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 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).

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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 R2, 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	EFFECTIVENESS 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 $< = 0.01$

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 R2 values of the remaining factors. Based on these findings the best predicator 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	R2 (CUMULATIVE)
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 CORRELATION	SIGNIFICANCE
Demographic Factors:		
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
Organization Factors:		
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
Inservice Factors:		
9. Total inservice training time	-.116	.300
10. The percentage inservice training—principals	-.104	.318
11. The percentage inservice training—teachers	.369	.041*
Degree of Computerization Factors:		
12. The number of years of operation	-.219	.096
13. The number of microcomputers currently in use	.071	.469
14. The original number of microcomputers	-.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 questionaires (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	SIGNIFICANCE	MULTIPLE R	R2 (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	SIGNIFICANCE	MULTIPLE R	R2 (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 indicate 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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