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ABSTRACT

The relationship between staff development and the integration of microcomputing into instructional practice is examined. Data were obtained from a survey of all public school districts in a midwestern state (N=427). The questionnaire elicited information about the districts' integration of microcomputers into instruction and the extent/scope of staff development related to microcomputers. The analysis is based on Joyce and Showers' model (1988) that identifies the following components of an effective staff-development program: (1) information or theory about the training topic; (2) live and mediated demonstration; (3) opportunities for practice in the training setting and work place; (4) feedback on performance; and (5) peer coaching. Findings tended to support Joyce and Showers' theory of staff development in the three ways. First, if greater student contact with microcomputers is a goal of public schools, then good staff development is related to that success. Second, good staff development may occur more readily in districts that have a lower pupil-to-computer ratio. And third, quality staff development is key in bringing about greater use of innovative technologies in instruction Five recommendations for practice are offered. Twenty-two tables are included. Contains 31 references. (LMI)

Integrating Technology into Educational Organizations:

The Role of Human Resource Development

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Running Head: CURRICULAR MICROCOMPUTING

Abstract

The purpose of this study was to examine the relationship between staff development and the integration of microcomputing into instructional practice. The questions addressed in the study were: To what extent have microcomputers been integrated into instructional practice in public schools; what is the nature and extent (type and scope) of staff development related to microcomputing in public schools; what is the relation between curricular integration of microcomputers and microcomputer staff development; and is there a relationship between comprehensiveness of microcomputer integration into instruction, staff development and demographic variables.

Results indicate that students continue to engage the microcomputer regularly as part of their instructional day. Results also suggest that the pupil to computer ratio is falling but that school size is not related to the pupil to computer ratio. Greater use of microcomputers does not necessitate increased use of emerging technologies. Further, there appears to be some positive relation with five key aspects of staff development and certain facets of curricular microcomputer use. Specifically, a relationship exists between the percentage of students with regular contact with microcomputers and key elements of staff development. Also, greater emphasis occurs in settings where there are fewer students per computer. Staff development is an important link in creating successful change, yet it is undervalued in many settings. In the conclusion, recommendations for practice are put forth.

Introduction

Many instructional methods, from the chalkboard to the television, resulted from new technologies (Cuban, 1986). Invariably some individuals, who as targeted end-users of a given technology, resist using it. Among pedagogues, this reaction is not new. Plato once described the invention of writing as a catastrophe in human history, killing the oral tradition and killing mental training in remembering (Bork, 1980). In spite of Plato's contention however, few today would argue that writing is not vital to communication and learning. But Plato's dissent still illustrates the inevitable reaction by some intended users of any new technology that affects the way people do things (Cuban, 1986). Microcomputers in schools met with similar resistance.

Microcomputers proliferated in elementary and secondary education in recent years. Congress estimates that American schools obtained nearly 2 million computers in the 1980s, and as of 1988 there were over 10,000 educational software products on the market for use in school or at home (U.S. Congress, 1988). A report in 1989 showed that 76,395 of the 79,963 public schools in the United States (over 95%) had two or more microcomputers (Ely, 1989).

In schools the movement to embrace computing has emanated from both "top-down" and "bottom-up" sources (Cuban, 1986). The move to embrace microcomputing in elementary and secondary schools was propelled by cultural forces in the late 1970s. In his analysis of the use of machines by teachers in the twentieth century, Cuban describes how the following factors contributed to the adoption of microcomputers in schools:

• corporate and legislative mandates for improved education on the heels of the report "A Nation at Risk." released in 1983 (Education, 1983);

• parental involvement ranging from urging school boards to purchase microcomputers to donating the machines themselves;

• administrators and teachers at the building level championing the virtues of computing and lobbying central office for resources to build a computing program.

As computers became more commonplace in public education settings, the tasks for which they are put to use continued to grow. For example, microcomputers initially introduced to improve instruction have been used by educational administrators for a variety of tasks, such as planning, budgeting, filing, student reports, and word processing (Rees, 1987).

The tasks assigned to microcomputers increased mainly because of the broad capabilities of the machines. Since 1975 the machines have become smaller, faster, more powerful, and less expensive. A study by the Ohio State Department of Education notes that, "for a few hundred dollars, one can obtain modern computer circuitry that provides computing power obtainable only through an investment of millions of dollars in the 1950s. This computing power is packaged in a unit whose physical size has shrunk by a factor of 10,000 while the speed of the equipment has increased 50,000 fold" (Ohio, 1987, p. 2).

In the future, microcomputers will continue to find new uses in elementary and secondary education. A report by the Commission on Schools for the 21st Century (Wisconsin, 1990) recommends that by the year 2000 "computers shall be readily accessible to teachers for daily use in their planning, teaching and managing of their classrooms (p. 83)," and every Wisconsin school district "shall have a minimum of an electronic on-line catalog, circulation system, CD-ROM and/or other emerging technology for each school library media center (coupled with) a microcomputer, printer, fax machine, dedicated phone line, and modem with software to access electronic mail (and) on-line databases..."(p. 84).

The above "wish list" includes a great deal of competence-destroying hardware. Whether school personnel make effective use of these new technologies, depends on their

attitude toward innovation and the evolution of the implementor (administration) and the user (teacher) relationships (Lav & Ruttenberg, 1982; Rice & Aydin, 1991). Some new uses affect the curriculum. The next section discusses aspects of microcomputer use in instruction.

Microcomputer Use in Instruction

For the most part, microcomputers are used by students in industrial countries for four main purposes (Hawkridge, 1990):

- to become aware of the uses and limitations of computers;
- to learn computer programming;
- to learn application programs for word processing, spreadsheets, and graphics;
- to learn topics across the school curriculum with the computer complementing or replacing the teacher.

The *tutor, tool, tutee* framework for microcomputer use in instruction, advocated by Taylor (Taylor, 1980), views all computer use within one of the three modes. To function as a tutor in some subject, Taylor notes that "the computer presents some subject material, the student responds, the computer evaluates the response, and, from the results of the evaluation, determines what to present next" (p. 3). As a tool, the computer has some useful function that it is programmed to do. Tasks that humans find laborious or tedious are well suited to the computer's tool mode. In schools this may include editing text, calculating math problems, or plotting a curve to a set of data. Taylor notes, yet, that "neither tutor nor tool mode confers upon the user much of the general educational benefit associated with using the computer in the third mode, as *tutee*" (p. 4).

When the computer is in the tutee mode, the learner tutors the computer. Taylor and others (Papert, 1980) have suggested that when students engage the computer in the tutee mode, "the focus of education in the classroom (changes) from end product to

process, from acquiring facts to manipulating them and understanding them" (Taylor, 1980, p. 4).

Seymour Papert's (Papert, 1980) programming language Logo is an example of the student engaging the computer in the tutee mode. Papert suggested that problem solving, project management, and the ability to utilize errors to one's benefit could be enhanced by engaging in simple programming projects. Children would have to express ideas in a simple, formal language (ie Logo), and rely on their skills to correct and debug the programs in order to have them run as intended. Cathcart's (Cathcart, 1990) study of fifth graders exposed to Logo programming suggested that Logo may have some positive effect on cognitive style, namely divergent thinking and field independence. Others have noted positive effects on students' creativity and reflectivity after their exposure to Logo (Clements & Gullo, 1984).

This is not to say that engaging in the tutor mode will bring about the greatest gains in student achievement for all subjects. In reading, for instance, tutorial applications achieved higher effects than other types in a meta-analysis of 84 studies related to computer assisted instruction (Roblyer, Castine, & King, 1988). Likewise, the same analysis suggested that word processing, a tool, was best suited to increasing quality of writing when computers were used for writing instruction.

Despite the mode employed, the microcomputer's use in instruction represents curricular transformation in schools. The next section addresses how its introduction into curricular practice relates to issues of innovation and change.

Microcomputer Staff Development in Schools

Methods of instruction have been the target of technological innovations in the twentieth century. Coupled with the introduction of an innovation is a change in the way tasks are carried out, and often times users will resist the change (Cuban, 1986).

Overcoming resistance involves providing users with a profound understanding of why the change is important (Fullan, 1982). This profound understanding can be accomplished through high quality staff development programs. Thorough staff development programs are a vital part of successful implementation of an innovation (Fullan, 1982, 1991; Loucks-Horsley, Harding, Arbuckle, Murray, Dubea, & Williams, 1987; Pink, 1989; Stallings, 1989). Unfortunately, staff development programs often fail to deliver the change that is critical to compel an innovation stay in place. Table 1 lists reasons why most professional development programs fail.

Table 1

REASONS WHY PROFESSIONAL DEVELOPMENT PROGRAMS FAIL

1. An inadequate theory of implementation, resulting in too little time for teachers and school leaders to plan for and learn new skills and practices.
2. District tendencies toward faddism and quick-fix solutions.
3. Lack of sustained central office support and follow-through.
4. Underfunding the project, or trying to do too much with too little support.
5. Attempting to manage the projects from the central office instead of developing school leadership and capacity.
6. Lack of technical assistance and other forms of intensive staff development.
7. Lack of awareness of the limitations of teacher and school administrator knowledge about how to implement the project.
8. The turnover of teachers in the school.
9. Too many competing demands or overload.
10. Failure to address the incompatibility between project requirements and existing organizational policies and structure.
11. Failure to understand and take into account site-specific differences among schools.
12. Failure to clarify and negotiate the role relationships and partnerships involving the district and the local university (Pink, 1989, p. 21-22)

The listings above seem dismal given that "there is no single strategy that can contribute more to meaning and improvement than ongoing professional development" (Fullan, 1991, p. 318).

The importance of staff development in microcomputing has not gone unnoticed by researchers and policy makers. Priorities cited by educational computing pioneer Arthrur Luehrmann in 1979 (Luehrmann, 1980) are strikingly similar to the priorities called for by educational policy makers for the year 2000. Luehrmann called for a basic computer skills curricula in schools; in-service training of teachers, with specialized subject matter training to apply computer skills to all topics; and curriculum development centers to foster greater understanding of student use of computers in all academic fields.

In 1990, the Wisconsin Commission on Schools for the 21st Century, a panel reporting to the Governor, recommended that "all Wisconsin school districts shall develop a district-wide plan for the integration of computers and related technologies into the curriculum."; "an on-going staff development plan shall be developed and budgeted annually by all districts for continuing in-service of new and emerging computer and related technologies and to integrate these technologies into curriculum"; and there should be "regional technology centers to insure educator competence in the use of instructional computer and related technologies" (Wisconsin, 1990, p. 83).

Unfortunately, staff development is often overlooked, taken for granted, or undervalued sometimes, especially in implementing microcomputing in schools. The U.S. Office of Technology Assessment (OTA) noted in a large study that despite the presence of microcomputers in almost every elementary and secondary school in the United States, only half the Nation's teachers report that they have used computers in instruction. Many cite fears of using the technology and a lack of understanding of the computer's value in serving the curriculum (U.S. Congress, 1988). Further, the study's findings note that preservice technology training only serves as an introduction to microcomputing; teachers need continuing training as the technology changes.

In reviewing the implementation of an integrated instructional system (IIS), a computer based instructional tool where most of the learning is done on the computer,

Sherry (Sherry, 1990) found that to maximize the effectiveness of an IIS, teachers must be given the time and training necessary to take advantage of the system. He noted that poorly trained teachers felt that the IIS was nothing more than a nuisance. Further, staff training had been neglected in that most of the training consisted of "little more than allowing teachers to preview some of the software Compounding the lack of general training in the use of the system was the fact that almost none of the teachers had been advised on how to integrate the IIS into their regular classroom activities" (p. 119-120).

A Promising Framework for Practice

Joyce and Showers (Joyce, & Showers, 1988) model of staff development is built upon a large body of research related to change implementation (Fullan, 1982, 1977), learning theory, and teacher behavior (Lortie, 1975). Their model is based on five assumptions regarding human resource development in schools:

1. comprehensive resource-development systems for education personnel should be developed;
2. student learning can be greatly increased through human resource programs;
3. virtually all teachers can learn the most powerful and complex teaching strategies if staff development is designed properly;
4. when staff development is implemented properly, the energy of the workplace increases considerably;
5. staff development that is embedded into practice will have a great effect on the beliefs and behavior of teachers.

Joyce and Showers' (Joyce, et al., 1988) model holds that a staff development program that includes the presentation of information or theory about the topic of the training, live and mediated demonstration or modeling of new skills and teaching models, opportunities for practice of new skills and strategies in the training setting as well as in the

workplace, feedback on performance in practice trials, and peer coaching of new skills and strategies will increase teacher knowledge, teacher skill, and transfer of learning to new settings over other programs that employ fewer components.

Staff development programs that employ only some components listed in the above model do not provide as great an amount of increase in knowledge or skill acquisition as do programs enlisting the *theory, demonstration, practice, feedback, coaching* model.

Joyce and Showers (Joyce, et al., 1988) model suggests that schools would have greater curricular integration of microcomputing if they embraced the notion of *theory, demonstration, feedback, practice, coaching* in their inservice programs related to microcomputer integration. I suggest that schools that use components of training encompassing introductory ideas or theory accompanied by only demonstrations may produce staff with knowledge and skills related to operation of the machines, but not the transfer of training needed to carry out the practice of curricular integration of the machines.

Research Questions

The following research questions, guided by the literature review and Joyce and Showers model of staff development are posed for this study:

1. To what extent have microcomputers been integrated into instructional practice in public schools?

2. What is the nature and extent (type and scope) of staff development related to microcomputing in public schools?

3. What is the relation between the dependent variable of curricular integration of microcomputers and the independent variables of curricular microcomputer staff development, comprised of theory, demonstration, practice, feedback, and coaching?

4. Is there a relationship between comprehensiveness of microcomputer integration into instruction, staff development and demographic variables consisting of school size, school region (urban, suburban, rural) and by district expenditure per pupil?

Method

A survey was designed to gather data regarding school districts' integration of microcomputers into instruction and the extent and scope of staff development related to microcomputers.

Sample

The population of this study consisted of all public school districts in a midwestern state. The sample of the survey contained the entire population (ie: all 427 school districts in the state).

Instrumentation

A seventeen item questionnaire was developed based upon a questionnaire written by Lohr (Lohr, 1990), Petruk (Petruk, 1985), and the South Carolina State Department of Education (South Carolina, 1984). The questionnaire was also based upon Joyce and Shower's (Joyce, et al., 1988) model of staff development, Taylor's model of microcomputer use in education, and interviews with experts in educational microcomputing and staff development related to microcomputing.

The questionnaire covered five major content areas: demographics, microcomputer use, types of computers and software in use, and staff development related to microcomputing. Dilman's total design method (Dilman, 1978) provided a framework for the format and wording of the survey.

Data analysis occured as follows:

Question 1

To what extent have microcomputers been integrated into instructional practice in schools? Microcomputer integration was measured in four ways. First, respondents were asked to estimate the approximate number of students in their district who have direct contact with microcomputers as a part of their instructional program (at least fifteen minutes per week) (Item 6). Second, a variable was created representing the number of pupils per computer.

Third, respondents were asked to estimate the percentage of how much computers are used in all of three modes, tutor, tool, or tutee across subject areas math, language arts, science, and social studies (Item 8). To compute the use of the microcomputer for a given mode across the elementary and secondary setting, raw scores were converted to standardized z scores. The scores for the subject areas for each mode were added together to yield a total mode score for elementary and secondary schools and elementary/secondary combined, with higher scores indicating greater use for that mode. Fourth, respondents estimated to what extent CD-ROM, interactive videodisc, and hypermedia have been integrated into math, language arts, science, and social studies.

A grade-level use variable was created from the raw data to analyze the use of emerging technologies. Scores reflecting use in specific subject areas were summed within grade levels (elementary level and secondary level) to indicate the extent of CD-ROM, interactive video, and hypermedia use. Higher scores indicated more frequent use of the technology.

Question 2

What is the nature and extent (type and scope) of staff development related to microcomputing in schools? Staff development was measured in three ways. First, respondents rated the current emphasis placed on twelve aspects of microcomputer related inservice activities within their district. Further, the respondents indicated the amount of

emphasis that should be placed on the same twelve aspects of microcomputer related inservice activities. Included within the twelve probes were five discrete probes examining presence and need for theory, demonstration, practice, feedback, and coaching (Item 13). Second, the respondents indicated the title of the primary staff person responsible for microcomputer training and awareness (Item 14). Third, a new variable was created from this data indicating whether microcomputer training and awareness was facilitated within the district, outside the district, or both. The twelve aspects of staff development rated were:

1. District provides informational inservice for staff on basic instructional integration of microcomputers;

2. Inservices describe theories related to general instructional integration of microcomputers;

3. Inservices describe theories related to content specific integration of microcomputers (ie: mathematics, reading, writing, spelling, business, music, etc.);

4. Inservices provide demonstrations of hardware or software to be integrated into instruction;

5. Training allows participants to practice using the hardware or software in a setting similar to where the technology will be instructionally integrated;

6. Inservice trainers provide feedback to trainees; and trainees provide feedback to each other after practicing use of software or hardware;

7. Training provides skills or capabilities for staff to engage in peer coaching after integrating the hardware or software into instruction;

8. Inservices are provided for staff on specific application software (ie: word processing, database, spreadsheet, telecomputing, graphics);

9. Inservices instruct staff in areas of software and hardware evaluation;

10. District provides ongoing inservice on software and hardware upgrades;

11. District provides ongoing inservices on related emerging technologies (CD-ROM, interactive video, telecomputing, networking);

12. District provides ongoing inservice on curricular development and revision for microcomputer integration.

The scale for the ratings was as follows: 1 = No emphasis; 2 = Minimal emphasis; 3 = Some emphasis; 4 = Great emphasis. This question was answered using descriptive statistics, correlation, and analysis of variance.

Question 3

Research question three was "What is the relation between the dependent variable of curricular integration of microcomputers and the independent variables of curricular microcomputer staff development, comprised of theory, demonstration, practice, feedback, and coaching?" This relationship was measured by correlating the mean ratings of five aspects (those specifically related to the theoretical framework, items 3-7 listed above) of Item 13 on staff development with data related to microcomputer use in instruction (percentage of students with regular contact, pupils per computer, mode of use, and use of emerging technologies).

Validity and Reliability

The instrument was submitted to a panel of experts who reviewed it for content validity. The panel consisted of a microcomputer consultant with a state Department of Public Instruction, and professors educational administration in a major midwestern university.

Reliability was measured during the study using Cronbach's (1951) Alpha test for reliability. The reliability of questions 8 and 9 on the survey instrument about curricular microcomputer use in elementary and secondary grades were tested (comprising a major

part of the dependent variable). Additionally, question 13 on emphasis placed on inservice activities was tested (a major independent variable).

On questions 8 and 9, respondents were asked to estimate the percentage of computer use devoted to each of three modes, tutor, tool or tutee, in a given curricular area. The Cronbach's Alpha coefficients (displayed in table 2.1) of reliability for tutor, tool, and tutee use in elementary settings were .8591, .8288 and .6952, respectively. The Cronbach's Alpha coefficients of reliability for tutor, tool, and tutee use in secondary settings were .7469, .7515 and .4879, respectively. The Cronbach's Alpha coefficients of reliability for tutor, tool, and tutee use in both elementary and secondary settings combined were .8328, .8202 and .6545, respectively.

On question 13, respondents stated the emphasis placed on twelve aspects of microcomputer related inservice in their school district and then showed where they believe the emphasis should be placed for those same twelve aspects. The Cronbach's Alpha coefficient of reliability for perceived current emphasis on twelve aspects of microcomputer inservice was .9349. The Cronbach's Alpha coefficient of reliability for where emphasis should be placed on twelve aspects of microcomputer inservice was .8922. Thus, it was believed that the reliability and the validity of the instrument were properly established for this study.

Results

Demographic Profile of Respondent Districts

A total of 429 surveys was delivered to the school districts. Of these, 267 were returned for a response rate of 62.24 percent. A total of 255 surveys were suitable for analysis, yielding a 59 percent usable return rate. Twelve surveys were dismissed for one of three reasons: 1) the respondent returned the survey indicating they refused to participate; 2) the respondent only partially completed a survey; and 3) a survey arrived after analysis had taken place. Table 2 contains descriptive information on the demographic

characteristics of the respondent districts, including average daily membership (ADM), grade levels served, per pupil expenditure, and area type (urban, suburban, rural).

TABLE 2

DEMOGRAPHIC VARIABLES PERTAINING TO DISTRICTS

Variable	Mean	Frequency	Percent
Rural	-	193	78
Suburban	-	47	19
Urban	-	9	3
Serves K-12	-	213	83
Serves K-8	-	34	14
Serves 9-12	-	7	3
Elementary ADM	1079	-	-
Middle ADM	486	-	-
High School ADM	627	-	-
Per Pupil Expenditure	5313	-	-

Seventy-eight percent of the sample were rural school districts. Nineteen percent were suburban, and three percent were urban. The mean number of elementary students per district was 1079. The mean number of middle school students per district was 486. The mean number of high school students per district was 627. The average per pupil expenditure per district was $5313.00.

Research Questions

Research Question 1

Research question 1 was "To what extent have microcomputers been integrated into instructional practice in schools?" This question was answered by examining direct student contact with microcomputers, pupils per computer, mode of computer use, and use of emerging technologies.

Direct Student Contact with Microcomputers

Overall, a majority of students have regular contact with microcomputers as a part of their instructional program (table 3). The greatest percentage of students with regular

microcomputer contact as a group (defined as at least fifteen minutes per week) are in elementary school, with seventy-four percent. They are followed by middle and high school with seventy-two and sixty-six percent respectively.

Suburban districts tend to have more students receiving regular contact with microcomputers than rural or urban districts, with 85 percent of the students having regular contact. Only at the high school level do urban districts have a greater percentage of students receiving regular contact (72 percent versus 70 percent for suburban and 65 percent for rural). Rural schools report the least percentage of students engaging microcomputers regularly for the elementary and high school level (70 and 65 percent respectively), but not the middle level (68 percent). For middle schools, urban districts show the smallest percentage of students engaging computers regularly (65 percent).

In terms of average daily membership (table 4), districts in the third quartile (921-1,877) have 68 percent of their students engaging the computer regularly, followed by quartiles one (72 percent), two (73 percent), and four (78 percent). That is, school size has no bearing on student engagement with computers. In terms of per pupil expenditure (table 5), districts in the second and third quartiles have 67 and 68 percent of their students engaging the computer, respectively. Districts in quartile one and four display regular contact at 72 and 80 percent, respectively. Therefore, per pupil expenditure has no bearing on students' contact with the microcomputers.

TABLE 3

PERCENTAGE OF STUDENTS WITH
REGULAR MICROCOMPUTER CONTACT
BY GRADE LEVEL AND DISTRICT LOCATION

Level	Aggregate	Rural	Suburban	Urban
All levels	72	68.14	80.74	70.04
Elementary	74	70.86	85.44	71.87
Middle	72	68.35	85.90	65.86
High School	66	65.21	70.88	72.41

TABLE 4

PERCENTAGE OF STUDENTS WITH
REGULAR MICROCOMPUTER CONTACT
BY AVERAGE DAILY MEMBERSHIP (ADM)

ADM	Category 1 0-535	Category 2 536-920	Category 3 921-1877	Category 4 >1877
Percent with regular contact	71.63	73.21	64.31	78.28

TABLE 5

PERCENTAGE OF STUDENTS WITH
REGULAR MICROCOMPUTER CONTACT
BY PER PUPIL EXPENDITURE (PPE)

PPE	Category 1 0-4787	Category 2 4788-5200	Category 3 5201-5718	Category 4 >5718
Percent with regular contact	72.23	67.07	68.68	80.25

Pupils Per Computer

There are between six and thirteen pupils per computer in the sample public schools. Table 6 displays the number of pupils per microcomputer. Middle school students must share more computers (thirteen to one), compared to high school students (seven to one). The differences across rural-urban lines are less (urban students - nine to one; suburban and rural students at ten to one). Average daily membership is not significantly related to the student to computer ratio. However, per pupil expenditure is. A significant negative correlation indicates that as per pupil expenditure goes up, the student to computer ratio goes down (table 7).

TABLE 6

PUPILS PER COMPUTER

Level	Pupils per computer
Elementary	10.513
Middle	13.083
High School	6.884
Rural	10.708
Suburban	10.791
Urban	9.483

TABLE 7

CORRELATION OF AVERAGE DAILY MEMBERSHIP (ADM) AND PER PUPIL EXPENDITURE (PPE) WITH PUPILS PER COMPUTER (PPC)

Variable	Coefficient
ADM & PPC	.055
PPE & PPC	-.250*

* Significant at $p < .01$

Computer Use

Table 8 shows which mode is used most, either tutor, tool, or tutee, across math, language arts, science, and social studies. To function as a tutor in some subject the computer presents material, awaits a student response, and then evaluates the response. From the results of the evaluation, the computer determines what to present next. As a tool, the computer has some kind of programmed function. When the computer is in the tutee mode, the learner tutors, or programs the computer in some fashion.

At the elementary level, the microcomputer tends to be used most as a tutor in mathematics (64%), science (57%), and social studies (54%), and as a tool in language arts (51%). At the secondary level the microcomputer is used as a tutor mostly in math (39%) (with tool use second at 34%), and as a tool in language arts (72%), science (46%) and social studies (49%). The greatest amount of tutee use is found in mathematics in both the elementary and secondary level with six percent and seventeen percent respectively.

TABLE 8

MEAN PERCENTAGE OF STUDENT COMPUTER USE
BY SUBJECT AND MODE

Subject	Tutor Mode	Tool Mode	Tutee Mode
Elementary Math	64.55	27.82	6.13
Elementary Language Arts	43.96	51.76	2.6
Elementary Science	57.15	28.15	3.5
Elem. Social Studies	54.29	34.43	2.98
Secondary Math	39.23	37.87	17.82
Secondary Language Arts	18.62	72.42	4.33
Secondary Science	39.48	46.18	6.13
Secondary Social Studies	31.12	49.31	2.52

To examine the use of the microcomputer across rural, suburban, and urban settings, an analysis of variance was performed (table 9). In elementary settings, tutor use primarily occurs in rural settings. Tool use occurs most often in urban settings, and tutee use occurs most in suburban settings. At the secondary level, again, tutor use occurs most

in rural settings. Tool use occurs most in urban settings, as in the elementary schools. However, at the secondary level, tutee use occurs most often in urban settings, although the analysis was not significantly different. Combined use scores reflected the differences found at the elementary level, again with the variance on tutee use not significant.

TABLE 9

ANALYSIS OF VARIANCE ON INSTRUCTIONAL COMPUTER USE BY GRADE LEVEL AND SETTING

Variable	Rural n	$\bar{x}$	Suburban n	$\bar{x}$	Urban n	$\bar{x}$	F	p
Elementary Tutor Use	170	.247	41	-.731	9	-1.629	2.69	.070
Elementary Tool Use	171	-.268	41	.813	9	1.907	5.44	.005
Elementary Tutee Use	171	-.262	41	1.179	9	-.564	4.34	.014
Secondary Tutor Use	147	.249	39	-.345	9	-.1996	2.72	.068
Secondary Tool Use	147	-.344	39	.817	9	1.485	3.45	.034
Secondary Tutee Use	148	-.062	39	-.025	9	1.710	0.86	.427

Average daily membership is negatively correlated with the use of the computer as a tool in elementary, secondary, and combined settings, indicating that smaller schools emphasize tutor use of the microcomputer in instruction. Conversely, the use of the computer as a tool increases with enrollment in elementary, secondary, and combined settings (table 10)

TABLE 10

CORRELATION OF AVERAGE DAILY MEMBERSHIP AND STANDARDIZED USE-MODE SCORES

	Elem. Tutor Use	Elem. Tool Use	Elem. Tutee Use	Sec. Tutor Use	Sec. Tool Use	Sec. Tutee Use	Comb. Tutor Use	Comb. Tool Use	Comb. Tutee Use
ADM	-.162 ‡	.186 *	.024	-.117	.151 ‡	.012	-.176 ‡	.218 *	.023

*significant at .01
‡significance at .05

A correlation of per-pupil expenditure and computer mode was performed. Significant coefficients appeared with tutee use at the elementary and combined level, suggesting that as per pupil expenditure rises, one may find more students engaging the microcomputer in the tutee mode (table 11).

TABLE 11

CORRELATION OF PER PUPIL EXPENDITURE AND STANDARDIZED USE-MODE SCORES

	Elem. Tutor Use	Elem. Tool Use	Elem. Tutee Use	Sec. Tutor Use	Sec. Tool Use	Sec. Tutee Use	Comb. Tutor Use	Comb. Tool Use	Comb. Tutee Use
PPE	-.113	.116	‡.152	-.084	.046	.126	-.104	.064	‡.175

‡significant at .05

Emerging Technology

Tables 12-14 show the amount of emerging technology (CD-ROM, interactive video, and hypermedia) used in instruction. Overall, the majority of districts report no use of any emerging technologies. Fifty to ninety-four percent of the districts report no use of

any emerging technology in any subject. The most frequent use of CD-ROM in a subject area is in secondary language arts (4.9 percent of respondents reporting daily use). Interactive video and hypermedia appear to be used most in the secondary science area with 3.2 and 1.8 percent of the respondents, respectively, using it daily.

TABLE 12

PERCENTAGE OF DISTRICTS REPORTING USE OF CD-ROM BY SUBJECT

Subject	No Use	Once per quarter	Once per month	Once per week	Daily use
Elementary Math	90.5	5.3	1.6	1.6	.8
Elementary Language Arts	77.8	5.3	8.1	6.1	2.4
Elementary Science	82.8	6.5	4.5	5.3	.8
Elem. Social Studies	79.9	5.7	7.3	5.3	1.6
Secondary Math	80.9	9.0	5.8	3.1	.9
Secondary Language Arts	58.0	14.4	11.7	9.9	4.9
Secondary Science	63.2	16.3	11.3	6.3	2.7
Secondary Social Studies	61.8	17.7	8.1	8.1	4.0

TABLE 13

PERCENTAGE OF DISTRICTS REPORTING USE OF INTERACTIVE VIDEO BY SUBJECT

Subject	No Use	Once per quarter	Once per month	Once per week	Daily use
Elementary Math	94.6	4.1	1.2	-	-
Elementary Language Arts	90.4	3.3	5.4	.40	-
Elementary Science	86.8	4.5	7.0	1.2	.4
Elem. Social Studies	87.5	4.9	6.2	1.2	-
Secondary Math	88.0	6.4	4.5	.40	.40
Secondary Language Arts	83.4	8.7	4.5	3.2	-
Secondary Science	69.2	11.4	13.7	2.2	3.2
Secondary Social Studies	77.5	10.0	9.6	2.2	.4

TABLE 14

PERCENTAGE OF DISTRICTS REPORTING USE OF HYPERMEDIA BY SUBJECT

Subject	No Use	Once per quarter	Once per month	Once per week	Daily use
Elementary Math	92.1	5.8	1.2	.8	-
Elementary Language Arts	88.7	8.7	1.6	.8	-
Elementary Science	90.4	7.0	1.2	1.2	-
Elem. Social Studies	89.6	6.2	2.4	1.6	-
Secondary Math	83.0	10.0	3.6	1.8	1.3
Secondary Language Arts	81.6	11.9	3.6	2.7	-
Secondary Science	80.7	9.6	5.0	2.7	1.8
Secondary Social Studies	82.5	11.9	3.2	1.8	.4

In the use of emerging technologies, area type elicited significant differences in all technologies. Across all use, urban areas used emerging technologies most and rural areas used them least. At the secondary level, use of the technologies tends to increase somewhat across the spectrum, regardless of the geographical setting (table 15).

TABLE 15

ANALYSIS OF VARIANCE OF USE OF EMERGING TECHNOLOGY BY AREA TYPE

Variable	Rural n	$\bar{x}$	Suburban n	$\bar{x}$	Urban n	$\bar{x}$	F	p
Elementary CD ROM	186	5.199	44	6.045	9	8.22		.005
Elementary IVD	187	4.626	44	4.886	9	6.333		.016
Elementary Hypermedia	184	4.413	44	5.295	9	6.00		.000
Secondary Tutor Use	165	6.40	41	7.298	9	9.444		.034
Secondary IVD	162	4.809	41	5.829	9	7.667		.000
Secondary Hypermedia	165	5.158	41	6.360	9	7.111		.427

Regarding use of emerging technologies, average daily membership is significantly correlated with elementary level interactive video and hypermedia use, and with high school interactive video use, suggesting that as average daily membership rises, so does the use of interactive video at the elementary and secondary level, and hypermedia use at the elementary level (table 16). A correlation of per-pupil expenditure and emerging technologies does not yield any significant relationships (table 17).

TABLE 16

CORRELATION OF AVERAGE DAILY MEMBERSHIP AND EMERGING TECHNOLOGY USE

	Elem. CD	Elem. IVD	Elem. Hyper media	Sec. CD	Sec. IVD	Sec. Hyper media
ADM	.128	.164‡	.290*	.090	.237*	.134

* significant at .01
‡ significant at .05

TABLE 17

CORRELATION OF PER PUPIL EXPENDITURE AND EMERGING TECHNOLOGY USE

	Elem. CD	Elem. IVD	Elem. Hyper media	Sec. CD	Sec. IVD	Sec. Hyper media
PPE	-.082	-.026	-.027	-.027	.031	.064

none significant

Research Question 2

Research question two was "What is the nature and extent (type and scope) of staff development related to microcomputing in public schools?" To answer the question, variables related to current inservice emphasis and need, sources of staff development, and staff responsible for training were examined.

Inservice Emphasis

Figure 1 and table 18 display the mean emphasis ratings for twelve aspects of microcomputer-related inservices or activities. Overall, respondents were dissatisfied with the emphasis placed on all aspects of staff development. Further, all respondents expressed a significantly higher desire for emphasis on all aspects of staff development. In rating the current state of staff development related to microcomputing, fewer than nineteen percent of the respondents indicated that "great emphasis" is given to any of the twelve aspects of staff development. Further, the range of mean scores spanned from 1.92 to 2.48, surrounding the "minimal emphasis" selection. Inservices that provide demonstrations of hardware or software to be integrated into instruction receive the most emphasis, while ongoing inservices related to emerging technologies receive the least attention.

In contrast, thirty to fifty-seven percent of the districts felt that "great emphasis" was needed on all aspects of staff development. The range of mean scores for desired inservice emphasis spanned from 2.99 to 3.54, surrounding the "some emphasis" needed, leaning towards "great emphasis." Basic instructional integration of microcomputers was deemed most important by the most respondents (57.66 percent).

Of the five aspects of staff development related to theory, demonstration, feedback, and coaching, respondents rated demonstration highest in terms of current inservice emphasis (mean score of 2.48). Coaching was given least emphasis in current practice

(mean score of 2.06). As noted above, desired emphasis was high for all aspects of staff development. The range of scores for theory, demonstration, practice, feedback, and coaching was 3.27 to 3.49, with highest desired emphasis on the practice aspect.

FIGURE 1

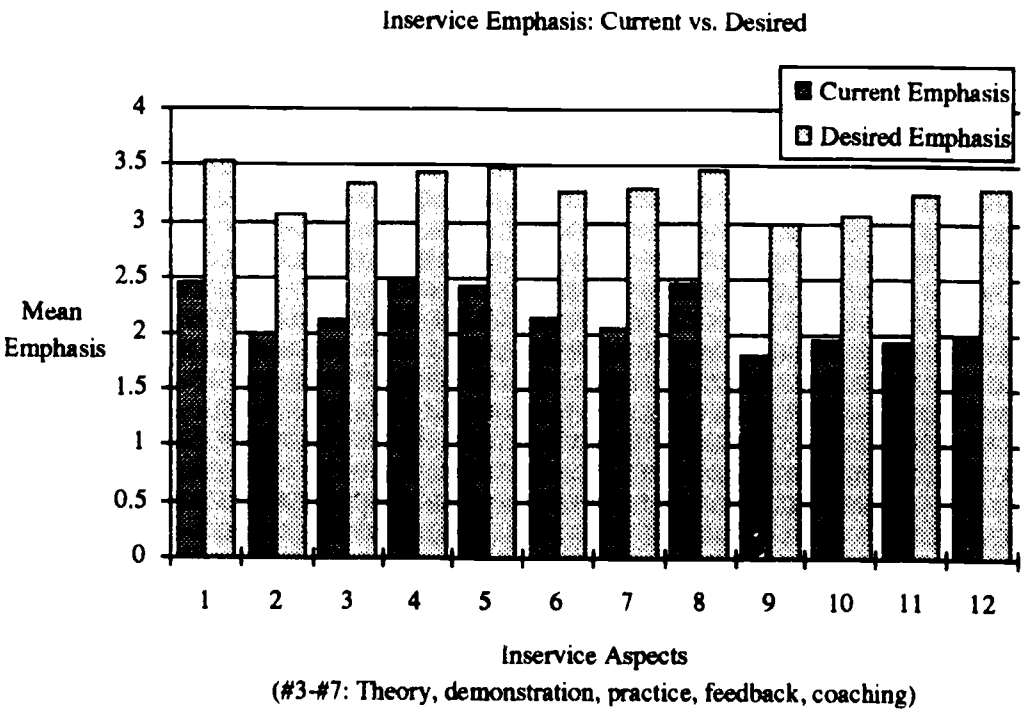

TABLE 18
ANALYSIS OF VARIANCE OF CURRENT VS.
DESIRED INSERVICE EMPHASES

Inservice Aspect	Current Emphasis n	Current Emphasis $\bar{x}$	Desired Emphasis n	Desired Emphasis $\bar{x}$	F	p
1	252	2.45	248	3.54	261.40	0.00
2	251	2.00	246	3.07	194.33	0.00
3	252	2.11	246	3.35	304.96	0.00
4	253	2.48	248	3.43	160.5	0.00
5	250	2.43	247	3.49	204.95	0.00
6	250	2.14	248	3.27	224.49	0.00
7	252	2.06	250	3.29	300.62	0.00
8	252	2.45	250	3.47	193.46	0.00
9	252	1.82	250	2.99	269.70	0.00
10	252	1.96	250	3.07	208.44	0.00
11	252	1.92	249	3.24	303.82	0.00
12	249	2.00	249	3.29	304.90	0.00

Research Question 3

Research question 3 was "What is the relation between the dependent variable of curricular integration of microcomputers and the independent variables of curricular microcomputer staff development, comprised of theory, demonstration, practice, feedback, and coaching?" This question was answered by examining student contact, mode of use, use of emerging technologies, and pupils per computer in relation to five aspects of staff development.

Student Contact

Table 19 shows that the five aspects of staff development related to theory, demonstration, feedback, practice, and coaching are significantly related to the number of students with regular contact with microcomputers as part of their instructional program. It appears that as emphasis on key components of training increases, so to does the number of students engaging the computer.

TABLE 19

CORRELATION OF THEORY, DEMONSTRATION, PRACTICE, FEEDBACK, COACHING WITH PERCENTAGE OF STUDENTS WITH REGULAR CONTACT WITH MICROCOMPUTERS AS PART OF THEIR INSTRUCTIONAL PROGRAM

Setting	Theory	Demon-stration	Practice	Feedback	Coaching
Elementary	.194*	.263*	.304*	.248*	.245*
Middle	.103	.135‡	.143‡	.200*	.181*
High School	.156‡	.265*	.235*	.226*	.312*

* significant at .01
‡ significant at .05

Mode of Use

Table 20 displays correlations of the standardized use-mode scores with five aspects of staff development, theory, demonstration, practice, feedback, coaching. Significant relationships arise with demonstration and practice where the computer is used as a tool, both in the secondary setting and as a combined variable across both elementary and secondary levels. Demonstration and practice appear to be two aspects of training that are stressed in settings where the computer is used as a tool, both in secondary programs and in overall district use. The aspect of feedback is significantly related to programs that use the computer as a tool and as tutee, specifically at the aggregated district level.

TABLE 20

CORRELATION OF STANDARDIZED USE-MODE SCORES WITH THEORY, DEMONSTRATION, PRACTICE, FEEDBACK, COACHING

Mode	Theory	Demon-stration	Practice	Feedback	Coaching
Elementary Tutor Use	-.004	0.022	-.034	-.057	.086
Elementary Tool Use	.040	.055	.076	.090	-.030
Elementary Tutee Use	.031	.114	.013	.105	.018
Secondary Tutor Use	.072	.023	.008	-.041	-.016
Secondary Tool Use	.108	.197*	.158‡	.121	.110
Secondary Tutee Use	.010	.067	-.006	.121	.014
Combined Tutor Use	.039	-.004	-.042	-.079	.030
Combined Tool Use	.098	.200*	.178‡	.143‡	.071
Combined Tutee Use	.026	.117	.017	.145‡	.023

* significant at .01
‡ significant at .05

Use of Emerging Technologies

Theory, demonstration, practice, feedback, and coaching appear to be significantly related to emerging technology use in three ways (table 21). First, the use of feedback in training is significantly related to the use of emerging technologies in all settings. Second, all five aspects of staff development (theory, demonstration, practice, feedback, and coaching) are significantly related to the use of hypermedia in both elementary and secondary settings. Third, staff development is significantly related to the use of more types of emerging technologies in secondary settings than it is in elementary grades. This is not surprising given that there is greater use of emerging technologies in secondary settings, as noted in the section responding to question one.

TABLE 21

CORRELATION OF USE OF EMERGING TECHNOLOGIES WITH THEORY, DEMONSTRATION, PRACTICE, FEEDBACK, COACHING

Mode	Theory	Demon-stration	Practice	Feedback	Coaching
CD-ROM Elementary	.084	.124	.063	*.138	.108
Interactive videodisc Elementary	.091	.128	.035	‡.149	.067
Hypermedia Elementary	*.246	*.297	*.258	*.314	*.237
CD-ROM Secondary	.094	*.207	.109	‡.140	‡.147
Interactive videodisc Secondary	*.207	*.244	‡.180	*.198	‡.154
Hypermedia Secondary	‡.158	*.219	*.188	*.197	‡.163

Pupils Per Computer

Table 22 displays the negative relationships between the five aspects of staff development and the number of pupils per computer. The inference is that in districts where emphasis on staff development is greater, the pupil to computer ratio is lower.

TABLE 22

CORRELATION OF PUPILS PER COMPUTER AND THEORY, DEMONSTRATION, PRACTICE, FEEDBACK, COACHING

	Theory	Demon-stration	Practice	Feedback	Coaching
Pupils per computer	-0.063	-0.174 *	-0.148 *	-0.142 *	-0.173 *

* significant at .05

Discussion

Joyce and Showers' (Joyce, et al., 1988) model holds that a staff development program that includes the presentation of information or theory about the topic of the training, live and mediated demonstration or modeling of new skills and teaching models, opportunities for practice of new skills and strategies in the training setting as well as in the workplace, feedback on performance in practice trials, and peer coaching of new skills and strategies will increase teacher knowledge, teacher skill, and transfer of learning to new settings over other programs that employ fewer components.

The data from this study indicate that few if any key elements of staff development are emphasized to the degree that other elements are. Elements not as strongly linked to successful practice are rated higher. When the five key elements of Joyce and Showers (1988) theory are emphasized, the percentage of students engaging the computer regularly as part of their instructional program increases and the ratio of pupils to computer decreases. Therefore, if one of the objectives of instructional technology is to increase student contact with computers, then strong emphasis on key components of staff development may be one route to achieving this goal. Good staff development takes place where the pupil to computer ratio is lower.

Emphasis on demonstration and practice were shown to be related to the use of the computer as a tool in secondary and combined elementary/secondary settings. Tool use involves application use as a means to some instructional end. This may include word processing for writing, or using a graphics program for a drafting project, for example. These results are consistent with previous findings in this study that, overall, emphasis in current staff development seems to stress demonstration in training, and inservices on specific application packages.

The results of this study suggest that when the key elements of Joyce and Showers' (1988) training model were emphasized, there was greater use of hypermedia in elementary and secondary settings, and of interactive videodisc in secondary settings. Emphasis on the aspects of demonstration and trainer/trainee feedback correlated most positively with emerging technology use. Since these are new technologies, their use has not achieved the relative mainstream status that the stand-alone microcomputer has. This may explain why all five aspects of Joyce and Showers' (1988) theory are significantly related to emerging technology use and not to general computer use. Schools may not see the need to explain the theory behind the reasons teachers should use computers, or allow time for feedback and post-inservice coaching, *aka* the Everest Syndrome (Maddux, 1988). Schools that succumb to the Everest Syndrome believe that:

- microcomputers should be brought into an educational setting simply because they are there;
- mere exposure to microcomputers will be beneficial to students; and
- if schools can obtain a sufficient quantity of hardware and software, quality will take care of itself.

However, the newer technologies, hypermedia in particular (which is often the kind of software that drives CD-ROM's and interactive videodisc players) represents an important breakthrough in making computers more compatible with human cognition, in that their storage of information is nonlinear. This conceptual leap may dictate the need for initial emphasis on all five aspects of Joyce and Showers' (1988) model.

In sum, this study tends to support Joyce and Showers' theory of staff development in the following ways:

- Assuming greater student contact with microcomputers is a goal of public schools, then good staff development is related to that success.

• Good staff development may occur more readily in districts that have a lower pupil to computer ratio.

• For new, novel, or emerging technologies, quality staff development is key in bringing about greater use in instruction.

Implications for practice

The recommendations by state commissions, like the Commission on Schools for the 21st Century (Wisconsin, 1990), include implementing on-line cataloging, CD-ROM capabilities, acquisition of educational hardware, software, and peripherals, as well as development of ongoing staff development programs for the integration of such technologies. The finer analyses of mode of use across subject and grade (ie : tutor, tool, tutee) can assist policy makers and administrators understand where limited resources may need to be allocated for program support. The results of this study can inform school leaders where further study should be made to carry out these goals.

The Wisconsin State Department of Public Instruction (DPI) has acknowledged the need for coherent staff development programs in integrating microcomputers into instructional practice (Lohr, 1990). This need, coupled with the historical speed at which changes take place in microcomputing technology, suggests the need to map the current status of instructional microcomputing and staff development in public schools. As microcomputers become more capable, so too must the staff that operate and integrate them into instructional practice.

Based on the findings of this study, the following recommendations for practice are put forth:

1) The data indicates that the majority of students are engaging the computer in instruction. Future policies need to insure equitable student access to microcomputers and emerging technologies continues across grade, geographic size, and funding levels.

2) Educators must insure that the microcomputer's mode of use is the most appropriate possible within the given subject it is used.

3) Given that rural schools tend to emphasize the use of the computer as a tutor more than any other setting, and districts with high per pupil expenditure utilize tutee mode more than any other group, educators must insure that mode of use is not a function of demography or financial exigency.

4) Emphasis on quality inservice must be placed high on the priority of goals if quality microcomputer integration is to occur in instruction.

5) Given the recommendations of the Commission on Schools for the 21st Century (Wisconsin, 1990) regarding integration of microcomputer technologies, implementation of a staff development model designed to improve staff and student performance, such as Joyce and Showers (1988), may lead to increased integration of microcomputers and emerging technologies within instruction.

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