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ABSTRACT

A 3-year project examined the potential of a computer-managed instruction (CMI) system to improve the academic performance of students in small rural elementary schools. A CMI system consisting of 32 student work stations, 6 courseware packages, 2 testware packages, and a management package was installed at 3 sites in Maryland, Pennsylvania, and New Jersey. The New Jersey school at the time the project began enrolled 180 students in grades two, three, and four; the Maryland school began with 216 students in grades K-6; and the Pennsylvania school with 275 students, grades K-5. Each had significant numbers of at-risk students. Each school year, students completed the Waterford Test of Basic Skills (WTBS) for placement, then received CMI approximately 30 minutes daily throughout the year, alternating among subjects (reading, language arts, writing, mathematics, and typing). A posttest on the WTBS and an attitude survey were administered to students at the end of the school year. Regular observations and interviews assessed teacher attitudes and practices relative to CMI. Following modest gains in the first year, achievement results in the second and third years showed significant gains for all grades and sites. Student attitudes toward their experience with computers were extremely positive and consistent. Many teachers initially viewed the program as an add-on and resented the loss of instructional time. However, in the second and third years, teachers began to incorporate CMI into their instructional activities. Contains tables detailing achievement results. (SV)

Impact of Computer-Managed Instruction on Small Rural Schools

by

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Introduction

Rural education in America is beginning to receive the attention it deserves. Educators and policymakers have moved beyond the urban-centered school reforms of the 60's and 70's to a growing concern with the quality of education in rural, as well as urban schools. In 1987, the U. S. Congress, in support of this rise of concern with rural education, passed a continuing resolution providing special funds for the nine regional educational laboratories to identify and support efforts to meet the needs of rural small schools within their regions.

In response to this initiative, Research for Better Schools, Inc. (RBS), the educational laboratory serving the mid-Atlantic region, saw as its first task the identification of those needs perceived to be most critical by rural educators in the region. The results of several RBS surveys, and those of a survey conducted by the National Rural and Small Schools Task Force (Arends, 1987), identified as a major priority for rural education in the mid-Atlantic region, to improve the academic performance of rural students from low-income families. Moreover, upon examination of regional data to further define this target group, it became clear that this rural target population was, in many cases, equal to or greater than the number of urban students in need of academic remediation (Houston, 1988).

Purpose and Hypotheses

One strategy for addressing this need was to infuse technology into rural small schools as a means for extending instructional capacity and capability. To address this, RBS designed a project to investigate the potential of a computer-managed instruction (CMI) system for meeting the needs of students in three small, rural elementary schools in the mid-Atlantic region. The purpose of this study was to determine if the CMI intervention would enable the students in these schools to do better in their basic skills learning than comparable students who were not participating in CMI.

CMI was selected because of its unique potential to offer highly engaging, sustained, and individualized instruction and reinforcement. Research has shown computer-based systems to have a positive impact on a number of student variables, such as achievement, attitude toward computers, attitude toward learning, and learning time (e.g., Kulik, 1983). In addition, CMI was developed to provide teachers with software which would support them with performance assessment and monitoring, evaluation, and recordkeeping. Thus, the following three hypotheses were developed for the project:

- CMI would contribute positively to student learning and achievement in reading, language arts, and mathematics in the three schools
- CMI would have a positive affective impact on participating students
- CMI would have a positive impact on existing patterns of instructional delivery.

Procedures

The first step RBS took in launching its CMI project was to develop a joint venture approach which would maximize limited resources and build commitment for implementation and continuance of the project. The approach stipulated that first year implementation costs for the CMI project would be split among three partners: RBS, each of the school districts where the CMI sites would be located, and a CMI vendor. Specifically, the school districts' financial responsibilities were to be:

- the district would bear approximately 40 percent of the first year purchase, installation, and maintenance costs of the CMI system, but would own the system
- the district would bear the costs of all subsequent years' operation and expansion, including maintenance and courseware leasing

- the district would bear all incremental costs such as salary expenditures for additional staff, costs for facilities modifications, in-service renumeration for teachers, and the like.

RBS' next steps were to select a CMI vendor and system and to select the three sites. These steps were carried out more or less simultaneously. After reviewing a number of CMI systems and vendors, RBS selected a WICAT 300XA because it met the following rigorous requirements:

- the system was designed specifically for school use; that is, it was reliable and able to take a lot of punishment

- the system courseware was comprehensive, covering basic skills for a wide range of students

- the system was highly flexible both in terms of memory and delivery capacity and in terms of the variety and scope of courseware

- the system had a high degree of versatility; teachers could schedule students to work on differing items of courseware simultaneously without noticeable diminution in the speed, efficiency, or instructional integrity of the system

- the system courseware had the potential to be sequenced, paced, and articulated according to local site curricular decisions and to fit local school objectives, textbooks series, and scope and sequence charts as well as standardized state or national tests

- the system had the capacity to serve a wide variety of school and non-school populations to enable sites to broaden use of the system effectively

- high quality, responsive technical assistance, training, and support for teachers, administrators, and other associated staff was included with the system

- the system was easy to operate, not requiring a great deal of staff time and technical expertise to learn to operate

- the maintenance and courseware costs for the system beyond the first year were reasonable enough not to burden or exceed the capacity of the participating school districts.

In addition, this system had been previously tested both experimentally and in field situations, and these results showed promise for gains in student achievement.

The CMI system to be installed at each site consisted of 32 student work stations, six courseware packages, two testware packages, and a management package. This was installed in a single classroom, converted into a computer laboratory setting. The hardware system installed was a WICAT 300XA, with hard disk storage, disk subsystems, a tape drive, a system console, and dot-matrix print capability. Courseware selected for use consisted of a primary (K-3) reading program with audio, reading comprehension (4-8), language arts (2-6) with audio, writing (K-6) with audio, mathematics (K-8) with audio, and typing (K-6) with audio. In addition, two testware programs (reading ability test for grades 2-adult and the Waterford Test of Basic Skills for grades 2-8), were included.

RBS developed the following criteria to help select the most appropriate sites for the project.

- District and school administrators must demonstrate a willingness to initiate and conduct a major change effort.
- The school and district must exhibit characteristics commonly applied to rural or small schools and referenced in the funding guidelines, e.g., small enrollments, remote location, resource scarcity, shrinking community tax base, small community population and geographic size, etc.
- District, school, and community representatives must support RBS' project objectives, activities, and processes and be willing to have their school serve as a site.
- District, school, and community representatives must demonstrate a capacity to contribute financial and other resources necessary to install, maintain, and expand a CMI system.
- District and school administrators must demonstrate an ability and willingness to move quickly to gain required approvals for the project so as to enable implementation to begin the first month or so of the 1987-88 school year.
- There must be clear potential for participation by significant numbers of students at risk of educational failure.
- Staff must be computer knowledgeable to some degree and motivated to become part of a project emphasizing computer-managed instruction.

Three rural districts agreed to these criteria and financial responsibilities cited earlier, one in New Jersey, one in Maryland, and one in Pennsylvania. Each nominated one of their public elementary schools to serve as a CMI site.

The New Jersey school was in a small blue and white collar community in Southern New Jersey. It had, at the time of the project's introduction, about 180 students enrolled in grades two, three, and four. Approximately 21 percent of the students were minority, 22 percent were Chapter 1 eligible, and nine percent were classified as special education students. According to their standardized test scores, the school ranked slightly above the national average in achievement. Although the principal was new to the school, most teachers had been there for many years.

The Maryland school was a small school near the Chesapeake Bay whose students came from two diverse populations: a relatively affluent one of young professionals and one comprised of welfare recipients and seasonal workers. When the project began it had 216 students in grades K-6: 36 percent were minority, 27 percent Chapter 1, and 10 percent special education. They were at grade level according to their standardized test scores. The principal had been at the school for four years, the teachers had been there an average of three years.

The Pennsylvania school was in a very small rural town in the south central portion of the state. The enrollment, at the time of the project, was 275 students, grades K-5. Although the school's scores on standardized and state tests appeared to be on a par with national and state norms, there were sub-areas where students were significantly below average. One part-time Chapter 1 teacher was serving 30 students. As with the New Jersey school, most teachers had been there for many years and the principal was fairly new (beginning his second year). It should be noted that the Pennsylvania district originally committed to the project withdrew at the last minute and was replaced later in the school year; thus, implementation in this school was a year later than in the other two sites.

Design and Data Sources

During year one of the project, funding allowed for a control group evaluation design. The control groups for the two CMI sites consisted of children attending classes in other schools in comparable surrounding districts. However, this design for year one was costly and, due to cuts in funding for the project's evaluation, control groups were not able to be included in the evaluation design for years two and three of the project.

Each of the three CMI sites staffed its computer laboratory with a full-time lab manager who met on an ongoing basis with teachers for the purposes of planning and reviewing reports. The lab manager also maintained contact with WICAT trainers and representatives. WICAT trained each school staff prior to implementation and upon providing new and/or revised courseware. WICAT also developed curriculum correlation guides which matched each district's reading, mathematics, and language arts objectives with the CMI activities. The curriculum packages (and associated training) were introduced one at a time during the first few months of school.

At the beginning of each school year students in each of the three elementary schools were administered the Waterford Test of Basic Skills (WTBS), an on-line basic skills achievement test, for placement. They then received computer-managed instruction for an average of thirty minutes daily, alternating between subjects, and were posttested on the WTBS at the end of the school year. It should be noted that, during year one the WTBS was administered with paper and pencil to help ensure comparability between project and control groups.

Pretest and posttest scores on the WTBS, for reading and mathematics, were collected during each of the three years of the program, from each of the sites in operation (it should again be noted that, during the first year of the program, only two sites had begun operations). An attitude survey was administered to all students following years one and two of the program. Also, RBS monitored the three CMI implementations during the three-year period 1987-1990, which included regularly scheduled staff interviews and observations, along with the collection and analysis of student achievement and attitude data.

Results

Two approaches were utilized in analyzing the first year WTBS scores; the first involved analysis of covariance, and the second involved gain score comparisons. Analysis of covariance on the adjusted posttest means, for year one, indicated three statistically significant gains for CMI students (second grade reading; second grade mathematics; fourth grade mathematics), over non-CMI students, at one school, and two significant gains for CMI students (second grade mathematics; third grade reading), over non-CMI students at the second school. In addition, three out of six mean gains favored the CMI group at one school, and eight out of ten favored the CMI group at the other school. These results are displayed in Table 1 (New Jersey site) and Table 2 (Maryland site). The year one results were modest but encouraging in view of the implementation problems typically experienced by projects during start-up.

Further analysis of the differences between pretest and posttest means, for years two and three, using t tests for correlated samples, shows

Table 1

Analysis of Student Achievement on the Waterford Test of Basic Skills for CMI and Control Students--the New Jersey Site (1987-88)

Grade/ Subject	School	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain	Adj. Mean	F
2 Rdg	CMI	67	40.40	10.39	55.96	7.27	15.56	56.27	13.58 **
	Control	77	41.62	10.40	52.96	8.05	11.34	52.68	
2 Math	CMI	71	47.79	9.68	64.61	6.05	16.82	62.99	10.10 **
	Control	76	41.26	10.54	58.24	8.83	16.98	59.74	
3 Rdg	CMI	67	60.09	14.20	67.12	11.72	7.03	64.54	.37
	Control	72	50.96	15.99	63.17	13.28	12.21	65.56	
3 Math	CMI	64	49.58	10.55	60.50	7.97	10.92	58.93	.76
	Control	51	41.18	9.65	55.43	11.33	14.25	57.40	
4 Rdg	CMI	48	68.67	14.40	76.98	11.19	8.31	74.83	3.43
	Control	61	62.13	15.90	69.10	16.16	6.97	70.79	
4 Math	CMI	48	50.67	12.42	70.58	9.52	19.91	68.56	36.33 **
	Control	62	45.35	10.48	55.23	14.35	9.88	56.79	

* Statistically significant at .05 level.
** Statistically significant at .01 level.

Table 2

Analysis of Student Achievement on the Waterford Test of Basic Skills for CMI and Control Students--the Maryland Site (1987-88)

Grade/ Subject	School	N	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain	Adj. Mean	F
2 Rdg	CMI	31	32.97	12.02	56.16	8.92	23.19	56.80	.24
	Control	21	36.19	14.13	56.71	10.92	20.52		
2 Math	CMI	31	36.68	12.50	61.46	8.73	24.80	61.39	13.97 **
	Control	21	36.29	13.02	54.05	12.44	17.76	54.19	
3 Rdg	CMI	24	45.92	15.23	66.46	15.20	38.30	62.60	4.97 *
	Control	17	35.06	11.70	48.59	18.07	13.53	54.04	
3 Math	CMI	23	36.04	8.91	52.74	8.79	16.70	49.41	.83
	Control	17	24.94	10.04	41.59	14.82	16.65	46.09	
4 Rdg	CMI	20	51.60	17.40	59.55	18.33	7.95	56.28	.81
	Control	19	42.74	19.47	56.42	18.50	13.68	59.88	
4 Math	CMI	19	31.37	7.50	47.05	10.76	15.68	47.46	.00
	Control	20	32.30	10.18	47.80	15.03	15.50	47.42	
5 Rdg	CMI	17	58.76	19.17	67.24	18.93	8.48	64.23	.04
	Control	17	52.41	17.48	60.47	21.82	8.06	63.47	
5 Math	CMI	20	35.15	14.86	61.85	21.02	26.70	61.33	1.07
	Control	16	33.56	12.13	52.44	30.16	18.88	53.09	
6 Rdg	CMI	16	50.00	18.25	59.00	19.54	9.00	63.34	.06
	Control	18	59.72	23.71	66.17	23.59	6.45	62.30	
6 Math	CMI	15	42.60	14.03	62.33	22.07	19.73	66.39	.04
	Control	19	49.00	30.02	70.84	38.71	21.84	67.64	

* Statistically significant at .05 level.
** Statistically significant at .01 level.

statistically significant gains in WTBS scores, across all grades, sites, and subjects, for both the 1988-89 and 1989-90 school years. These results, presented in Tables 3 and 4, suggest a more convincing case for the effectiveness of the CMI program in motivating and educating participating children. Although pretest-posttest gains are obviously expected for a school year, the size of most gains exceeded expectation based on year one results. This is particularly impressive in light of higher pretest scores, which may be due, in part, to students taking the test on-line.

Also included in Tables 3 and 4, for comparison purposes, are the mean gains for the two control groups utilized in year one. These results show that all six gain score comparisons at the New Jersey site for 1988-89 and 1989-90 favored the experimental group. For the Maryland site, six out of eight gain score comparisons favored the experimental group, for 1988-89, and four out of eight favored this group for 1989-90. The results of district testing confirm these findings. Thus, it appears that once hardware and software problems are resolved, teachers become experienced with the software, and students develop the necessary typing and other skills, consistent and significant gains in student reading and mathematics performance can be realized.

An attitude survey was also administered to students participating at each of the CMI sites following years one and two of the program; it was not administered in year three as most students had been exposed to the survey and the increasing positive results were creating a ceiling effect. Due to the well-demonstrated link between attitude and achievement of students, positive attitudes toward CMI were believed to be of considerable importance as a complement to improved achievement results. It was also expected that the attitude survey would reveal if there were any gender differences in

Table 3

Analysis of Student Achievement on the Waterford Test of Basic Skills for New Jersey (NJ), Maryland (MD), and Pennsylvania (PA) CMI Sites in 1988-89

School Site	Grade/ Subject	Number	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain	(Comparison Mean Gain)[b]	t
NJ [a]	2 Reading	55	57.49	16.21	81.21	13.17	23.72	11.34	12.89 **
NJ	2 Math	56	58.76	13.53	83.96	7.82	25.20	16.98	17.04 **
NJ	3 Reading	64	64.60	15.08	80.68	10.96	16.08	12.21	12.11 **
NJ	3 Math	65	59.75	15.21	84.70	10.24	24.95	14.25	16.87 **
NJ	4 Reading	54	67.24	14.34	79.16	9.76	11.92	6.97	10.17 **
NJ	4 Math	57	58.01	12.82	78.12	13.57	20.11	9.88	13.94 **
MD	2 Reading	35	46.34	17.95	63.26	17.72	16.92	20.52	9.98 **
MD	2 Math	33	48.61	16.19	70.24	16.72	21.63	17.76	13.35 **
MD	3 Reading	34	55.18	18.15	75.47	17.77	20.29	13.53	10.70 **
MD	3 Math	32	54.13	16.76	80.72	13.57	26.59	16.65	12.80 **
MD	4 Reading	27	58.59	14.08	72.70	13.23	14.11	13.68	10.82 **
MD	4 Math	28	44.79	9.93	72.89	12.00	28.10	15.50	13.73 **
MD	5 Reading	21	53.90	17.50	62.57	18.84	8.67	8.06	2.22 *
MD	5 Math	20	42.05	16.83	57.40	13.30	15.35	18.88	5.03 **
PA	2 Reading	52	54.98	14.52	72.73	13.22	17.75		13.26 **
PA	2 Math	52	53.42	11.88	76.75	9.04	23.33		20.06 **
PA	3 Reading	44	59.15	15.48	72.56	14.00	13.41		9.32 **
PA	3 Math	43	53.11	14.04	75.93	11.09	22.82		16.16 **
PA	4 Reading [c]								
PA	4 Math [c]								
PA	5 Reading	38	66.05	13.36	76.52	12.83	10.47		9.11 **
PA	5 Math	40	49.77	13.15	69.27	19.56	19.50		9.44 **

* statistically significant at .05 level.

** statistically significant at .01 level.

a New Jersey CMI site does not have a fifth grade.

b Mean gain for children in the same grade level exposed to a control program during the first year of CMI operation (PA site not in operation year one).

c Data not received from district.

Table 4

Analysis of Student Achievement on the Waterford Test of Basic Skills for New Jersey (NJ), Maryland (MD), and Pennsylvania (PA) CMI Sites in 1989-90

School Site	Grade/ Subject	Number	Pretest Mean	Pretest SD	Posttest Mean	Posttest SD	Mean Gain	(Comparison Mean Gain)[b]	t
NJ [a]	2 Reading	60	58.43	15.72	80.63	11.23	22.20	11.34	13.22 **
NJ	2 Math	60	59.15	12.65	82.67	9.06	23.52	16.98	15.62 **
NJ	3 Reading	58	68.22	14.41	82.10	10.58	13.88	12.21	11.56 **
NJ	3 Math	69	65.07	14.40	88.43	7.93	23.36	14.25	15.39 **
NJ	4 Reading	60	65.42	16.00	75.37	13.36	9.95	6.97	7.78 **
NJ	4 Math	60	58.28	14.03	74.13	14.09	15.85	9.88	12.37 **
MD	2 Reading	49	52.63	17.11	72.69	14.32	20.06	20.52	14.63 **
MD	2 Math	50	51.30	14.21	76.82	12.23	25.52	17.76	18.71 **
MD	3 Reading	44	49.14	19.62	65.53	20.71	16.39	13.53	8.10 **
MD	3 Math	44	56.27	17.26	74.07	17.52	17.80	16.6[illegible]	11.13 **
MD	4 Reading	24	68.13	10.76	78.80	7.27	10.67	13.68	9.63 **
MD	4 Math	24	54.29	12.23	80.50	10.06	26.21	15.50	13.69 **
MD	5 Reading	25	63.92	15.05	71.36	14.91	7.44	8.06	4.90 **
MD	5 Math	25	49.84	11.69	67.84	12.39	18.00	18.88	10.46 **
PA	2 Reading	34	57.47	15.91	75.38	15.38	17.91		10.03 **
PA	2 Math	34	56.94	15.45	77.09	9.56	20.15		9.65 **
PA	3 Reading	47	61.34	17.08	78.60	11.36	17.26		12.19 **
PA	3 Math	48	57.00	12.99	82.71	10.30	25.71		18.44 **
PA	4 Reading	43	68.86	11.61	78.93	9.80	10.07		11.12 **
PA	4 Math	39	54.51	11.03	71.72	11.37	17.21		12.99 **
PA	5 Reading	35	68.03	14.41	76.57	12.63	8.54		7.60 **
PA	5 Math	34	48.71	13.01	67.95	14.61	19.24		11.99 **

* statistically significant at .05 level.

** statistically significant at .01 level.

a New Jersey CMI site does not have a fifth grade.

b Mean gain for children in the same grade level exposed to a control program during the first year of CMI operation (PA site not in operation year one).

student attitude towards CMI (racial and ethnic differences were also examined). Table 5 shows student attitude results by grade for two years of program operation, whereas Table 6 shows student attitude results by sex for the two years.

Attitude findings for students across all sites and grade levels for the two years of CMI program operation were quite similar. Students indicated that the computers were fun to work with and easy to use, made learning fun, and they felt that they learned a lot on the computer. When asked whether they had worked on a computer before this year, responses varied by grade level, year in the program, and by school. As an example, in 1987-88 at the New Jersey site, only half of the K-2 students reported that they had worked on a computer in school before, whereas less than half in grades 3-6 had in-school computer experience. That same year, at the Maryland site, less than half of the students in grades K-2 had worked with a computer in school before, whereas a majority (75 percent) of those in grades 3-6 had in-school computer experience. The following year, as a result of the program, these figures increased. For the newer Pennsylvania CMI site, prior computer use in school was appreciably higher, particularly for younger students. Interestingly, the majority of students in all grades and sites reported that they did not have a computer at home. Other analyses by sex and ethnic groups yielded similar findings. The results of teacher and administrator interviews and observations supported the positive student attitude and motivation, and indicated this impact did not dissipate over student time of exposure to the CMI system.

Interviews with school staff and on-site observations provided information on the impact of CMI on existing patterns of instructional delivery. Teachers initially did not integrate the CMI system into their

Table 5

CMI Student Attitude Results
(Percent Combined "Yes" and "Sometimes" Responses)

	Eastport				Palmyra				Wellsville	
	87-88 (N=194)		88-89 (N=201)		87-88 (N=203)		88-89 (N=190)		88-89 (N=214)	
Item	K-2	3-6	K-2	3-6	K-2	3-6	K-2	3-6	K-2	3-6
Do you like school?	89	90	89	90	78	91	79	88	78	92
Is the computer easy to use?	94	98	91	96	86	100	81	95	84	98
Is working on the computer fun?	96	100	95	97	96	98	97	97	94	97
Do computers make it fun to learn?	96	99	94	97	96	98	96	95	98	99
Do you learn a lot on the computer?	93	98	93	94	93	98	86	95	96	96
Have you worked on a computer in school before this year?	41	75	64	93	50	43	66	88	69	76
Do you have a computer at home?	40	48	40	48	45	38	47	38	43	42

Table 6

CMI Student Attitude Results by Sex
(Percent Combined "Yes" and "Sometimes" Responses)

Item	Eastport 87-88 (N=104) Boys	Eastport 87-88 (N=90) Girls	Eastport 88-89 (N=102) Boys	Eastport 88-89 (N=101) Girls	Palmyra 87-88 (N=99) Boys	Palmyra 87-88 (N=103) Girls	Palmyra 88-89 (N=98) Boys	Palmyra 88-89 (N=92) Girls	Wellsville 88-89 (N=101) Boys	Wellsville 88-89 (N=113) Girls
Do you like school?	89	90	88	91	82	93	82	89	84	88
Is the computer easy to use?	96	94	90	97	93	97	92	90	93	92
Is working on the computer fun?	98	98	95	97	97	97	97	96	95	96
Do computers make it fun to learn?	96	99	95	96	96	99	94	98	98	99
Do you learn a lot on the computer?	93	97	93	94	97	95	91	93	94	97
Have you worked on a computer in school before this year?	54	58	81	75	57	34	79	84	73	73
Do you have a computer at home?	46	40	41	46	41	40	37	45	47	37

classroom instruction. They believed the value of CMI was mainly as an extra tool for drill and practice. However, during the three-year period, these views began to change as staff began to understand and explore the system's vast potential and realized the system's impact on student achievement and motivation. In addition, most of the implementation problems, including those involving hardware and software, were resolved. Teachers reported being more comfortable using the CMI system and were beginning to experiment with customizing lessons and integrating CMI within their regular classroom instruction. This feeling of control was also reflected in teachers having some input into how the system was to be used (e.g., scheduling, planning meetings, reports, staff development, etc.).

During the 1989-90 interviews, staff in the three schools agreed that the CMI program had become an integral part of their school operations and school instructional program. After some experimentation by the principal with strategies for scheduling students in the lab, each school had incorporated CMI lab time into their daily routine (and adjusted times for younger and special students). Moreover, time spent on a particular WICAT curriculum accounted for time in that subject area. Teachers reported that the lab and the lab manager were providing effective supportive services, and, as reported earlier, they were beginning to value and explore the vast potential of the CMI system.

Conclusions

Recently, there has been much concern with the quality of education in small and rural schools due to their limited resources. Educational technology has been proposed as an instructional strategy for addressing many of the needs of rural schools. The results of this study support the use of one type of technology, a computer-managed instructional program, as a viable means for meeting the needs of at-risk and other students and helping them to succeed in school. In addition, these results also suggest the need to recognize, before adopting an innovation such as CMI, the difficulties associated with the start-up of such a project, and the need for staff involvement in the initial adoption process. The findings of this study, with respect to the three hypotheses stated earlier, can be summarized as follows:

Student Achievement

- Following the first year of implementation, reading and mathematics achievement gains on the WTBS, for CMI students as compared to non-CMI controls, were modest. However, this is what one would expect following the introduction of a new and complex innovation, such as CMI. Implementation problems must be addressed and resolved, teachers need experience with the software, and students need necessary typing and other skills before an impact can be expected to occurr.

- The achievement results for years two and three suggest a more convincing case for the effectiveness of the CMI program in motivating and educating participating children. WTBS gains for all grades and sites were statistically significant and, in most cases, exceeded those of the initial control groups (when used as a baseline). Staff reported their school's standardized test results to be consistent with these WTBS achievement gains.

Student Attitude

- Student attitudes toward their experience with computers, during their participation in the CMI project, were extremely positive and consistent over time. These positive attitudes were reflected in student surveys administered in years one and two. In interviews, the staff at each school also consistently reported positive student attitudes toward WICAT during the three-year period.

- Teacher attitudes toward CMI during the three-year period evolved from viewing the program as an "add-on" and resenting the loss of instructional time to viewing it as "here to stay" and adjusting to schedule changes. This was not surprising, particularly in light of the staffs' lack of involvement in the decision to initially adopt the program. In contrast, the strong administrator support for CMI at each site was constant during all phases of implementation and may, in part, account for the success of the project. This commitment was shared with the parents and school community, in addition to school staff.

Instructional Delivery

- As teacher attitudes toward the CMI system evolved, so did the system's impact on instructional delivery. During the start-up year, teachers resented the loss of class time when their students were scheduled for the CMI lab. They viewed the CMI system as a reinforcer or extra to follow-up classroom learning, if time permitted, and thus made little change in their classroom instruction. Also, they were not prepared for making changes in instructional delivery.

- During years two and three, teachers began to incorporate CMI into their instructional activities; they made changes in their planning, utilized CMI reports on student progress, and prescribed specific activities in which their students were to be working in the lab. It should be noted that Chapter 1 teachers at each site, unlike other instructional staff, readily saw the potential for the lab in working with their students.

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