinement, each one antiquating the previous advancements.

With the advent of microcomputers, perceptive educators began to see the tremendous potential for education which now seemed within the grasp of the individual professional as opposed to the prior mainframe computer technology which had primarily been reserved for large, intricate, and expensive operations within the bureaucratic domain of the central administration of the school system. Microcomputers meant decentralization, which in turn could foster creativity, whether in the realm of instructional or admin-

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istrative uses of the technology. The impact the technology would have upon professional educators would be profound.

The ultimate focus of knowledge and skills in computer technology, as it relates to educational administration, will and should generally follow the pattern of administrative competency domains. Computer technology constitutes yet another of the many areas which the administrator will oversee in a management capacity, facilitating decisions for the organization relative to the extent of computer utilization in education, both in an immediate context and over a long-range period of time. The administrator will be the individual responsible for a plan to assess the needs and requirements for the technology as they relate to the goals and philosophies of the school system. In this capacity, planning and decision making will be necessary with respect to such issues as:

- (1) Needs assessments
- (2) Areas of utilization
- (3) Software requirements
- (4) Hardware/equipment requirements
- (5) Training/in-service needed
- (6) User/utilization audience
- (7) Accessibility planning
- (8) Maintenance and repair
- (9) Building/facility requirements
- (10) Security of hardware and software
- (11) Need for specialized personnel

In order to function competently in an administrative setting where technology plays such an important role, both educational administrators currently in our school systems and those in preservice preparation programs will have the need for specialized understanding in two principal areas, (a) personal familiarity/understanding of computers, and (b) the general impact of computer technology on the total educational spectrum.

## Personal Knowledge

The first of the aforementioned areas, personal computer literacy skills, serves to foster the adoption of computer technology generally by demonstrating in a very immediate sense the value(s) to be gained by the technology. If an administrator is able to see and experience the tasks and routines of his/her professional job alleviated by the technology, it is logical to assume that decisions relative to adopting computers for school administrative tasks will be much more readily forthcoming. Additionally, the sense of value gained from the technology in a personal sense will be more easily transferable to the needs and requirements of others. Therefore, team planning and decision making processes which send forth recommendations based on the need and importance of computer technology will be more likely to be embraced by an administrator who has developed an understanding of and a personal commitment to the technology.

Current computer software applications for educational administration typically follow a framework characterized by the following specific use areas:

- (1) Wordprocessing
- (2) Financial spreadsheets
- (3) Database systems
- (4) Graphics
- (5) Networking

Utilizing these applications, administrators are increasingly better prepared to make the many administrative decisions requisite for the smooth and efficient operation of their system or campus. Middle level administrators will be concerned with those applications which serve to catalog and organize data in such a way that it is easily accessible for planning and information purposes. Spreadsheets and databases facilitate recordkeeping with respect to students, teachers, inventories, lists, and budgets. Wordprocessing and graphics will provide the means of communicating these data to employees, students, parents, or central administrators. Central office administrators will utilize computers with respect to districtwide accounting and recordkeeping, long range planning via simulations and projection processes, and general public relations via wordprocessing and graphics. Recent advances and refinements made in the area of networking and electronic communication will allow administrators at all levels to bypass much of the "paperwork" burden which has plagued public and governmental enterprise far too long. Computerized electronic mail will provide an efficient and economical means to communicate with the many individuals and groups who impact the management of a school system.

The level of training necessary for administrators to gain personal familiarity with computers will approximate the level of training that is generally received in many of the other specialized tasks of administration. It should not be the intention that the typical administrator become a computer specialist, but rather they should have a sufficient overview and general understanding of the technology to feel comfortable and at ease in directing and overseeing roles as characterized by the administrative job function. A comparison could be made to many of the other specialized coursework offerings in typical administrator preparatory programs such as finance and law. In these areas it was not the intention that the administrator replace the lawyer or the CPA, but rather that there would be a sufficient level of understanding to allow for the oversight management of the enterprise. The administrator would be sufficiently conversant with computer technology to be able to facilitate planning and projecting activities as well as being able to adequately supervise staff employees who are more directly involved with the use of the technology. The mode of delivery of administrator computer training described here should follow a not-threatening, application-oriented format, allowing the novice administrator to gain quick, usable skills upon which can be built further understandings deemed necessary at a later time.

#### **Impact on Education**

The second area of concern for administrators' relates to an informed appreciation of the general impact which has already been felt in the world of education as a whole and which will continue in years to come. Administrators must realize the differences between computer assisted instruction (CAI) and computer managed instruction (CMI) and realize the proper setting for each. Drill and practice must be differentiated from tutorials and simulations, and menu-driven programs must communicate something meaningful to him, as must light pens, mice, icons, and sketch pads. Voice synthesizers and interactive vocal communication must be appropriately utilized. There must be a general understanding of the differences between dot printers, impact printers, and laser printers, and the appropriate settings for the use of each. The potential offered by hard disk storage, bubble memory, laser disk/computer interfaces, and other emerging technologies for the world of teaching and in-

struction must be explored and understood sufficiently to allow for informed and forward-looking decision making by those with administrative responsibilities. At the same time, administrators must realize that there is good software and bad software on the commercial market today. Informed decisionmakers will utilize personnel who understand the attributes of appropriate, educationally sound software and will make every effort to ensure that proper selections and choices will have been made which are consistent with the educational goals and outcomes desired.

#### **Proactive Posture**

With both a specific and a general understanding of computer technology, administrators will be equipped with important background information necessary for the infusion of computers into the educational enterprise for which they are responsible. However, another very important aspect for the success of such infusion efforts is found in the realm of personal commitment to the concept on the part of the administrator. The old cliché, "... as the principal goes, so goes the school ..." is applicable here. Principals' attitudes very profoundly influence the directions taken by their campuses. Administrators must believe in, and be committed to, the concept of computer infusion. This belief must be spoken, it must be seen, it must be evidenced, by practice and deed. Whether in the course of faculty meetings, before the central administrative cabinet, or at the PTA, the principal must plan, promote, and publicize the benefits to be gained, educationally, by computer technology. The reticent and skeptical must be given special attention and consideration, and every effort should be seized to allay their doubts and suspicions. This enthusiasm for computers will emanate naturally and freely from the administrator who has taken care to plan and prepare himself/herself personally. For potential administrators, preservice programs should have coursework and hands-on training included in preparation requirements. For those administrators already in the field who may have missed the opportunity for skill development, every effort should be made to gain the necessary understandings and skills individually or by way of inservice programs.

The proactive posture should also be in evidence with regard to budgetary and funding requirements necessary to implement computers in school systems. Districts which are financially able, should be shown the benefits to be derived by having teachers and students involved with programs representing the "cutting edge" of educational innovation. They should be instilled with a justifiable sense of pride for having opportunities for providing their young people the "best" in this area. School systems which are not as wealthy should be convinced of the importance of the concept, and should be encouraged to make a commitment to a basic or entry level effort regarding the technology. In these settings, administrators should actively pursue outside funding to make up shortfalls of the local constituency. State and federal government support should be pursued where possible. Additionally, private individual and business support of the program should be actively sought. Many times, those commercial enterprises involved in the manufacture and/or merchandising of computer hardware and software will either donate their products, loan them for extended time periods, or sell them at substantial monetary discounts to educational institutions. Districts who have manufacturing firms located within their boundaries sometimes stand to gain particular advantage in the commercial benefactor arena. As mentioned earlier, the school administrator needs to be enthusiastic and should actively pursue

such potential opportunity for low-cost software and hardware acquisition rather than waiting for others to promote and carry forward the infusion concept in his behalf.

### Planning

The perceptive administrator who is planning to provide for the adoption of computer technology into the schools under his jurisdiction will be well aware of the proper management activities and postures necessary to accomplish the task. Two important concepts at work here are (a) involving others in planning and development, and (b) properly publicizing and promoting the project.

The first issue deals with the administrator's leadership style. Modern practice recognizes that authoritarian, top-down, unilateral decision making has been replaced largely by more democratic collegial approaches sometimes characterized as "team management." Very important for the success of computer infusion into schools is the practice of involving everyone who will be working with, or affected by the technology, an opportunity for participation in the planning and decision-making process. Teachers, campus administrators, and central office liaison representatives should become a minimum necessary representation on the planning committee. The planning committee should establish a realistic time line which will facilitate information gathering and time for weighing and deliberation relative to the issue(s) of concern. The planning committee should have a place and time conducive for conducting meetings. The administrator should assume a leader/facilitator role and provisions should be made for keeping accurate records of proceedings. The planning committee should be working from, or should if necessary, develop a written set of goals. This document would include a broadly defined purpose to be gained from the phase of computer infusion currently under consideration. It is understood that such goals would reference and be consistent with espoused educational philosophies and goals of the school system.

Data gathering should involve the assembling of all characteristics, features, and capabilities of proposed hardware and software acquisitions. Dealers and company representatives should be invited to make presentations and/or give demonstrations of their products. The planning committee should have an objective evaluation document at its disposal to rate each of the items previewed. Other activities might find the committee traveling to other school systems which already have made computer acquisitions to find out both the strengths and weaknesses of particular products, as well as gaining insights as to how another system has organized for computer utilization. Personnel from other districts are usually quite willing to offer suggestions and assessments as to how the acquisition process might have been better accomplished.

After the data have been assembled, the committee has the task of considering all possible contingencies and to derive several alternate sets of recommendations relative to both acquisition of equipment and implementation of the

infusion plan. The alternatives suggested should be prioritized from most preferred to least preferred with respect to desirability and feasibility. In any such ordering of alternatives, it will be very important to secure direction from the central office administrator in charge of financial planning. Questions pertaining to the availability of local funds for the project will have an important effect upon later activities relative to planning for external funding for the effort. Related to fund accessibility perhaps, will be the need for the committee to consider the project in a number of phases, rather than in a single effort.

Once the committee has come to closure on the many decisions to be made, final recommendations should be assigned and printed in a concise, clear, cohesive, and attractive formal document. In the initial launching of the planning committee, its timeline should have included provisions for a formal, scheduled presentation of the completed report to central administration or the board of education. Assuming the recommendations are adopted in some manner, definite information should be sought relative to scheduled implementation and who will bear responsibility for this task. Another important item at this juncture is to ascertain whether computer-oriented education practices are addressed in the formal district policy document, whether at the board or administrative level. If policy seems to be absent, this moment might represent an excellent opportunity for an appropriate policy statement concerning computers in education to be accepted and adopted formally. With formal policy recognition, future efforts to expand and improve the system will be much more easily accomplished. A final management skill for the administrator in his/her dealings with the planning committee is to ensure that, according to previous planning, the committee ceases to exist after it has accomplished its purposes.

### Conclusion

Consistent with the theme reflected throughout this writing, the adept administrator will publicize the (hopefully successful) results of the planning and implementation for the each phase of computer infusion. Recognition should be given to committee members who were diligent in pursuance of the collective task as well as to individuals and organizations who may have been responsible for financial contributions to the effort. Progress concerning the advantages and educational gains made as a result of a computer/technological orientation should be publicized periodically over an extended period of time.

In summary, the process of infusing computer technology into our school systems becomes an important leadership responsibility of administrators. Individual commitment and enthusiasm, fortified by personal knowledge and involvement of individuals will foster a climate in the classroom, the corridors, and the community which will serve as a catalyst for consciousness and commitment. The technology is with us—the dream is before us—the challenge remains.

The proliferation of microcomputer software has exacerbated three problems: piracy of software . . . piracy of information . . . and security of data. . . .

# Piracy, Privacy, and Security: Legal Issues of Computer Use in Schools

by Dr. Grover H. Baldwin

Since the early 1980s, there has been a proliferation of microcomputers in the schools. Fueled by the external demands for computer literacy, the rush to keep up with other nations technologically, and the "promise" of greater achievement at lesser costs, school districts have purchased microcomputers, developed curriculum, and purchased software at an amazing rate. The costs of hardware have come down and greater power is now available for less money; however, the cost of software has remained high.

Concurrently, the infusion of software programs into the schools has not been consistently well-planned across district lines. This has led to unrestricted and uncontrolled use of the software, lack of solid curriculum planning, random infusion of computers into the instructional process, and the unrestricted access to both program and data disks, and schoolwide databases, by a variety of school personnel.

This proliferation of microcomputer software has exacerbated three problems: **piracy** of software to "beat" the high cost of programs; **privacy** about information of students' lives through the use of programs not appropriate for instructional purposes and easy access to students' information; and **security** of data disks and databases via the ready access by any school employee, whether or not he has a legitimate interest in the information.

This article will examine these three legal issues involved with the use of microcomputers in the public schools

## Piracy and Software Copyright Protection

In their work on intellectual property law, Kintner and Lahr (1975) made only passing reference to computers and copyrights, saying that it was an arising problem. The American Library Association handbook on copyright law failed to mention the legal issues surrounding the copyrights at-

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tached to computer software (1977). Yet, one year later, the National Commission on New Technological Uses of Copyrighted Works (Final Report, 1978) dealt at great length with the additional changes needed in the copyright law to cover this growing area. These changes became part of the revised copyright law and have a dramatic effect on the school use of computer software.

With the purchase of any piece of software, the owner signs a licensing agreement. By signing the agreement, the owner of the software agrees to abide by the stipulations of that agreement. Typically, the owner is permitted to make one archival copy of the piece of software in case the original is destroyed or damaged beyond normal use. Stipulated in licensing agreements is the clause that the owner of the software "may not use, copy, modify, or transfer the program or documentation" except as provided within the licensing agreement and any unauthorized use is a copyright violation punishable by law (Microsoft, 1984).

With the high cost of software, and the decrease in school funds available to purchase additional pieces of software for any particular grade level or subject area, some school districts have made multiple copies for all the classrooms/teachers needing the program. While the piracy issue has been with us since the beginning of the "micro" revolution, and while "locksmith" programs abound to open up the program for multiple copies, the legal issues involved in such activities are just now coming to the fore.

There are two copyright issues involved here. First there is the issue of fair use. The fair use standard involves four aspects:

- (1) the purpose and character of the use, including whether such use is of a commercial nature or is for a non-profit educational purposes;
- (2) the nature of the copyrighted work;
- (3) the amount and substantiality of the portion used in relation to the copyrighted work as a whole, and;
- (4) the effect of the use upon the potential market for or value of the copyrighted work.  
(17 USCA 107).

The most important aspects of the fair use doctrine for school districts are numbers 1 and 4. Schools are normally considered non-profit educational institutions. However, when they engage in the transmission of knowledge via use of multiple copies of copyrighted materials, they are in violation of the law and lose that status. The recent decisions in the Encyclopedia Britannica vs. Crooks cases bring this point poignantly home (1982; 1983). While the copied materials in this BOCES case were films, and while the materials were distributed among teachers in the BOCES service area, the U.S. District Court found the BOCES in violation of the copyright law as they had made multiple copies, and had kept them beyond the normal two-three day rental period. Under these circumstances, the Court held that the BOCES had violated their non-profit educational status. Further recognition of copyright violations, through making multiple copies of computer software, comes from the SAS Institute, Inc. vs. S & H Computer Software, Inc. decision (1985).

The second issue, that of the effect on the potential market for or value of the copyrighted work, should be obvious. By making multiple copies to permit the school district to lessen its instructional costs and save on the high cost of software, the educational agency is in direct violation of the copyright law. An offshoot of this issue is the typing of com-

puter programs from magazines that carry listings of computer programs. While the court has held that the purchaser of the magazine may type in the program, and use it for his own use, the listing cannot be copied and distributed to other individuals, nor may a **third party** copy the program into an electronic device to permit operation of the program (Micro-Spart, Inc., 1984).

For computer software, making a copy includes not only copying to another disk, but the loading a program into electronic memory devices and using the program to control activities of the machines (William Electronics, Inc., 1982). Thus, subsequent booting to additional computers, even if there is only one copy of the program, or the use of the program in a networking set-up, have the potential of being a violation of the copyright law. Therefore, the only valid copies that can be made of computer programs are the single, archival copies that permit retrieval if disks are damaged or programs crash.

While many school districts, service agencies, and school personnel may be tempted to "forget" the copyright law pertinent to computer software, the penalties are rather stiff. Growing out of the Sony case (Sony Corp., 1984), the standard of contributory infringement of copyright violations was established. This notion of contributory infringement was enforced in the Encyclopedia Britannica decisions (1982; 1983). The contributory infringer is considered to be the individual who is "in a position to control the use of copyrighted works by others and had authorized the use without permission from the copyright owner" (Sony, at 437). Thus, this standard holds the school administrator (both district superintendents and building principals) responsible for the acts of copyright violation of their employees. The penalties range from a minimum of \$250 for infringement of any one work to a maximum of \$50,000 if the court finds willful infringement for damages against the copyright owner. Also, criminal charges and penalties may rise to \$10,000 and/or imprisonment of not more than one year for willful infringement of copyrights for commercial advantage or private financial gain. These penalties were inflicted for **each incident** of copying in the Williams case, and have dramatic effect if we consider the subsequent "booting" and networking capabilities districts are beginning to have implemented in the schools. The penalties for violation of fair use and contributory infringement far outweigh the cost of purchasing additional copies for school use.

### Privacy and Security

Turning to the use of computers and software within the schools, we find the second problem area, that of privacy and security. Privacy is used here in the context of both privacy of information about the students' attitudes and beliefs, and privacy and security of information dealing with records kept by school district personnel on individual students.

Under the Hatch Amendment (20 USCA 1232h), pupils are protected from certain types of questions that tend to reveal information about their political beliefs; mental and psychological problems; sexual behavior and attitudes; illegal, anti-social, self-incriminating, and demeaning behavior; and specified other pieces of information that are potentially damaging to their health, safety, and well-being. While the amendment covers psychiatric or psychological examinations, testing, and treatment, the amendment has been used to permit parents and concerned citizens to examine the instructional materials and curricular programs of schools. The rub for microcomputer software comes with

the use of specific programs designed to assist students to be come familiar with the operation of computers. These conversational programs are designed to permit student interaction, with little fear of fouling up the computer program, while gaining an understanding of the operation of the computer and its potential. However, what about the nature of the conversational program and its suitability for specific age groups of children? Two conversational programs come to mind that create dangerous and embarrassing situations for students and school personnel. These two programs, "Hello" or "Psycho," are very entertaining, both have interactive capabilities, but both are potentially dangerous. "Hello" asks students questions about sex, money, health, or job. "Psycho" asks the student to use projective analysis to render a description of the inner personality characteristics of the individual. It ends with an explanation of the respondent's sex drive.

Yes, they are cute and the vast majority of students will be able to handle the questions in stride. However, in the context of the developing new teaching techniques and instructional methodology using microcomputers, such material is open to inspection under the Hatch Amendment. Not only can it be inspected, but the use of such programs places schools in the similar dilemma fostered by values education and moral development programs. Further, while not a psychological examination in the strict sense of the Hatch Amendment, the use of such programs as part of computer literacy programs does have the effect of holding students up to sarcasm, ridicule, and peer approval/disapproval and comes close to the burgeoning notion of psychological maltreatment. Again, while most students will deal with the program easily, the use of such programs does open the schools, and school personnel, to close scrutiny of the public under the Hatch Amendment.

An additional privacy problem, also linked to security of information, deals with information about student attitudes, values, and parental background when gathered via career and vocational guidance programs. This adds to the problem of privacy, especially if the information pertinent to these sensitive areas is retained for later use by guidance personnel, but is accessible by school personnel.

The second aspect of privacy links with security of data and databases that contain information regarding students, both personal and academic. The problem lies in who has access to this information and for what purpose. The Family Rights and Privacy Act makes provision for who has access to files and information regarding students (20 USCA 1232g). The amendment provides that access to educational records must be with parental, or student, consent except for school officials within the school district who have a legitimate educational interest, or school officials of other systems in which the student seeks to enroll. Given computer programs dealing with database management, recordkeeping, and gradekeeping, anyone accessing these files for a particular individual will be faced with a screen full of other information not pertinent to the particular query or their legitimate interest. While professional staff members, including teachers, have an interest in students they are dealing with in a particular year, and perhaps need additional family information, the computer programs used in schools allow for global access to all information by anyone using the program. Parental permission may not be necessary to access student information by school personnel, but the school must establish the limits of legitimate educational purpose and work from that position.

There is also the concern for security of the information stored on disks and internal memory of computers.

Given the recent spate of illegal intrusions into computer systems by individuals not entitled to have access to such information, extraordinary precautions need to be established. Policy must be established to determine who enters and edits data in school files; who has access to what files; who can copy information from the files; and who should have ready access to district, building, and teacher's files. Further precautions must be taken to guard against breaks in security of the information. Part of the security of building and district information flows back to the copying problem mentioned earlier.

The key to the security, privacy, and piracy issues is supervision by the building administrator and the awareness of the other school personnel to the problems they face in dealing with the use of microcomputers in the schools.

#### **Recommendations for School Personnel: for Piracy:**

1. School districts should seek software from companies that offer "site licensing." This is a relatively new phenomena and one that, while costly initially, will benefit the schools by payment of a one-time licensing fee and allowing school personnel to make multiple copies as needed. If that is not feasible, then the district should purchase one copy for each site (building or classroom) in which the program would be used.

2. In lieu of site licensing, school district and building policies need to be established and supervised covering the following area:

a. Making of one archival copy and distribution of the software program using the single copy for use in the classroom or office.

b. Close security by the building administrator of the use of the software to ensure that multiple copies are not made.

c. All software should be inventoried and regularly accounted for, both in terms of its use and for possible violation of the copyright laws.

d. Specific in-service should be held to delineate the overall copyright law and its effects on teachers and other school personnel. All school personnel must be cognizant of the law and the penalties involved for its violation.

e. On all copyrighted material that would be used by school personnel, the Copyright Statement should be prominently displayed.

#### **For Privacy and Security:**

While most school districts have policy statements on accessibility and privacy of student records, they have been concerned with the written records stored in the schools. With the use of computerized databases, additional precautions need to be taken to insure the non-violation of the Family Rights and Privacy Act.

1. Establish exact policies and procedures for access to computerized databanks of student records, including who has access and for what purpose; checkout and return procedures; who may copy data from the master files; and empower one individual per site with oversight responsibility for these areas.

2. In hiring an individual to enter, edit, and delete data

from school records, place emphasis on the individual's capability of dealing with confidential data. While routine data entry might be handled by a paraprofessional or a volunteer parent, as they are dealing with student and family information, care must be taken to insure the confidentiality of information will be kept.

3. Make use of passwords to insure that in the event data is obtained by non-authorized school personnel, that they cannot access areas to which they are not permitted.

4. Provide teachers with data disks on which to maintain their own data files of student grades and other academic information so that this information is protected. Further, insure that teachers have a safe place, preferably locked and secure, or via password arrangements, so that their data cannot be accessed and altered.

5. See that data on student's achievement is placed on master files at the end of the year and that individual teacher records are destroyed.

6. In dealing with the curricular issues found above, establish a software evaluation process, that includes parents and students, that evaluates the proposed software not only in terms of its applicability to the curriculum and instruction process, but also protects the rights and privacy of individual students.

Overall, the use of microcomputers will continue to grow in schools. The need for additional software to fulfill teacher demands will increase. The need for access to information stored in various databases will become increasingly pronounced. Recognition of these factors, and the legal issues raised above, will force school districts to reassess their policies regarding purchase and use of such materials. While the legal issues are important, they are manageable and can lead to greater and more effective use of microcomputers in the schools.

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Many practitioners believe the MIS is only the computerization of the clerical and fiscal operations of a school district . . . operation of the MIS is dependent upon the people that use the system.

# Management Information Systems in Educational Organizations

by Dr. Frederick L. Dembowski

In this article, great stress is placed on the concept of the management of the computer as a tool used in the administration of a school district. The reason for this emphasis is that the computer industry is progressing so rapidly in both technological advances and applications that by the time an article is written and published, it may be essentially obsolete. Because of this, it is very important to understand the role the computer plays in the management process. Thus, this article will begin with a general discussion of Management Information Systems (MIS) and then focus on the organizational and management aspects of computer usage.

## Management Information Systems

Many practitioners believe that a MIS is only the computerization of the clerical and fiscal operations of a school district. Others think it is an ultra-sophisticated computer system that will provide answers and decisions for complex problems to managers at the push of a few buttons. Both of these beliefs are partially incorrect. The concept of MIS can be understood most fully by examining the three words management, information, and systems separately.

**Management** consists of the activities carried out by managers. They plan, organize, and control the major activities of the organization and initiate actions. The practice of management consists of the artful application of scientific principles to problem-solving in order to select courses of action that optimize the utilization of scarce resources in achieving the desired objective. Because decision-making plays such a major role in all of the functions of management, the MIS becomes a facilitating system for developing decisions in planning, organizing, controlling, and initiating courses of action. This yields the purpose of the MIS.

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**Information** is the raw material needed for the decision-making process and is often confused with data, but there is an important distinction between the two concepts. Data are facts and figures that are not currently being used in a decision process. Files, records, and reports not under consideration are examples. Information consists of classified and interpreted data that are being used for decision-making.

A **system** is a set of two or more elements which are joined together to attain a common objective. A system may be further delimited into sub-systems. The sub-systems and elements work more effectively together in the system than if they were working separately. A computer consists of many components all working in harmony which is why it is often called a computer system.

Putting these three concepts together, MIS is the means for connecting the operating systems in an organization by the exchange of information. The computer is only one component in the MIS. The human element is another important component in the MIS. The administrator must take an active role in the design of the MIS as the principal user, and all the users of the MIS must be accustomed to accept the MIS and trained in its efficient use.

## The MIS and Organizational Structure

In order for the development and implementation of the MIS to successfully occur, three changes must concurrently take place in the organization:

1. management must become systems-oriented and more sophisticated in management techniques;
2. information needs must be planned for; and
3. a system of informational flows must be developed which ties planning and control by managers to operational systems of implementation.

The MIS collects, analyzes, stores, and displays data to management decision-makers at all levels for the management of the resource flows of supplies, equipments, and personnel in the organization. The MIS raises management skills from the level of intuitive guesswork and "firefighting" to the level of systems insights, systems information, sophisticated data processing, and systems problem-solving. Thus, it is a powerful method for aiding managers in making decisions.

The overall job of a manager is to create within the organization an environment which will facilitate the accomplishment of its objectives. In doing this, the manager plans the work of his subordinates and his own activities, selects and trains his subordinates by staffing his operations, organizes the work and task relationships, directs the work, and control results by measuring performance against plan. Many managers make the mistake of believing that a MIS can be designed and made operational without an adequate management system. However, one is dependent upon the other. Without the firm foundation of a good management system, the MIS will not provide the manager with the information needed in the form, place, and time that he needs it in order to perform his job according to the specifications of the management system.

How does a computer fit into this scheme? There are several prerequisites for a modern, effective computer-based management information system. The first is the development of a management system of the organizational arrangements, the structure and procedures for adequate planning and control, and the other management functions. Second, there must exist data and information about the organization's goals, resources, policies, operations, plans,

and performance against the plans. Third, in order to process this data, it is necessary to have appropriate equipment that will a) provide the capability for rapid retrieval of stored data, b) process this information economically and at high speed, and c) enter information into the system, retrieve and display it in the form desired. These three activities are performed by the computer. A final prerequisite to an effective computer-based MIS is information management, a capacity for designing, maintaining, and managing the required systems and procedures. This function is performed by the software.

### The Human Aspects of Management Information Systems

While the hardware and software in a computer-based MIS are important, the human aspects of the MIS are equally, if not more, important. There are at least three major facets of the human component of MIS that require attention: 1) overcoming resistance to the implementation of an MIS; 2) training for efficient MIS usage; and 3) managing the MIS operation. This section of the article contains a brief discussion of each of these aspects.

Without proper consideration of the behavior of the people in the office setting, the best technically designed system is likely to fail. This is because the introduction of a new MIS represents a threat in terms of the organizational relationships and psychological needs of the people in the office. Thus, the introduction of a new MIS in the office may be resisted unless proactive steps are taken to avoid this resistance. There are a number of specific reasons for implementation resistance:

1. Threat to status—a supervisor may be downgraded below a technician in the organization.
2. Threat to ego—a key skilled clerical job is performed by an unskilled computer operator.
3. Economic threat—fear of loss of a job.
4. Job complexity—a new microcomputer requires knowledge of the DOS, programs, etc., which have to be learned.
5. Isolation—the top manager feels he will be deprived of the "personal" information now gained when he is made dependent on computer output.
6. Superior/Subordinate relationships change—new information flows produces new balances between the superior and subordinate.
7. Job ambiguity and loss of control—planning and control is performed largely by the MIS except for special occasions that occur randomly.
8. Time rigidity—the total system requires "programmed" coordinated actions similar to a mass production assembly line.
9. Interpersonal relationships changed—former informal work groups and working relationships are broken up.

There are three actions that may be taken to reduce to perception of a threat from one of the nine causes listed above. First, a climate for change must be created by getting the managers and clerical staff dissatisfied with the present system. This may be accomplished by holding a series of meetings with discussions focusing on what is wrong with the present system and ways to revise the present system. Participants should be left with a feeling that changes were needed, that changes would be made, and that their views were being taken into account before any specific changes were made. Second, effective agents for change must be developed within the organization. Within any organization, there are informal leaders to whom

other members of the work group look for protection and security. These key actors must be identified and their support for the MIS must be gained. Finally, modify the organizational requirements as specified by the MIS to more closely fit existing arrangements if such adaptations enhance the effectiveness of the MIS. The "required" organization is a mechanistic technical organizational design. However, rearrangement of the organization into one that is not "technically" ideal may be made to achieve working relationships that are far more productive.

Once the resistance has been overcome, the staff needs to be trained in the use of the MIS, and the MIS needs to be managed on a day-to-day basis. The training that is required is dependent upon the type of MIS that is implemented. If the MIS is designed for the sole use of the manager as an extremely sophisticated desktop planning tool, the training required would most easily be accomplished by sending the single user to a training program at the local microcomputer dealership or college. However, if the MIS is designed for multiple uses by a wide variety of staff, the complexity of the required training is substantially increased.

Once the MIS has been implemented, and the staff trained in its use, the management procedures of the MIS deserves some attention next. Successful use of the MIS is dependent upon an infrastructure or supporting system. The first step in establishing this support structure is to specify a set of procedures to control how and by whom the MIS is to be used. This should include rules and decision standards for issues arising in every day usage: Who may use the machines and for how long? For what purposes? What work takes priority? How are support resources to be allocated? Remember that working on the microcomputer becomes addictive, and the same people that were complaining over its implementation are likely to be the same people complaining that they do not have enough access to it!

Another management task is providing any resources that the computer used may need to solve problems of implementation and use. Complete documentation of hardware and software is necessary. In-house consultants should be readily available because going outside is too time consuming and expensive. Encourage workers to help each other, share experiences, and engage in group problem solving. This may result in some lost time initially, but the rapid gain in computer expertise will rapidly make up for this loss. Information should be shared vertically with the management also. If encouraged and rewarded, management will discover problem areas and successes quickly enough to initiate timely action.

The third element in the support system is control and security. MIS equipment is vulnerable to accidents, theft, and misuse. There are a number of security concerns: 1) maintaining security of sensitive information when the MIS is in use; 2) securing the hardware and software from theft of vandalism; and 3) securing the MIS from accidental damage. The value of the information stored in files far exceeds the value of the hardware and software because hundreds of hours of staff time was invest in creating those files. Electronic storage media such as floppy and hard disks can be damaged by exposure to static electricity, electromagnetic fields, x-rays, high temperatures, bending, scraping, and fingerprints. Simple backup procedures for files and operating instructions for all personnel that come into contact with the MIS will help avoid a catastrophic loss.

Theft of misuse of information is an equally dangerous possibility. Procedures must be established for coding and

protecting sensitive files, such as personnel data. Logs and signout rules for file users should be established. Where microcomputer systems are linked to mainframes, the problem of security extends to files maintained on the larger systems.

Security against theft or damage to the hardware requires both organizational support and physical resources. Users must be trained in the proper use of the equipment. The sugar content in a can of soda can erode the electrical connections in the keyboard, bringing all operation of the MIS to a stop until the problem is resolved. A single static charge can wipe out files on a floppy disk. Theft and accidents can be avoided by establishing and enforcing simple but reliable procedures. Hardware and software manuals detail many of the most common problems and how to avoid them. Physical security for the MIS installation may require additional hardware purchases, such as special microcomputer workstations that may be bolted to the floor and locked up after working hours. Placing floppy disks in locked file cabinets may be necessary.

Finally, the manager of the MIS should ensure that an adequate supply of printer paper, ribbons, print heads, daisy wheels, disks, fuses, etc. are maintained and readily available for use as needed. The complete list of needed supplies depends on the specific work site, but might also include dust covers in dusty areas, voltage surge protectors and backup power supplies, disk drive cleaning kits, anti-static sprays, binders for output and documentation, disk storage containers, special purpose printer papers such as labels, etc. The amount of supplies needed for computer operations typically exceeds expectations, so a reserve budget for these items is necessary.

The design of the operating environment of the MIS is as important as the design of the hardware and software aspects of the MIS, and the successful implementation and operation of the MIS is dependent upon the people that use the system. The manager of the MIS must attend to all these facets in order to gain the full benefit of the investment in the management information system.

Computer managed instruction is a technological concept that links computers, other information processing technologies, the curriculum, and the teacher for more efficient and effective instructional management.

# Computer-Managed Instructional Systems: An Essential Component of Educational Reform

by David Bryant and Dr. Bettye MacPhail-Wilcox

History may record the 1980s as the decade of performance reforms in public education. Concern for accountability has renewed interest in testing students and teachers, and momentum for school and teacher appraisal plans that are linked to student performance continues to build. Though few would argue with the intended consequences of these reforms, many would protest their efficacy. Reforms based on the beliefs that more testing and the adoption of merit pay or career ladder plans are sufficient for improving school productivity are ill-founded. They are oversimplistic in the identification of performance problems in education, and they ignore the question of what teachers can reasonably be expected to accomplish in the current context of public schools.

For example, nationally normed standardized tests are not appropriate means for judging school and student performance. These tests **do not adequately**: (1) measure the more significant aspects of cognitive development; (2) reflect the curriculum adopted or emphasized in the locality;

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(3) tap the social and psychomotor attainments of students; (4) empower teachers to improve instructional diagnosis or prescription; (5) account for the effects of student socioeconomic circumstances or level of mastery prior to the most recent set of instructional activities. They are, therefore, of limited utility in identifying or encouraging quality education.

Furthermore, conclusions about teacher performance which are based on these standardized test scores **do not**: (1) distribute responsibility for learning between the student and the teacher; (2) recognize the many factors affecting learning which are beyond the control of either teacher or student; (3) acknowledge the inherent injustices of comparing the student performance records of teachers with qualitatively different groups of students and kinds of subject matter. When reforms are not tempered by these realities, they are destined to disillusion all who are involved with them.

In addition to these metric problems, current reforms fail to address the technical difficulties of planning, presenting, and monitoring classroom instruction on the basis of individual student needs. Though this has been a problem of long standing in public education, it is exacerbated by: (1) organizational technologies designed for masses of students rather than individual students; (2) organizational structures which ignore differential learning rates; (3) the increased diversity of needs among students populating public school classrooms today; and, (4) the use of manual accountability systems of instructional management.

In short, the performance reform movement, while intended to foster educational improvement, may actually inhibit it by displacing the goals of improved classroom instruction and student performance with time consuming and ineffective accountability systems. These conditions will neither help the teacher improve instruction nor adequately reflect what students have acquired through schooling. Without other substantial changes, current performance reforms will result in an artificial form of accountability which trivializes rather than improves learning and teaching.

One promising technological solution to some of these problems is computer managed instruction (CMI). In the sections which follow, CMI will be defined and described. Ways in which it can help to resolve many of the problems cited will be described, and some of the policy issues underlying the use of CMI will be presented.

## Computer-Managed Instruction

In modern schools, computers are used by administrators, students, and teachers. They are employed as management and communication tools by administrators. Students study them as well as use them, and teachers either teach about them (literacy, programming), use them to provide instruction (computer assisted instruction), or use them to manage instruction (computer managed instruction). Managing instruction is a complex process incorporating all of the intricate steps of selecting, implementing, and assessing the content and process objectives of a curriculum. It requires that students be diagnosed and placed in a curriculum with appropriate instructional materials and pedagogical techniques, and that performance be monitored. Under the best circumstances, these activities are undertaken and recorded for each individual student. It is this time consuming process of managing and monitoring instruction at the level of the individual student which CMI can improve.

CMI is a technical concept that links computers, other information processing technologies, the curriculum, and

the teacher for more efficient and effective instructional management. Though CMI systems existed in the 1960s, not until the advent of powerful microcomputers did this technology become more accessible to all teachers. This accessibility has increased teacher control over the management process and made it possible to introduce criterion-referenced outcome measures. Depending upon equipment and software sophistication, CMI systems can perform very simple or complex sequences of instructional management activities. The least sophisticated CMI system performs recordkeeping tasks only. More sophisticated systems can test students, analyze performance, diagnose mastery levels, prescribe instructional objectives, materials, and activities, schedule the next assessment, and produce a permanent record of student activities and performance levels.

The strengths of CMI systems derive from an instructional philosophy which encompasses individualization of instruction, high quality learning objectives, and the use of technology for data analysis and management. The computer alone does not insure successful instructional management. Without comprehensive instructional objectives which are tied to valid measures of them, the assessment of individual progress could not occur. Hence, the computer's role is to aid the educator in data manipulation and management for better analysis, decision-making, and reporting.

Clearly, CMI has the potential to help teachers manage and monitor the increasingly diverse instructional needs of students in a classroom. In addition, such systems can maintain an auditable trail of instructional activities and student performance levels. But, before CMI systems can be used effectively, policy makers must clearly specify the goals to be obtained by students. Educators must then determine the instructional objectives, materials, and methods appropriate for particular groups of students and the means by which student progress will be assessed and reported. While these may seem a simple and straight forward set of tasks, each is affected by contentious, substantive, and potentially costly policy issues.

#### **State and Local Control**

Because state and local governments share legal and financial responsibility for public schools, there is political tension about what the curriculum will include and how accountability will be monitored. While state governments are interested in an efficient and uniform system of education about which summative performance judgments can be made, localities are equally concerned about responsiveness to community and individual needs and formative progress assessments. This tension is one determinant of the kind of data that will be part of a CMI system and how it will be used. Consequently, issues associated with curriculum content and accountability measures must be confronted if CMI is to be effective from both the state and local perspective.

Additional tensions are produced by heavily reliance on state adopted textbooks. Discrepancies among the curricula provided in textbooks, state mandates, and local preferences are not uncommon. If CMI is to be efficient and effective, these discrepancies must be tractable, and the CMI must not add to them. This raises the issue of whether standardized, generic, or customized CMI systems are most appropriate for public education.

A standardized CMI system is a stand-alone curriculum. It contains prescribed objectives, test items, analytical procedures, and information management strategies. A ge-

neric CMI system is a shell that allows each educational unit to specify its own objectives, tests, prescriptions, resources, and information handling routines. A customized CMI system is standardized for a specific purpose—to match the curriculum in a textbook for example. Standardized and customized CMI systems are usually more sophisticated and comprehensive than others. They are developed by experts and widely marketed, so that the substantial costs of producing these systems are offset by subsequent profits to the manufacturer.

A hybrid of the customized and generic CMI offers one solution to the shared responsibilities of state and local governments for education. Such a system might be customized at the state level, containing objectives, test items, test analyses, instructional prescriptions, and recordkeeping which reflect state mandates. In addition, this system should be flexible enough so that localities can add objectives, instructional routines, test items, and analytical procedures. From the state perspective, the customized portion of the CMI system would provide for efficient implementation of a state mandated program of studies and centralized monitoring of performance. Cost efficiencies would accrue from volume purchasing and updating of the CMI, contracted distribution plans, and standardized user training programs. From the local perspective, additions to the CMI system could provide a measure of responsiveness in the curriculum and student assessment procedures which would empower teachers to engage in diagnostic-prescriptive instructional cycles.

Because comprehensive CMI systems require such a large data base, they should be developed for subunits within a discipline. Or, CMI might be used for basic skill instruction only. Whichever route is selected, CMI data bases must be capable of integration if their utility is to be maximized.

#### **Institutionalized Mediocrity**

While it is easy to imagine the efficiencies and utilities of CMI, they must not come at the expense of quality education. Policy makers must be wary of the threat of institutionalized mediocrity that can accompany large scale technologies. When emphasis shifts to objective measures of teacher and student performance, what is tested is a significant determinant of what is taught. Instructional objectives and related test items may represent minimized learning because it is easier to develop objectives and test items with high validity for low level cognitive skills than for the more complex skills of critical reasoning and problem solving. Failure to plan for instruction and assessment in these more complex skills will trivialize learning and provide grossly misleading data about the quality of teacher and student performance.

This is a critical consideration with large scale technologies like curriculum guides, textbooks, CMI systems, and teacher evaluation systems. When they are tightly linked to graduation, promotion, tenure, and compensation, these systems will institutionalize curricula and performance expectations. Once in place, massive technologies, like these, exhibit an inertia that is difficult to overcome, despite evidence that they have outlived their usefulness. Consequently, CMI systems must be adaptable, easily modified, and comprehensive. Periodic review of curriculum, instructional routines, assessment strategies, and data manipulations are essential. Otherwise, the technology will not be responsive to a changing society, nor will it foster high levels of student and teacher performance.

### **Teacher Appraisal, Program Evaluation, and Student Performance**

Can CMI data be used in teacher and program evaluation plans? As demands for accountability continue to rise, more accurate, reliable, and valid appraisal systems are essential. Although the degree to which teachers and programs can influence the performance of particular students is debatable, it is unlikely that student performance measures will be abandoned as one source of appraisal data.

Evaluation research indicates that teacher performance, as measured by student performance, is unstable. That is, it varies from student-to-student, class-to-class, year-to-year, and subject-to-subject. Research also indicates that some forms of pedagogy are more effective with some students than others and that instructional strategies vary in their potency to produce particular kinds of student outcomes (e.g. the ability to recall vs the ability to analyze critically). Most researchers conclude that it is inherently unfair to compare teachers' performance without adjusting for student, subject, and other important contextual variations.

With a comprehensive CMI system it is possible to access individual student data and classify students in multiple ways. Variables such as socioeconomic status, prior performance level, intelligence, instructional activities, and the like can be used to stratify samples of students and to make statistical adjustments for instructional differences. These adjustments can improve the validity of teacher performance comparisons for individual and groups of students. This kind of information would be useful for both summative and formative evaluation. In fact, teachers would have a tool for conducting their own formative appraisals. They could inquire about the success of particular instructional materials and pedagogical practices for particular individual or groups of students and make attendant adjustments.

Furthermore, CMI data can be stored, making it possible to monitor student performance on a daily, weekly, quarterly, semester, year, or year-to-year basis. With the availability of state wide criterion test items that are geared to curriculum objectives and instructional prescriptions, CMI systems can enhance the evaluation of particular programs. For example, special state funded summer programs, minimum competency remediation programs, exceptional children programs, vocational education, and the like could be compared across districts, schools, or teachers. These data might be used for both program adjustment and program evaluation. In fact, if CMI data were linked to fiscal data, cost effectiveness studies and program budgeting would be possible.

Without complex information processing technologies that are comprehensive, flexible, and integrated, individualized instruction, teacher, and program assessment based on student performance are not practical. The time and reporting demands are so overwhelming that instruction and learning are displaced in order to accommodate the management process. If, on the other hand, basic skill tests can be scored by optical scanners or directly on a computer while software manipulates, stores, and reports instructional data, improved instruction and assessment are possible. When teachers are relieved of the burdensome clerical tasks associated with instructional management, they will have more time for academic instruction, and they will have faster access to the kinds of information necessary for informed instructional decisions.

#### **Legal and Ethical Concerns**

As access to student and teacher performance data in-

creases, responsible handling of that information becomes critical. Student records are protected by the Family Educational Rights and Privacy Act, and individual test scores of students are among the protected class of data. Because many microcomputer systems often have only minimal security systems, there are major concerns about data integrity and unauthorized access which policy makers and administrators must address. In addition to policies and practices which limit physical access to performance records, electronic "locks and keys" are available. However, electronic security systems entail additional costs.

Policy makers must also be wary of the many validity issues associated with interpreting CMI data. As a general rule, the average citizen is not a very sophisticated user of information. Human information biases often result in the neglect of base line data, overgeneralization, inappropriate comparisons, the attribution of causal relationships on the basis of correlational data, and a host of other logical errors. For example, a strong correlation between test scores and instruction by one teacher, may not be due to the teacher's proficiency, it may be due to a characteristic that all students assigned to that teacher exhibit, such as high socioeconomic status or high entry level performance. Likewise, gain scores may be misleading in that some learning gains are more difficult to obtain than others or the performance trend may be due to regression to the mean.

These concerns suggest that educators must become more sophisticated users and interpreters of information, and they raise a red flag regarding the release of teacher appraisal data derived from student performance measures. Teacher performance appraisal documents are not public information, and one might infer that student test scores for a particular teacher are a part of these documents. Legal issues aside, however, it would be inappropriate to release such information without an interpretive context that accounts for or details data interpretation limitations such as those noted in the previous paragraph.

#### **Summary**

CMI systems offer educators a means of accomplishing multiple objectives. A hybrid form of CMI, customized to state curricula, texts, and assessment plans, which can be tailored local needs, can provide accountability data and information for instructional improvement. Such a system could bring individualized instruction, summative and formative personnel appraisal from textbook descriptions to classroom realities. While reducing the clerical demands that accountability strategies place on teachers, CMI can provide an auditable trail of planned instructional interventions and student performance.

Herbert Kohl, classroom teacher, education critic, and author of several books, cautions educators about the use of CMI. "But ultimately, all of this analysis would trap me into the same kinds of activity: getting scores, finding numbers to record on the machine, digitizing my students. Even the computer's best analysis wouldn't tell me how to deal with human problems or suggest solutions—and I wouldn't want it to. Teaching is my business, not the machines."

Kohl's assumptions underestimate the significant number of factors about students that teachers must consider when planning for instruction and monitoring student performance. Learning style, brain modality, prior achievement, and special learning problems are but a few factors which affect the quality of individualized instruction. Few teachers have the capacity to process all this information for multiple students, maintain a mental inventory of all the resources and materials available to help the student ac-

quire a particular skill, and diligently assess and record student progress. Other professions which rely on extensive data to make complex decisions use computers to manage that data. Why should educators expect less?

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The key to successful implementation of technology into the instructional domain is the involvement and preparation of staff personnel as catalytic agents.

# Strategic Planning and Staff Development in Computer Applications

by Christine M. Black and Dr. Larry E. Decker

The introduction of inexpensive microcomputers and the concerns expressed in the national report, *A Nation At Risk*, place pressure on educational institutions to be responsive to innovation and futuristic direction in planning and implementing the use of technological equipment. Larry Blasch, educational consultant for IBM, points out the fact that "many school districts are being forced into buying computers by a society that says, 'Thou shalt have.'" (AS&U Roundtable 1985) Twenty states already have legislative mandates which add "computer literacy," a phrase which has no clear content or universal meaning, to high school graduation requirements. (Crawford 1984) These and other indications suggest that computers will be included in many future school budgets.

Although the American public reinforces the Madison Avenue sales pitch that personal computers can do anything, the importance of development and training of personnel using the computers, especially teachers, is given little attention and is often understated. (Hall-Sheehy 1985) Scanland and Slattery (1983) suggest that teachers must understand the necessity for instructional improvement and its relationship to "personal philosophy of the teaching/learning experience, the nature of the teaching role, national and educational long-range goals, and present perceived roles within the educational process." (McMeen 1986)

There is a sense of ambiguity and uncertainty about equipment and its relation to the necessity of microcomputer installation within the school program. Conflicts of professional opinion and public sentiment center on the polarization of instructional programs rather than technologi-

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cal homogenization of instructional applications of computer use for improved educational and curricular function.

Dr. Edward E. Brickell, Virginia Beach City superintendent, recently cancelled the purchase of \$350,000 worth of computers and software designated for kindergarten through second grade with the query, "Are they enhancing the instructional process the way we think?" (Boyer 1986) Thomas Mulkeen and Toby Tentenaum at Fordham University doubt "cognitive benefits of learning to program: and suggest a moratorium on computer instruction." (Pipho 1985) Parker (1984) cites a September 21, 1983 *Washington Post* editorial addressing this computer concern with the statement:

Without thoughtfully designed instructional programs that are thoroughly understood by teachers and made a part of their routine curricula, computers will be of no more enduring interest or value to students than the latest arcade game. (Parker 1984)

These questions and opinions are indications of an emerging concern which focuses on the importance of effective utilization of human and economic resources and the importance of developing a strategy to prevent the purchase of inappropriate or obsolete hardware. Microcomputer technology may be the tip of the iceberg. The next dimension of technological wizardry, such as robotics, slow-scan television, and advanced satellite networks, is looming on the instructional horizon. (Decker and Krajewski 1986)

## Training and Staff Development

Lack of computer use by well-intended staff, lack of administrative knowledge of computer hardware, and computers placed in closets focus on the question of educational accountability and credibility to responsive planning. The cost of initial computer placement with no program standardization in the industry, shakeouts of manufacturers and some product lines, and a lack of interface between the home and school place additional emphasis upon the priority of properly trained personnel. (Neights and Jobe 1985)

Training and staff development is generally recognized as a need, but uncertainty exists concerning the dimensions and design of the programs. A 1984 report by the Office of Technology Assessment, *Computerized Manufacturing Automation*, is cited by Schuck to make the point that:

Individuals and employers are demanding education, training, and retraining programs (however) . . . There is a basic uncertainty about how current instructional programs should be revised or expanded to reflect the increased use of advanced technologies and changing skill requirements, given the ongoing nature of technological change.

Training plans must consider more than the development of skills. The first step in strategic planning related to the use of computers is to develop a philosophical statement for the division. The statement should delineate the beliefs and values the division places upon the affective worth of the individual student to society as a result of educational participation. The philosophical statement should be an integral part of the division's mission and the long-range goals. Once this statement concerning technological participation and subsequent long-range goals has been developed, an executive committee should use it in formulating staff development plans.

In designing a staff development program, the ratio-

nale should be to train staff in computer use and to familiarize personnel, especially teachers, with the selection of equipment to enhance instructional possibilities related to division goals and planning. Technological improvement and advancement are a given; and as Catherine Mitchell of the University of North Carolina emphasizes, "It is a mistake for educators to devote too much time to teaching the operation of machinery." (Pipho 1985)

The development of a strategic plan is critical. However, Bender and Church (1984) identify the following areas which may impede computer training program development and implementation:

1. Lack of acceptance of the need for strategic and contingency planning.
2. Continual changes in technology.
3. Financial limitations.
4. Lack of knowledge of existing resources.
5. Unfamiliar jargon.
6. Resistance to newness and change.
7. Lack of strong and continual administrative support.
8. Staff roles not clearly defined.
9. Unclear performance standards
10. Lack of acceptance of the need for reward and motivation procedures.
11. Lack of recognition of the need for feedback and follow-up training.
12. Ineffective time management.

#### Areas of Computer Application

Strategic plans must consider the potential areas of application—(1) computer-assisted instruction; (2) computer-managed instruction; (3) administrative applications; and (4) communication applications—and training and development considerations in each area.

Computer-assisted instruction consists of flashcard tutorials or text courseware which appear on a screen that advances when the students press a return key. The basic drawback to this system is the lack of provision for critical thinking skills and the lack of flexibility within the structure of the program menu.

Computer-managed instruction permits program flexibility and instructional extension. However, teachers must be aware of equipment and computer programming to fully appreciate the technological amenities of curriculum development.

Administrative applications focus on a data-based management system which permits a district or individual administrator entrance to a range of data elements and information manipulation through a specified format. A data base which includes all pertinent information can produce reports, teacher schedules, room availabilities, and other applications without entering new data. Routine reports can be produced as needed; consequently, administrators must be well-trained and versed in the integration of computer systems to realize the full potential of the equipment.

A wide range of communication applications is possible. The word processor, text-editing tool, is capable of writing letters, bulletins to parents and staff members, general correspondence, and making reports efficiently and economically. The electronic spreadsheet, such as Visi-Calc and Multi-Plan, enables administrators to modify budget plans, payroll programs, and education inventory controls. Again training is necessary to utilize both hardware and software efficiently.

#### Personnel Training

The participation of educational administrators and instructors in the development of a strategic plan is critical because the design of the program will depend on the anticipated areas of computer application. IBM suggests the forum format to organize and initiate a cooperative team effort.

At the division level, the "tech team" should be composed of individuals with the appropriate experiences and backgrounds to provide expertise concerning recommendations, advice, and counsel. Prior to the initiation of a forum, a needs analysis which consists of physical plant data as well as student enrollment and course projections should be compiled into one interrelated organizational component.

The forum should be designed to challenge the education of today with the technological developments of tomorrow. Discussion should focus on the most viable method to implement technological education with the needs and wants of the community. Questions which emphasize the relationship of computers to the mission and philosophical purpose of the division should be answered and understood by all division members and community segments prior to initiation of a computer strategic plan. Privacy laws related to feasible physical security, new storage possibilities, and copyright legalities should also be addressed prior to total program involvement. Through forum participation, a pilot study can be developed and conducted which incorporates the computer strategic plan in relation to instructional development into a research-based educational site prior to total district involvement and commitment.

The initiation of a strategic plan responsive to continual changes in technology permits flexibility. By logically disseminating information among personnel, long-range objectives are generally defined and understood by all staff members. Through the enactment of a plan which outlines the immediate objectives in relation to a long-range educational perspective, "key actors" acquire a sense of mission and purpose in the development and nurturing of individual school needs. (Martisko and Ammentorp 1986)

The key to successful implementation of technology into the instructional domain is the involvement and preparation of staff personnel as catalytic agents. The role of the principal as instructional leader and liaison agent of the community and division policy is critical. Through active participation with staff, parents, and students, the principal can be an active role model for microcomputer applications. As a principal becomes more confident and proficient, instructors and support staff are more likely to accept the computer as an extension of instruction.

Every subject teacher and administrator should have direct input and should participate actively in the computer curriculum development process. The perpetuation of the myth that computers are the property of mathematics or science departments is self-defeating to the total instructional component.

Training plans must consider the needs and wants of instructors and the importance of the focus of leadership on the total process to combat "computer phobia." Personnel must be aware of computer jargon and the strengths and weaknesses of educational technology and understand the role of each individual within the total educational program. In-service training should utilize community corporations, college classrooms, and computer advisors as extensions of the schoolhouse environment.

#### Summary

Winston Churchill once stated that "first we shape our

structures than afterwards they shape us." Educational administrators and instructors are the technological architects of the electronic schoolhouse. Decisions concerning school programs will affect generations across the myriad of society. Educators cannot afford to lose sight of the purpose of education.

Technology is not the solution to all instructional situations or the answer to all instructional problems. As architects of technological applications in education, instructional professionals need to comprehend and use the potentials and recognize the limitations of computer hardware and software in the school setting. Training and staff development programs must focus on enhancing administrators' and instructors' ability to integrate computer capabilities in the school setting within the educational plan.

As architects of technological applications in education, administrators and instructional personnel in a school division must develop a strategic plan which incorporates multiple options for the new, intermediate, and experienced computer user. They cannot afford to adopt a "wait and see" attitude in relation to the division's involvement in the use of computers. This attitude will place the division in jeopardy of retardation and stagnation—conditions which students, staff, and the general public will become increasingly aware of as inexpensive technological apparatus continues to be introduced for home use.

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Developing applied critical thinking skills in students seems the most effective and efficient use of current and future computer technology.

# Critical Thinking and Microcomputers: Education's New Tools for the Information Age

by Thomas McCahon

Since the widespread introduction of microcomputers into the public schools approximately three years ago, there has been considerable controversy over how and if computers should be used in the classroom. The issue of whether computers should be used in the classrooms is a moot point, since there are considerably more advocates than opponents to their introduction into education. The only question that needs to be addressed presently, is **how** are educators going to effectively and efficiently use this new technology? While the lure of the computer monitor is a great asset to educators in holding a student's attention, merely placing computers in the classroom and advocating their usage does not make students proficient or even functional citizens of the information/computer age.

Public education's primary technological dilemma has been a lack of direction in establishing educational criteria and priorities for the classroom use of computers. If microcomputers are in the classroom to stay, and it seems they are, there needs to be a different approach taken to the process of education, as well as a rethinking of what constitutes a "good" education. What may have been important in the classroom yesterday during the industrial age, is not as important during the computer age. Society's concepts about education are changing. It is no longer sufficient for students to merely be informed about technological and scientific changes in society, but they also must be able to function within those changes.

To make the transition into a process-oriented society, educators will need to endow students with reasoning skills that will be functional, regardless of the chosen profession. The ability to digest, analyze, and assess computer output, or think critically, becomes a necessary basic skill in the information age, much like reading. This fact has

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brought some educators to the realization that students will not be able to adequately function in the computer age without thinking skills that transcend linear or sequential reasoning ability.

There at once arises obstacles that must first be overcome if critical thinking skills are to be introduced into the classroom. Two of the more important issues facing the introduction of critical thinking into the classroom are teacher training and societal acceptance. It is essential that teachers learn to develop critical thinking skills and be able to pass those skills on to students through the curriculum. The instruction of teachers in critical thinking will necessitate a change at colleges of education. Secondly, critical thinking raises social and philosophical questions over whether society can fully adjust to the concept of a well-reasoned populace, though this has always been the goal of education.

## What is Critical Thinking?

Prior to advocating the introduction of critical thinking into the educational process, there must first be an agreed upon definition of what constitutes critical thinking. Many definitions of critical thinking are continuously being formulated by educators, but most agree, at least tentatively, that it is the ability to produce dependable observations, generate reliable inferences, and present rational hypotheses. This definition in no way addresses all the necessary reasoning skills needed for one to become a critical thinker, but it provides a foundation. Critical thinking can be divided into two separate skills categories: simple and complex reasoning skills.

Thinking skills currently used in the classroom are of the simple type. Simple reasoning skills are essentially sequential or linear, and seek solitary or unique solutions to given problems. Solutions in simple reasoning are generally restricted by constraints, or boundaries of a solution space, specified in the problem. Deductive reasoning, analytical reasoning, logical reasoning, and cause-effect relationship activities are examples of simple reasoning skills. Such thinking processes tend to be rigid and do not allow for interactive factors or probabilities. This manner of thinking offers limited solutions to potential problems, but is central to most empirical research. Simple reasoning skills are used in practically all mathematics or science-related courses.

Complex reasoning skills are those that are currently beginning to receive more attention with the introduction of microcomputers into the classroom, but they are not new. Moreover, complex skills are what distinguish the successful thinker from the individual who is limited by linear thinking processes, which restrict one's decision making ability. Successful thinkers are persons who can observe without preconceived bias, and see numerous solutions to a problem where most can only see one. The versatility of the microcomputer, especially in graphic simulations, allows for the introduction of experimentation, creation, and evaluation of more complex problem structures that offer more than one problem solution. Complex reasoning skills are inductive and intuitive reasoning, synthesized reasoning, and recognition of interactive relationships in observations. These complex reasoning skills are found in some of the better algorithmically based programs, but they are more characteristic of heuristic-based software. Complex skills have often been neglected in the classroom in favor of the more common simple reasoning skills. Computers are beginning to expand from algorithms, which give unique solutions, to heuristic structures, which give numerous possibilities of solutions for problem-solving. Software based on

algorithms can only grow so large before it becomes impractical. By amassing larger data structures to offer more flexibility in applications and problem solutions, algorithmically based systems will inevitably slow computer response time. This limitation of application and growth potential is also true of individuals who use only the simple reasoning skills presently found in the classroom. While heuristics do not guarantee an empirically verifiable solution, they offer the potential for a multiplicity of solutions based on different approaches to a single problem. Heuristics also offer a wider diversity for application, by not being completely restricted to subjects that require a rigorously mathematical algorithmic structure.

#### **Why do We Need Critical Thinking?**

One of the fundamental omissions of public education today is the formulation of curriculums that develop problem-solving skills in the students. This failure becomes more critical and apparent as our society becomes more technologically complex and change or innovations continue to occur at their current rapid pace. With such a "knowledge explosion", schools in the future will not possibly be able to deliver all the important information that a student will need to adequately function in a complex technocracy. Information overload is a certainty in the computer/information age. Schools are going to be forced to start developing curriculums that stress process rather than product. Therefore, it becomes increasingly important that a student be able to independently research, digest, and evaluate information through a process of developed critical thinking. The current mindset of educators must be redirected toward developing reasoning skills in students, which will ultimately offer lifetime application.

Developed critical thinking skills, if introduced in the schools, can provide students with skills that are universally applicable, regardless of trade or profession. Some educators may assert that such skills are currently found in mathematics, grammar, and basic logic. Mathematics, logic, and grammar structures as they are currently being taught supply the student with simple reasoning skills, and only occasionally address the more complex skills.

#### **The Implementation of Critical Thinking**

Presently, many proponents of critical thinking advocate its introduction into the schools as a separate course, apart from other subjects. These critical thinking courses are generally based on learning logic, and such classes have been initiated in some public schools. This hurried introduction of logic into the curriculum is a response to parental pressure over various reports bemoaning the lack of problem-solving skills in public school students. While logic is an important precursive stage in critical thinking development, many educators invariably underestimate or neglect the importance of foundational knowledge used in structuring and supporting logical statements. Logic cannot assist the student in the formulation of a hypothesis or theory, but logic can lead to an eventual justification of that hypothesis or theory (McPeck, 1981).

There are many developmental stages to traverse in the educational process before true critical thinking is developed in a student. Every developmental stage has its own associated skills, which build upon previously learned facts and skills and can eventually produce the independent critical thinker. One of the essential elements in the critical thinking process is the ability to draw inferences. The need for such an ability as inferential thought means that critical thinking cannot effectively take place with any consistency

prior to the formal stage of a student's development.

It is worth noting that many advocates of critical thinking use Piaget's developmental learning theory for determining the implementation of critical thinking skills. The formulation of thinking skills coupled with the introduction of microcomputers in keeping with Piaget's theory have been instituted statewide in Oregon and California. The primary factor that educators must consider when implementing critical thinking skills at any grade level, is the knowledge base of the student. A student must have some knowledge of the subject before they can think critically about that subject (Mcpeck, 1981). Thinking cannot take place in a vacuum.

#### **The Impact of Computers on Critical Thinking**

The microcomputers' strongest asset is its problem-solving capabilities. Utilizing this asset to teach students to think critically seems a far more effective application of current technology than is presently in use. Present usage of the microcomputer is merely an extension of rote learning to another medium, the "electronic flashcard" monitor. While the microcomputer is not a necessity for teaching critical thinking, it can be an enhancement to the process.

Currently, microcomputers are being used to develop some foundational skills necessary for problem-solving, such as basic logic statements in computer programming, but not critical thinking specifically. Some educators believe that by having computers in the classroom, critical thinking will spontaneously develop out of student interaction with the machine. This may be true with some strong spatially oriented students, but not with the majority.

There is some similarity between the processes of critical thinking and computers which makes computer-aided critical thinking instruction a viable alternative. The similarity of computer processing and critical thinking can be observed in algorithmic processes, which parallels simple reasoning, and also in heuristic-based expert systems which resemble intuitive thought. This linkage of critical thinking and computers is especially strengthened by the advent of expert systems on microcomputers. Expert systems utilize heuristics which incorporate models that allow for more complex reasoning skills found in critical thinkers.

#### **Software for Critical Thinking**

The only present limitation with the microcomputer and its application to critical thinking instruction is software availability. Most educational software is drill and practice oriented. A notable exception to the drill and practice software, is Seymour Papert's LOGO for children. LOGO is supposed to help develop younger children's thinking skills, but its success is still open to question. However, there exists other software currently available on the market, which could be used or adapted to teaching critical thinking skills; it is game software. This does not include the mediocre products repackaged by most game software companies and sold as "educational" software (Ma, 1986). This pertains to the software that uses graphic simulations to concretely present abstract concepts, and other software packages that have the potential for developing thinking skills. Game software has for the most part tended to be more educational than the actual "education" software. Educators need to overcome the label "game" and seek out potential learning application wherever they exist.

Better game software incorporates two features that are necessary in developing critical thinking skills: the knowledge of the various forms of reasoning, and the need for the correct assessment of statements and observations.

An example of the value in game software for educational purposes can be found in the analysis of two games, Pong and Space Wars, reviewed by Carl Sagan (Sagan, 1978). Sagan points out that there is a learning experience involved in Pong which depends essentially on Newton's second law of linear motion. The game, according to Sagan, gives the player an intuitive understanding of Newtonian physics through graphic simulation. The game of Space Wars uses inverse gravitational fields set up by a planet to complicate spacecraft flight. To play the game properly a player needs to develop an understanding of Newtonian gravitation that is not only intuitive but concrete, as presented through the graphic simulations.

The type of graphic simulation software mentioned above is exactly what is needed by educators to teach certain abstract concepts. This opens up many possibilities for certain individuals who have not been able to grasp such concepts in the past. Since the physics concepts or laws used that games generally require an understanding of algebraic and analytical statements, not all students are going to readily grasp formulated problems. A student with strong left-hemisphere capabilities needs only to see Newton's second law presented as  $F=ma$  to understand the concept (Sagan, 1978). But now educators have at their disposal for the first time, a method whereby students with less developed left-hemisphere capabilities can understand certain concepts, through the process of computer graphic simulations. This game software allows all students the opportunity of developing better analytical and intuitive capabilities, which serve to strengthen their critical thinking skills.

#### Problem-Solving Procedures

Microcomputers currently on the market employ two distinct information processing models: algorithms and heuristics. Both models serve functional purposes at present, so one is not necessarily better than the other. Algorithms offer procedures that are guaranteed to obtain unique problem solutions in certain steps are followed. Comparatively, heuristics are procedures which use a non-structured method to achieve a problem solution. But while heuristic procedures may lead to a solution, there is no certainty of this.

Algorithmically structured software is presently being used in the classroom to support traditional teaching methods. Since algorithms are the formal procedures guaranteed to produce correct or optimal solutions, they adapt well to the behavioral engineering concept of conditioned learning, as seen in drill and practice software. Relying on empirical principles of verifiability, algorithmic-based software programs are more adaptable to the traditional classroom method of instruction.

Heuristic approaches to teaching have been around since Socrates, but have invariably lived in the shadow of the more popular didactic or lecture method of instruction. This is essentially due to the skill level required of the teacher using heuristics. The lecture method, unlike heuristics, requires more preparatory time on the part of the teacher. Heuristics requires of the teacher a mastery of his/her subject that allows a class to move in whatever direction questions or statements may dictate. Similar to complex critical thinking, the use of heuristics requires a base of knowledge by teacher and student, and most importantly, demands logical procedures in presenting and answering problems.

Fostering heuristic skills in students is the logical progression for students if they wish to understand expert systems. Heuristics would assist students in understanding

how expert systems work, but, unfortunately, would not help in evaluating the probabilistic and fuzzy outputs of these systems. To evaluate expert systems' outputs, students will need skills which transcend heuristics. These evaluative skills can only be found in developed critical thinkers.

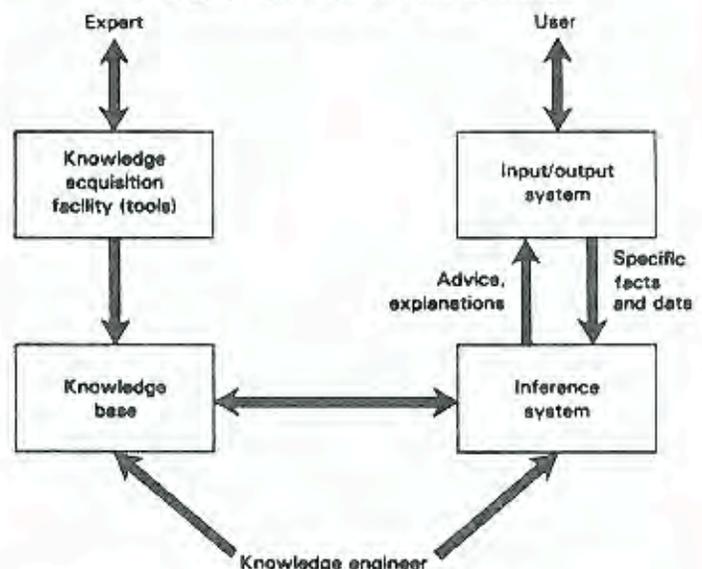
Heuristic methods are currently embodied in software called expert systems. An expert system is the decision-making logic of numerous practitioners encapsulated in a software program. Expert systems form the basis of "artificial intelligence" in computer systems, so called because of the ability to take input data from non-practitioners and return an expert decision, almost as if the machine itself was doing the "thinking."

#### Artificial Intelligence and Critical Thinking

Artificial intelligence programs operate by erecting data structures to depict certain concepts, and then comparing this with a given example. The variances found specifies the future changes to be made to the data structure. Through this, the program "learns" from "experience" and not by some drawn-out statistical process (as implied by many learning theories).

This type of program, known as expert system, is developed as follows: A knowledge engineer will interrogate numerous experts in a particular field to build a knowledge base and determine the logic involved in making a particular decision (See Figure 1). The knowledge engineer will also work with systems developers who will write the actual computer program to store the logic and knowledge acquired from past experiences and apply the decision logic through the inference system to new applications. The inference system is also programmed to utilize experts' "rules of thumb" to be used when problems do not fit exactly into the existing knowledge base. Note that the inference system and knowledge base are interactive. This is where the "learning" takes place. Also developed is the knowledge acquisition facility, which enables experts to update the system as required. The user can access the system through a highly interactive and use friendly input/output system. The computer will prompt the user for the required data and, using its knowledge information processing system, return to the user the appropriate decision response.

Figure 1. The Expert System (Feigenbaum and McCorduck, 1983)



### Conclusion

Teaching critical thinking will become extremely important as computers move toward the use of expert systems software. While expert systems are based on heuristics, this is still, at best, only dealing with probabilities. To maximize the potential of the new expert systems, operators will have to critically evaluate output from these systems. Unlike the output of algorithmic-based computers, an expert system's output is not black and white, but requires critical evaluation.

At the present time, only humans are capable of proposing problems and formulating theories. In this same frame of thought, only humans can decide whether to accept or reject a computer's output. In assessing computer output, the decision process used by the operator must surpass the analysis done by the computer. This implies that human's need to apply a thinking and decision-making process superior to that of the computer's. This process is criti-

cal thinking. Developing applied critical thinking skills in students seems the most effective and efficient use of current and future computer technology. Technology itself is a process, and computers are merely one example of this process that will impact on education. Microcomputers will force education into a process-oriented learning environment, and the development of reason and thinking skills will be the foundation of this process.

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While the initial adoption of microcomputers may be a highly ambiguous process, future implementations could be facilitated by an over-all strategy of linking teachers to specific applications.

# Microcomputer Adoptions and Educational Change

by Elden A. Bond

The increasing utilization of microcomputers in schools has created much debate, controversy, and confusion. Becker (1984) reported that microcomputer use in public education in the United States is frequent and widespread. Is this phenomenon an example of unplanned change or an example of purposeful instructional innovation? A study was undertaken to provide insights into this question and to provide an interpretation of the microcomputer adoption process. Specific objectives of the study included contributions to (1) an understanding of the decision to utilize microcomputers, including identification of the participants in the decision, (2) an understanding of the process of assimilating microcomputers into the instructional program, and (3) an understanding of the process of educational change itself.

Methods used in this qualitative study include the development of a conceptual framework which distinguishes change from innovation. Interviews with school district personnel and documents relative to microcomputer implementations were collected from two non-similar school districts. These data were analyzed using a **time-ordered matrix** to establish an event chronology as suggested by Miles and Huberman (1984). Results of the analysis are presented in the form of a narrative. Also included is a discussion of the similarities in the adoption patterns in the selected school districts, from which conclusions are derived. Implications for further microcomputer implementations are discussed in the context of planning and organizational theory.

The intent of the study was to identify processes that are present, and to contribute to knowledge of the variables involved so that further studies could explore these factors. It is important to note that the study was not designed to evaluate the educational uses of microcomputers, nor was it designed to evaluate the quality of the implementations in the selected school districts.

## Innovation and Change

The introduction of microcomputers into the school

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environment is an example of educational change. While change in itself implies neither planning nor direction, innovation implies both. In order to conceptualize innovation, it is important to distinguish between the subprocesses of diffusion, adoption, and implementation. Diffusion is the process of communication of change through social systems, as suggested by Rogers (1983). Change in institutions and organizations is reflective of the dynamic nature of society; innovation involves change selected by an organization.

Adoption is the decisional process that associates the school district with the innovation; it is the announcement of intentions. The involvement of decisions and intentions in the adoption process emphasizes the importance of understanding innovation from an organizational perspective. Adoption of educational innovations is ambiguous because intentions tend to be loosely coupled to actions (Weick, 1976). In the context of planning for innovation, the goals of a particular adoption may bear little relation to implementations. Clark (1981) has suggested that goals may be entirely inappropriate as necessary conditions for planning in educational organizations.

Implementation is the actual placement of the innovation in the instructional system, an important distinction because many innovations are adopted but never implemented (Aslin and DeArman, 1976). The implementation subprocess involves not only adjustment of the user to the innovation, but also adjustment of the innovation to the local situation, a concept which Fullan (1982) describes as **mutual adaptation**. Thus the form of the adopted innovation may be quite different from the form of the implemented innovation.

## Westview School District

Westview is the name that will be used for a small city in Western Washington, with a school district enrollment of approximately 10,000 students. Westview first became involved with microcomputers through some isolated early adoptions at the high school level. A background of pressure for implementing microcomputer use from teachers, parents, and the community resulted in the formation of a microcomputer review committee in December of 1982. This committee reported directly to the assistant superintendent of the school district.

The actual decision to adopt microcomputers stemmed from the attendance of Westview administrators at national conventions which featured reports of "successful" microcomputer implementations in major school districts. On the basis of this demonstrated feasibility of implementation, the superintendent decided it was time to "go ahead" with microcomputers.

Additional committees composed of teachers, principals, administrators, and consultants were formed to develop recommendations concerning (1) instructional uses, (2) management uses, and (3) community, staff, and miscellaneous uses. The committee approach was intended to secure broader involvement within the school district, and to methodically and deliberately develop their recommendations. These committees reported to the original microcomputer review committee, which reported to the assistant superintendent, thus creating a hierarchical structure.

The elementary schools in the district were required to justify the allocation of resources for microcomputers. Before funds were made available, each school would complete a "Microcomputer Implementation Plan." This policy was the result of administrative sensitivity to the relatively high national test scores in the elementary schools. Spe-

cific problems other than academic achievement would have to be identified as targets for microcomputer use. In addition, administrators felt that these plans would lead to the identification of those individuals best able to facilitate the implementation. The plans would stimulate the commitment in each school to their microcomputer plan.

Considerable effort was expended at the school, committee, and administrative level in the discussion and documentation of student learning objectives, which were stated in the form of specific microcomputer applications. The committee also developed an elaborate plan for continuing inservice training and course development. Topical areas include word processing for classroom and management uses, the development of problem solving skills, computer awareness for parents, and computer-assisted instructional applications. Teacher skills, support material, and hardware selection were seen as important but subsidiary factors in the planning process.

The clearest statement of the intended uses of microcomputers was found in a document produced for a "computer tour" by members of the Westview board in February of 1985. This tour was organized by the administration in response to board interest in the utilization of the allocated resources. With over 300 computers in the schools, Westview devoted considerable monetary and organizational resources to the implementation, in addition to the time spent by numerous school system personnel.

#### **Grass Valley School District**

The second case will be called Grass Valley. Located in rural Eastern Washington, the Grass Valley School District has an enrollment of about 100. Original school district consideration of adoption occurred due to pressure from the school board chairperson whose child showed an interest in microcomputers. In response to pressure from the chairperson, the superintendent formed a committee of parents, teachers, board members, and interested members of the community to "scout" computer usage in other school districts. While no formal, written policies were produced, the committee recommended the purchase of three computers to "get computers in use."

After this initial purchase was made, two teachers began using computers for word processing and computer-assisted instruction. A grant was written for three additional computers. Eventually, eight teachers would make substantial classroom use of microcomputers in several curricular areas, including vocational education, programming, computer-assisted instruction, and word processing for writing term projects in history. Although not intended by the committee, Grass Valley now has nine computers of three different, incompatible types. This is viewed, by the administration, as an advantage because students gain exposure to a wider variety of hardware and software.

Concepts that are considered by the school district superintendent as important to the implementation include (1) the close involvement of at least a few teachers, and (2) inservice. Several on-site inservice programs were conducted; these were critical to the expanded implementation, as perceived by the superintendent.

#### **Comparison of the Two School Districts**

There are some obvious differences in the scale of the implementation due to the sizes of the two school districts. Westview purchased over 300 microcomputers, and developed an elaborate series of inservice programs; Grass Valley purchased nine and conducted several inservice programs. Despite these differences, there are some

remarkable similarities in the patterns of microcomputer adoption and implementation:

1. Both school districts experienced internal pressure from teachers and students, and external pressures from community members to adopt microcomputers. The decision to adopt microcomputers was a direct result of these pressures.

2. In both cases, committees were used to control the rate of implementation. In the case of Grass Valley, the purpose of the committee, from an administrative point of view, was to "slow down" the implementation. In the case of Westview, the purpose of the committee was to ensure a formal, deliberate process, which had the same effect.

3. In both cases, the clearest statement of the intention of the microcomputer implementation came after the implementation occurred. In the case of Westview, this was in the form of the "computer tour" document. While no documents exist in the Grass Valley case, it is apparent that the intentions grew along with the implementation.

4. While no attempt was made to evaluate effectiveness, the perceptions of personnel in each school district is that the two microcomputer implementations were successful. The Westview implementation, despite some minor timing differences between individual schools, was accomplished in a single step. The Grass Valley implementation occurred in a more flexible, fragmented manner. Political pressure in Grass Valley forced an early, limited adoption.

Microcomputer adoptions differ from most other curricular and instructional innovations because of the extent and rapidity of diffusion of microcomputers within society. Large scale advertising and mass media coverage are important examples of this phenomenon. At the time of adoption, the two communities had a much greater awareness of microcomputers than awareness of, for instance, a new textbook series. The magnitude of this awareness resulted in (1) the existence of change agents within the school districts, and (2) the existence of considerable external pressures to adopt microcomputer use. These pressures created a potential for adoption, but the timing of the decision depended on a change in the value structure of the leadership.

The adoption process in the two school districts studied involved the change in values of the administrative leaders. The form of this change was acceptance of the association of the school district with the microcomputer innovation concept. In the case of Westview, the superintendent accepted the concept when presented with evidence of peer acceptance. In the case of Grass Valley, political pressure caused the superintendent to accept the concept, at least in a limited way. The purposeful nature of innovation implies assessment in relation to educational objectives, and concern with improvement of instruction. However, educational objectives of the innovation were not clear in the two cases presented above. Analysis of innovations, then, must reference the contextual intentions of the participants; an example is the important role of the board chairperson's child in the Grass Valley adoption. Clear explanations of the educational goals of microcomputers came only after the innovation had been implemented.

#### **Implications for Planning**

Rational models of educational change are inadequate to describe innovations because they assume that planning begins with a clear statement of goals. The ambiguous nature of educational goals, along with the lack of previous or-

ganizational experience of an innovation makes this assumption highly doubtful. Ambiguity of the educational objectives of microcomputer use, as experienced by the two school districts studied, illustrates the difficulty of applying rational models. Further, as suggested by Weick (1976), it may be a mistake to assume that planning is directly coupled to outcomes in educational organizations. If innovation involves the systematic allocation of resources based to some extent on values, a political perspective is implied. Such a perspective allows a more accurate explanation of planned change because it includes the portion of the decision process based on social value systems.

If the ramifications of an innovation were wholly understood, it wouldn't be new. Purposeful change is accompanied by unintended consequences in addition to intended consequences: freeways were not predictable when the automobile was first introduced. Where there is no specific organizational experience of an innovation, the consequences cannot be wholly anticipated, and planning becomes ambiguous, especially in loosely coupled organizations. This paradox suggests a possible explanation for the pattern of microcomputer implementation: The ill-defined nature of the educational goals of microcomputer use tends to make the planning of implementations a difficult process. Ambiguity in the implementation process is thus a reflection of ambiguity in the adoption, and planning becomes the rationalization of the adoption decision.

A large number of very specific educational applications of the microcomputer are available in the form of computer-assisted instructional courseware, languages, word processors and other programs. As suggested by Sheingold, Kane, and Endrewit (1983), the specificity of these applications may be well-suited to local interpretation of the microcomputer innovation. Microcomputers are no longer new; most educational organizations have a better understanding of the potential of microcomputers as

well as their limitations. School district administrators can take advantage of this experience for planning further implementations.

While the initial adoption of microcomputers may be a highly ambiguous process, further implementations could be facilitated by an overall strategy of linking teachers to specific applications. planners need to devote more resources to the identification, implementation, and maintenance of applications for single teachers or small groups, and less time to large scale standardized hardware, software, and inservice activities within the school district.

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The effective utilization of a new technology requires a proactive approach by administrators.

# Implementing Computer-Based Instructional Programs: A Report from a Rural School

by Lew McGill and H. Custer Whiteside

## Description of the School District

Riley County school district is a small rural school district of approximately 500 students. The population of the school district is evenly divided between agriculture and those who are employed in one of the neighboring communities. There appears to be a high number of college graduates among the students' parents and, over all, the district is very supportive of the educational efforts of the school district.

Riley County school district is small in area as well as population. The school district receives about 60 percent of its yearly budget in the form of state aid. The district has a low tax base and the mill levy is slightly below the state average. The community takes a lot of pride in the educational efforts put forth by the district.

## Status of Computers and Support

In 1982, microcomputers were just starting to be introduced in area school districts. Members of the board of education encouraged the administration to investigate the potential for using microcomputers in the district. The administration began investigating microcomputer applications. However, it became evident that very few educators in the state were knowledgeable about microcomputers. The district did not have staff members with computer training, but there were a number of teachers who expressed some interest in exploring the area of computers and their applications.

Conversations with salesmen concerning computer sales and possible training turned out to be a waste of time. The superintendent began to attend seminars and read articles on how to effectively introduce computer technology

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into classrooms. Turning to the literature on computers seemed to be a reasonable approach and was, in fact, very helpful. Unfortunately there was not much information available on the efforts of other schools and their attempts to assimilate computer technology.

## Plans, Goals, and Objectives

In the beginning, the school district had no policy regarding computers. Everything the school district did was going to be new. A review of computer articles identified potential parallels concerning the introduction of educational television and microcomputers. Several authors noted the mistakes made by educators in their attempts to introduce educational television into the classroom. They warned that similar approaches were being used to introduce computers into education. They suggested that a systematic approach be utilized to introduce this new technology to prevent the problems encountered with the introduction of educational television.

Another recommendation from the review of articles related to staff development. It pointed out that teachers need to understand how to use computers and be willing to accept their responsibility for incorporating computers into their classes. The primary goal of the district was "to train all of the teachers, clerical staff, and administrators in the use of the microcomputer, software, and operations so that this skill could then be taken back to the offices and classrooms and used without fear." A decision was made, based on the small size of the teaching staff, that all teachers should be trained on computer use at the same time.

When this training would take place and who would lead it became important considerations. A decision was made to devote all the teacher inservices for one year to training the teaching staff in the use of the microcomputers. A search began for someone with expertise in computer use to train the staff. An educational consultant from a local university was contacted and employed to conduct the district inservice.

The first inservice sessions were devoted to giving the teachers general information and attempting to relieve any fear they might have regarding microcomputer use. The following concepts were used as guidelines for the sessions:

- 1) Introduce participants to current developments in computer applications in education, business, and government;
- 2) Introduce participants to computer hardware, set-up procedures, general operation, care and use of hardware and software;
- 3) Introduce participants to public domain and commercial software which provide computer-assisted instruction;
- 4) Provide participants with information regarding different microcomputers and their advantages and disadvantages;
- 5) Provide participants with hands-on practice with computer applications for teachers in the classroom.

In addition to these guidelines, several policies were developed and approved by the board. These included the following:

A. The teachers will be given the opportunity to learn about computers in a non-threatening environment and advance their computer knowledge and skills to a point where they feel confident. It was the superintendent's opinion that it would be unfair to teachers and fatal to the project if the teachers were required to go back to the classroom and at-

tempt to utilize and teach what they had just learned.

B. The inservice computer training will be presented over a period of at least one year at a pace determined by the teachers' abilities to understand and apply their newly acquired computer skills. Teachers will be expected to spend additional time, out of school, to learn about computers and their applications.

C. Inservice programs will consist of one-half day per month devoted to computer education, for the full school year. The students will be dismissed for this half day and lunch will be provided for the teachers. (An on-going evaluation of this policy revealed that the amount of time allotted for the inservice sessions appeared to be sufficient. The teachers enjoyed the hands-on activities and stated that they looked forward to the next session. It appeared the teachers felt more responsibility because they could see the amount of commitment being put forth by the board of education.)

D. Inservice training will be provided at board expense. All essential books and materials will be furnished. A sufficient number of computers will be made available for the participants.

E. An experienced consultant will be hired to plan and present the inservice sessions. In addition to computer expertise, this person will need to demonstrate an understanding of contemporary theories and practices on effective schools and staff development principles. (The selection of this individual and his ability to work with our teachers and administrators were key elements to the success of our introduction to computers.)

By introducing computers to the teachers in this way, it was felt that the anxiety of teachers would be diminished and they would come to accept the computer as simply another teaching tool to assist them with their daily responsibilities. The training was planned so that the teachers had the opportunity to become skillful in using computers and gain experience in handling, reviewing, and selecting public domain software for use in the classroom.

A policy was also established for the purchase of software. Upon the request of a teacher, the district office wrote a letter to software publishers requesting permission to review that software which had been chosen. The publishers were guaranteed that their products would not be copied. After review, if the teachers approved of the software, the titles were put on a list to be purchased. If the software was not purchased, the requesting teacher was asked to respond to the publishers, in writing, and explain why their software would not be used. During two years of this procedure the district has never been denied a request to review a software product.

Since the district did not own any software, a line-item in the school budget was established to cover the purchase of such materials. Once the teachers became aware of this support, they began to request software of review and purchase. The teachers were very careful about the software eventually recommended for purchase. Methods for effective software selection became the most important topic of the computer inservice training.

The district established a policy regarding duplication of software. Simply stated, the copying of any copyrighted software was prohibited. This policy was reiterated frequently during the first year and illegal copying has not been a problem within the district.

When the introductory computer training was completed, the first computer purchases were made. At that time, little was known about computer hardware. However,

the software utilized during the inservice had been developed for the Apple or the Commodore computer. Since the teachers had selected software which would run on these machines, two Apple IIe and four Commodore 64 computers were purchased for teacher use.

One Apple and two of the Commodore computers were placed in each school. With six computers for 36 teachers, the training program developed by the consultant progressed very smoothly. The teaching staff was so enthusiastic that the computers were signed out nearly every hour of the day and more units were eventually purchased.

In December of 1984, teachers were asked to give their recommendations for computers to be used in the instructional program. Their answer was quick in coming because one of the computers was faster and easier to use. These computers were then purchased. In preparing this new order for computers, additional equipment was also purchased for secretarial and administrative training and use. Since the primary goal was to prepare teachers to use microcomputers effectively in their classrooms, the training to this point had focused on teachers. A program was soon planned to assist the office staff in making the transition. It had been apparent from the beginning that someone needed to be responsible for cataloging and distributing the new software and hardware. The responsibility for this job was discussed with the district librarian, who eagerly accepted the responsibility. At the time, it could not be anticipated how important this job was to become. The librarian had a solid understanding of what was needed to assure an orderly flow and accounting of all software and hardware. She established a comprehensive software catalog and an inventory of all hardware purchased by the district. It is important that a dependable person be put in charge of these responsibilities.

The board of education was constantly informed concerning the plans for implementation and the progress being made. This eliminated surprises for the board members as future plans and estimated costs were presented. Since they had been a part of this project from the beginning, it was not difficult their board support.

During the spring, some staff members and administrators discussed ways to introduce students to the computers. After some research, which included visits to several schools around the state, it was decided that the best approach would be to establish computer labs in both schools. There were sufficient computers to equip the labs and space was available to serve as the labs. During the visits to other schools, a list of ideas for what to do and what not to do in designing computer labs was collected. The computer labs were an instant success at both schools. Within a short time students were being taught a computer competency class, and some of the staff was confident enough to take their regular classes into the lab for additional work.

By the end of the first year of the plan, 25 computers and a moderate amount of software had been obtained. Requests for permission to take the computers and software home for the summer were received from the staff. Guidelines were established to allow the staff to check out software and hardware. It was encouraging that the teachers wanted to take the computers home for the summer in order to improve their computer skills.

The main thrust of the plan for the following school year was to begin developing students' computer skills. It was proposed that an interested teacher from the elementary school be appointed, and a new computer teacher be hired for the high school to work with both teachers and stu-

dents in the computer labs. These proposals were recommended to the board of education and approved.

While the district was making a sizeable investment in computer equipment and training, it was decided to look for a person with a computer background to serve as a resource person and coordinator. This was a difficult task because of the shortage of people with the necessary training. A person with math and computer skills was hired to teach at the high school, but that person did not have the leadership skills and training necessary to take an active role in directing the efforts of the school district.

The inservice for the next school year was to be devoted to assisting teachers in working with students on computer applications. The consultant was reemployed for another year to assist the teachers in this effort.

The school board wanted to continue encouraging teachers to use computers. A number of teachers were sent to a national conference on computers, and several other teachers also went to various state and local conferences on computers and software. Soon the board adopted a policy concerning the hiring of new teachers for the district. Teachers without some computer training would not be hired by the district. The members of the schoolboard were firm in their commitment to the program.

At the present time there is a computer in every classroom in the elementary school. The teachers use them as a learning center and the students are allowed to use this center as they would any other center in the room. The teacher is also free to use this computer to complete administrative or clerical duties and is encouraged to do so.

Evening adult computer courses have been offered and were well attended. There continue to be requests for more adult education on computers, but at the present time budget constraints have kept the district from expanding this area. However, funds have been made available to staff the computer lab in the elementary school after school hours for students.

The effective utilization of a new technology requires a proactive approach by administrators. Careful planning and formation of new policies are critical aspects of the process. Teachers, students, board members, and the public must understand the goals and objectives of these new programs. Two-way communication must be maintained between all participants. As we enter the 21st century, schools must be preparing students and educators to use effectively these new tools of the Computer Age, and our program is working toward that goal.

The general field of adult education is the most rapidly growing segment in all areas of American education . . . few institutional providers of adult education have established guidelines for computer education.

# Computer Education for Adults: Policies and Practices

by Dr. Charles R. Oaklief

State departments of education, colleges, universities, and professional associations are now being confronted with the need to discuss policy issues related to the increased presence of adult learners and the application of computer technology to serve this audience. The general field of adult education is the most rapidly growing segment in all areas of American education, an increase of 17 percent between 1978 and 1981. The National Center for Educational Statistics (NCES, 1981) estimates that 21 million adults participated in some form of organized educational programming in 1981. There are many reasons for the rapid acceleration of adult education in our society including the following:

1. The demographic shift is placing the baby boom in the age of greatest adult learning.
2. The explosion of knowledge is creating new information so rapidly that job skills and knowledge are becoming obsolete in even shorter periods of time.
3. Training and education programs are growing rapidly.
4. Social movements for equal opportunities in work and education are increasing the need, motivation, and opportunity for education. In this respect, women are the most active adult learners (NCES, 1983).
5. The level of educational attainment of the populace is rising and with it the demand for lifelong learning. A college graduate is five times as likely to participate in adult education as a high school dropout (NCES, 1983).
6. Adult education is also growing more rapidly among the elderly. A 29 percent increase in the three year period from 1978 to 1981 (NCES, 1983).

The reality of the growing demand for adult education is perceived by adult educators and those who benefit from adult learning such as employers, community leaders, marketing organizations, and society at large. According to

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Cross and McCartan (1984), many state policy makers are realizing the growing interest in adult education which promises to have dramatic effect on equal opportunity, the quality and condition of education, and the economic future of our country.

One approach to enhancing access to further education for the increasing numbers in adult education is the use of computer technologies, including computer-based instruction and computer-based instructional management (Lewis, 1983). This new emerging application of technology to adult education enhances knowledge and skills through self-directed learning in addition to the various adult teaching methods and techniques including participation training and human resource development. The increasing evidence of computer applications to education suggests a positive future for educational technologists, computer specialists, and a broad array of information processors (Gorny, 1982).

Knowles' (1983) prediction that by the end of this century most educational services will be delivered electronically may well go the way of other futuristic predictions. Futurists have predicted the demise of the book, the evolution of the nation's work force into information processors, the development of millions of high technology jobs, and that three million telecomputers will be operating by 1990 (Hodgeskinson, 1985). These propositions, like the idea that providers of adult and continuing education are offering learning opportunities in the necessary attitudes, knowledge, and skills of computer applications are highly speculative. If it is to be true, the mission statements and policy declarations of educational institutions would surely provide evidence of such program direction.

A review of data generated from a broad based computer search of adult and continuing education literature reveals quite the contrary. In fact, there is little information relative to policy statements in support of computer education and computer literacy to be found among the various organizations which provide adult education. The finding that few institutional providers of adult education have established policy guidelines for computer education may not be surprising but the reality of the situation raises some interesting questions:

1. Is there a lack of commitment by adult education organizations to the application of computer technology in the education of adults?
2. Is adult computer literacy the responsibility of others? Should organizations that employ the nation's work force be the primary source of computer competency training?
3. Is the application of computer technology a fad? Will it go away, or be replaced by something more advanced and worthy of educational endeavor?
4. Do these individuals responsible for adult education policy development believe that computer technology is still new to educational settings and that we should wait for more proven applications before committing instructional resources?
5. Is an organizational commitment still too early? Should we let the small number of innovators, risk takers, and others who may be somewhere on the periphery of an organization's main stream do the development work?
6. Could it be that problems associated with the transition from policy to practice prevent the implementation of "cutting edge" programs in most adult education organizations?

Although these possibilities are not exhaustive, it is reasonable to assume that the lack of policy development in computer education for adults is the result of a combination of obstacles. The basic problem is largely set in adult educators wishing to avoid preliminary policy development and long range planning in favor of addressing their perceptions of the immediate needs of learners; a scenario which leads to the marginality of adult education (Clark, 1956). An analysis relative to policy development in established adult educational organizations is that policies are (1) written in broad general statements which reflect the "larger" missions of the institution and not specific educational programming such as might relate to education for computer competencies, (2) that policy reflects the established and traditional educational service areas where computer education is considered as a new era, and (3) the process of policy development and up-dating tends to be neglected in favor of more immediate educational programming intended to meet the felt needs of adult learner audiences.

There is negligible evidence of the existence of policies outlining the provision for computer applications in areas relating to computer literacy for adults, yet, the practice of providing education and training in the application of computers in adult education is increasing at a rapid pace (Kasworm and Anderson, 1982). The growth in the application of computers in adult education is supported by various groups including the Institute For The Future (Amara, 1974). As their report on the social impact of computer technology states:

... there is a need for the public to acquire a deeper understanding how computers affect the decisions individuals and organizations make, the goods and services they produce, and the world that individuals perceive. It is concluded that such improved understanding must be acquired in the near future. (Abstract, p. 1)

Such a call-to-action does not address the reasons for this lack of policy. Rather, it asks what can be done to resolve the problem. If one makes the assumption that educational institutions maintain their vitality by fulfilling the goals and objectives outlined in educational policy, the following considerations for developing computer policy are indicated:

1. There is a practical expectation for the integration of computer education within existing adult education curricula and program areas.
2. There is a need for the development of new educational programming to enhance the attitudes, knowledge, and skills of adults in the utilization of computer technologies in the world of work, community development, and the solution of lifes' larger problems.
3. There is a need to involve adults as learners in the lifelong process of self-development through adult education opportunities. The application of computer technologies can enhance the adult's lifelong learning and self-development process.

The development and implementation of new educational policy is often only as difficult as overcoming established institutional traditions and the extensiveness of existing staff values and competencies. The more difficult aspect of the policy to practice scenario may be found in the process of making the appropriate decisions relative to program and curriculum development, teaching methods and techniques, and design of the adult learning environment. Basic policy questions which need consideration include

the following:

### 1. Separate Curriculum Area or Knowledge Base Approach

Many approaches which integrate computer training in the educational dimension have failed or have lost emphasis due to a lack of resources, competition from other curricula, and different demands brought by changing economic and social milieu (Apps, 1979). Computer skills and technologies, with the potential of their supportive and enhancing role in adult learning, are too important to be left to a singular instructional thrust or curriculum. In support of this idea Ennals and Cotterell (1985) believe that programs of study in computer applications should increasingly underlay teaching and learning in each subject area. This approach would offer a diffused knowledge-based approach to computer literacy.

There are numerous considerations for the application of computer technologies in adult education (Hoyt, 1985). The education of adults is delivered by most educational institutions and organizations through programs designed around the immediate problem areas of the learners (Cross, 1981) rather than through established curricula (Knowles, 1980). To fit this model, computer-based educational programs must be adaptable and dynamic in order to meet the proactive approaches to life, and the intentional approach to learning (Knox, 1977) as experienced by adults. Adult satisfaction and perceived benefits of learning are related to the learners' propensity for involvement in the process of education and learning (Oakleaf and Oakleaf, 1983).

Effective education of adults will interface with the learner in the solution of real life problems and will not be limited to a specific curriculum or a knowledge based approach. The educator of adults must be prepared to utilize a variety of approaches which will offer choices deemed most desirable for the application of computer education with adults.

### 2. Liberating Adult Education or Problem Solving Adult Education

Traditional perspectives on adult education in the United States describe the benefits of learning as most often related to the solution of immediate problems in either economic or non-economic benefit areas (Peterson, 1979; Oakleaf, 1982). This would include the acquisition of new attitudes, knowledge, and skills. In this learning process the learners adapt to the demands of occupations and responsibilities of citizenship. There is another important consideration for the application of computer technology in the field of adult education. Education, according to Jones (1984) and Apple (1979) seldom empowers the learner to change the given order of things; to take charge of their environment. In this respect, the interactivity of adult learner and computer technology may help to facilitate the integration of the adult learner into dominant social and economic patterns. According to Heaney (1982, p. 157), "Liberatory adult education . . . enables adult learners to deepen their involvement in the struggle to change their world through reflection and understanding." The impact of computer literacy upon the delivery of adult education and lifelong learning is to enhance the adult learner's potential for taking charge of their own learning thus making the transition from reactive to proactive learning behaviors (Knowles, 1975).

Computer applications in the practice of adult education can contribute to the decentralization of traditional information power structures through awareness and shared access in the public domain. The ideals of liberation and re-

construction through adult education are echoed in the following statement from UNESCO (1977) on reconceptualization of the education process:

Lifelong learning denotes an overall scheme aimed at restructuring the existing education system and at developing the entire educational potential outside the education system. In such a scheme men and women are agents of their own education through continual interaction between their thought and actions. Education and learning . . . should extend through life, include all skills and branches of knowledge, use all possible means, and give the opportunity to all people for full development of personality. (p. 2)

Educational policy for the enhancement of computer literacy and its application in adult education must deal with the basic question of what to do at every institutional level to insure that the administrative and program directions are supportive, that adequate resources are committed, and that instructional methods and techniques further computer literacy and the application of this technology through the principles and practices of adult education. The following policy areas represent larger individual and societal concerns:

**Policy Area #1: The Potential of Adult Learning and Development**—Educational policy should address the potential of adult learning and development through computer literacy training, the application of computer technologies to problem solving, and enhancement of proactive learning involvement for adults. Such policy should insure the availability of computer competency education for adults regardless of age, sex, social status, racial and ethnic background, economic and social status, intellectual ability, and learning style.

**Policy Area #2: The Locality of Adult Learning**—The adult learner audience includes a vast array of ages, socioeconomic groups, occupational areas, and individual interests. Adult learning opportunities take place in many different locations including the home, the work place, libraries, shopping centers, museums, and churches to name a few. Educational policy should provide for computer literacy and application training at the point where it will be used; the real life setting.

The sharing of learning environments with other educational and community organizations is an important policy consideration. Industry, business, health organizations, and community service groups can help resolve delivery problems, increase acceptance and direct computer education toward solving community problems and individual needs.

**Policy Area #3: The Integration of Computer Education for Adults**—Adult education is manifest in an on-going, dynamic, and lifelong process. Adults continue their learning over many life stages and integrate it with their life activities. Educational policy should provide for computer skills and applications of learning at times and locations convenient to the learner.

**Policy Area #4: Consumer Protection in Commuter Education**—Protection of the best interests of adult learners is one function of the competitive marketing system in adult and continuing education. Public institutions are accountable for the expenditures of their funds. The process of developing public educational programs for adults is sometimes slow and deliberate as compared to the rapid

innovation and adaptiveness of proprietary organizations in servicing adult audiences. Policy should call for collaboration between educational providers to insure the quality and integration of computer education and serviceability. Programming should transcend social and economic barriers to develop the potentials for benefitting privately sponsored adult learning programs. Policy should provide for the employment of personnel skilled in the process of helping adults to learn and in the application of learning to the solution of problems and the improvement of the quality of life.

**Policy Area #5: Information and Learner Services**—The interface between adult learners and the educational organization should be efficient, accurate, complete, helpful, and positive. Policy should create an awareness of computer learning opportunities for adults throughout the service area and provide a supportive environment. Policy should insure that educational services provide a supportive environment and facilitate the adults' potential for utilizing computer technologies in the process of lifelong learning. Adult guidance and supportive services should perform an advisory role and encourage adults to initiate personal choices about their learning needs and the most appropriate format for achievement.

This article has emphasized the nonexistence of computer educational policy among the institutional providers of adult education and the professional development programs in higher adult education. The primary concerns for computer literacy and application training, as reported in the literature, are related to the following:

1. Negligence on the part of administrators, program specialists, and adult education leaders to initiate realistic and practical policy which will drive computer educational programs for adults.
2. The need for developing policy which will bring cooperation among all providers of computer competency education with business, industry, and community organizations to reach all adult learner audiences with developmental training and application skills.
3. The facilitation of adult learning relative to those approaches which create learner centeredness and proactivity for adults as they develop as independent learners and controllers of their own destinies.
4. Development of learning environments which involve the adult in planning, sharing live experiences, evaluating progress and taking ownership in the computer education process.
5. Facilitating computer education and literacy training so that instructional programming is applicable to the real life problems of the learners.
6. Documentation, dissemination, and discussion of policy and procedures with program and instructional staff prior to beginning computer education and literacy programs.

The development and implementation of computer education policy in our adult education institutions is a major assumption. Even if it were true, the actual impact of such policies would be dependent on the integration, understanding, acceptance, and actual practice relative to such policies by teachers and facilitators of adult learning. All things considered, the development and evidence of educational policy to guide computer education for adults is the first place to start. Only a firm foundation of institutional policy for computer education will enable full development of the adult's potential and contribution to society.

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