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AUTHOR Alifrangis, Catherine
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ABSTRACT

This study examined a state-of-the-art computer-based integrated learning system to determine its conformance to research findings on effective learning practices; to describe its implementation in an elementary school setting; and to assess changes in students' achievement in either mathematics or reading. Pretest/posttest data were supplemented by observations, interviews, document reviews, and teacher and student questionnaires. Results of the achievement tests showed that students' test scores improved; however, treatment differences in reading were significant only in the white group for comprehension. Significant differences in the mathematics component were restricted to race and race by sex. Overall, this study supported research findings that indicate computer programs whose management is not an additional burden on the classroom teacher, match the local curricula, and address learning theory research can be implemented successfully. (23 references) (Author)

AN INTEGRATED LEARNING SYSTEM IN AN ELEMENTARY SCHOOL IMPLEMENTATION, ATTITUDES, AND RESULTS

Catherine Alifrangis
Fairfax County Public schools

ABSTRACT

This study examined a state-of-the-art computer-based integrated learning system to determine its conformance to research findings on effective learning practices, to describe its implementation in an elementary setting, and to assess changes in students' achievement in either mathematics or reading. Pretest/posttest data were supplemented by observations, interviews, document reviews, and teacher and student questionnaires. Results of the achievement tests showed that students' test scores improved; however, treatment differences in reading were significant only in the white group for comprehension. Significant differences in the mathematics component were restricted to race and race by sex. Overall, this study supported research findings that indicate computer programs whose management is not an additional burden on the classroom teacher, match the local curricula, and address learning theory research can be implemented successfully. (Keywords: computer-assisted instruction, integrated learning systems, achievement, evaluation)

One increasingly prevalent use of computers in education has been in the area of computer-assisted instruction (CAI). In an ideal mode, specially designed computer programs introduce the student to a concept or skill, provide interactive practice, and reinforce learning with appropriate feedback. As technology has improved, these CAI programs have become more sophisticated in terms of the speed, graphics, branching capabilities, and augmented sound and animation. Other improvements include the incorporation of principles of learning theory in the design of software and a correlation of activities to the developmental stages of children's cognition. Most recently, microcomputers or terminals have been networked to a high-speed central system or "host" which manages an interactive program of lessons, tests, and record-keeping. These "integrated learning systems" have addressed many of the earlier problems associated with CAI use and have incorporated much of what is considered sound learning theory into their design.

GOAL OF THE STUDY

Much work has been conducted on various aspects of learning theory and their relationship to achievement (Skinner, 1968; Piaget, 1966; Bigge, 1982; Thorndike, 1906). These basic tenets of learning theory, such as motivation, active participation, and use of feedback, are currently being related to the design and implementation of many computer-based instructional programs (Baker, 1978; Chandler, 1984, Dillon & Steinberg, 1986; Polson & Richardson, 1988). The premise of such work is that if computer-based instructional units are designed and implemented according to established theories of learning, increased achievement will result. This study was designed to investigate that premise by exploring those aspects of learning theory that, when incorporated into a computerized integrated learning system, can contribute to

a successful learning experience for a student. One such system was analyzed for its conformance to these practices. Achievement results of students using the system in either reading or mathematics were measured and compared to those of a control group.

PROGRAM DESCRIPTION

A Computer Assisted Instruction (CAI) system developed by Education Systems Corporation (now Jostens Learning Corporation) in San Diego, California, was pilot tested during 1987-88 at Denbar Elementary, a K, 4-6 grade school located in a large school system near a metropolitan area. The Education System Corporation (ESC) Integrated Learning System consists of mathematics and reading curricula for grades 1-6, a management system, and a testing system. The ESC Curricula parallel the scope and sequence of major textbooks, including those used in this particular school system, and provide continuous multi-sensory instruction through self-paced lessons enhanced with color, voice, music, friendly characters, and graphics. The system at Denbar is set up as a lab of 28 Tandy 1000 computer stations networked to a Tandy 3000 host. The curricula and management system are contained on one CD (compact disk) which is updated by ESC on a regular basis. One classroom at Denbar was set up as the ESC lab; an operator trained by ESC managed the system. Students were scheduled by class for three 20-minute sessions weekly from October to May. The teacher accompanied the students and was expected to monitor and assist students as necessary. When students entered the lab, they went directly to their assigned computer stations already loaded with the individualized, self-paced lessons. These lessons included tutorials, practice exercises, and periodic testing. As students completed each lesson, the next activity was accessed automatically. Use of the system was a complement to the regular curriculum program.

SIGNIFICANCE OF THE STUDY

Henry J. Becker of Johns Hopkins University discusses the need for more current, well-concucted research studies in a report in which he reviews both outdated and recent research and then urges researchers to address the studies' weaknesses as they design new projects (1988). "To be most helpful, studies need to describe in detail how computers (and control treatments) were implemented at each site, and to do so in some kind of standardized way..." (p. 23). Bozeman and House (1988) reiterate this need for descriptive research on the implementation of a program, saying that although we need be concerned about effectiveness, it is "essential to first know how, and the extent to which, the program was actually implemented" (p. 85). This need for "full-disclosure" is clarified by Nira Hativa (1988) when she stresses the need for descriptions of the major features of CAI systems including hardware, software, management systems, and method of daily operation to increase our knowledge of the interaction of such system characteristics with students. Gary Bitter (1986) also urges researchers to consider "software and its capabilities, application and their abilities to facilitate learning, and the many features of the microcomputer and their effect on children" (p. 33).

This study is significant for three reasons. First, it is based on the use of an integrated learning system, a concept recognized as the direction many school systems are moving in using computers for instruction. Second, although the study was conducted in a school environment, its design encorporates conditions that meet many of the criteria for effective and worthwhile CAI research (e.g., random assignment of students to classes and classes to treatment; a year-long study to reduce the novelty effect; standardized measuring instruments; and the elimination of the novelty effect

with a design in which both groups used the computer). Third, rather than addressing a single component of CAI design or one factor in achievement, the study focuses on the overall use of a CAI system within a particular context.

METHODS AND PROCEDURES

Sample and Population Description

Denbar Elementary is a kindergarten, 4th-6th grade elementary school located on an army base and operated by the local school system. The school has a population of approximately 460, of which 37% are minority. Prior to the 1987-88 school year, students had used Atari computers in the classroom for Logo, word processing, and independent CAI programs.

Research Design

This study employed a pretest/posttest control group design. Fourth through sixth grade students at Denbar were grouped through a stratified random assignment procedure used to ensure an equal distribution by sex, minority, and ability levels. In addition to the random student assignments, two of the classes at each grade level were randomly selected to use the reading curriculum and the two others to use the mathematics curriculum. Because of the above procedure, the two classes using the mathematics curriculum were the control group for the reading curriculum and vice versa.

Data Collection

Data were collected through various means. Fieldnotes were taken by the researcher at each of her monthly visits and the software was reviewed formally and informally. ESC documentation, including the correlation of objectives to the school's program, lab forms on special requests and problems encountered, and student histories were reviewed. All teachers were interviewed, and both teachers and students completed Likert scale

questionnaires. Test data from both the BSI (a computerized adaptive test developed by ESC) and from McGraw Hill's Comprehensive Test of Basic Skills (CTBS) were analyzed pre and post.

RESULTS

Document Review: Of the 205 mathematics objectives itemized by the school system framework, ESC matched 182 or 89%. Ninety percent were presented at the numerical level associated with the grade This high match meant that teachers were able to view the lab as a supplement rather than addition to what they were responsible for teaching in the classroom.

The review of the lab documents showed that although teachers increasingly began integrating lab use with classroom instruction as they became more familiar with the system and the software, effective use was not maximized. In addition, the system itself did not perform as the teachers expected in terms of its promise of individualized instruction. The review of student histories showed that students went through identical lesson patterns but at different times; little branching to remedial lessons was evident.

Software Review: The ESC software meets many criteria of good design both in curriculum presentation and programming style; however, improvement in some areas, especially in the counting of second and third tries as correct responses, is needed.

Observations: The ESC system is reliable and easy to use. Students like going to the lab and use their scheduled time effectively. Not all teachers, however, used their time in the lab optimally. Many looked at the lab as an opportunity to do other tasks.

Teacher Interview and Questionnaire: Although teachers were very positive about their experiences with the ESC lab, the common frustration of

an overloaded school day was given as a drawback to having the lab. Few indications were given that teachers had moved beyond the mechanical use of the lab as a separate activity to integrating its use with the rest of the school day. Both of these factors would inhibit effective use.
Responses to questionnaire items were varied, indicative of the range in use by the teachers. None of the teachers had tried more than half of the programs themselves. Logically, it would be difficult to plan for integration or assist students if one had little familiarity with the programs. All teachers did, however, feel that ESC was a good supplement to their classroom instruction and a positive experience for their students. Most did not want the lab removed.

Student Questionnaire: Students recognized that they could skip reading screens or guess and the computer would still give them positive messages. Students expressed frustrations when they had to repeat programs (a result of being cut off in the middle of a program because of a time factor rather than because of poor performance). In spite of these reactions, students were very positive about their experiences and felt working in the lab helped them learn.

BSI Test: Although most students showed growth from October to May based on the ESC level placement, results of the comparison of the students' working levels at the final testing compared to the testing level were problematic. Students were working anywhere from lower than to three or more levels higher than their final BSI level score. Such results raise serious questions about the use of the BSI as an accurate measure of a student's ability.

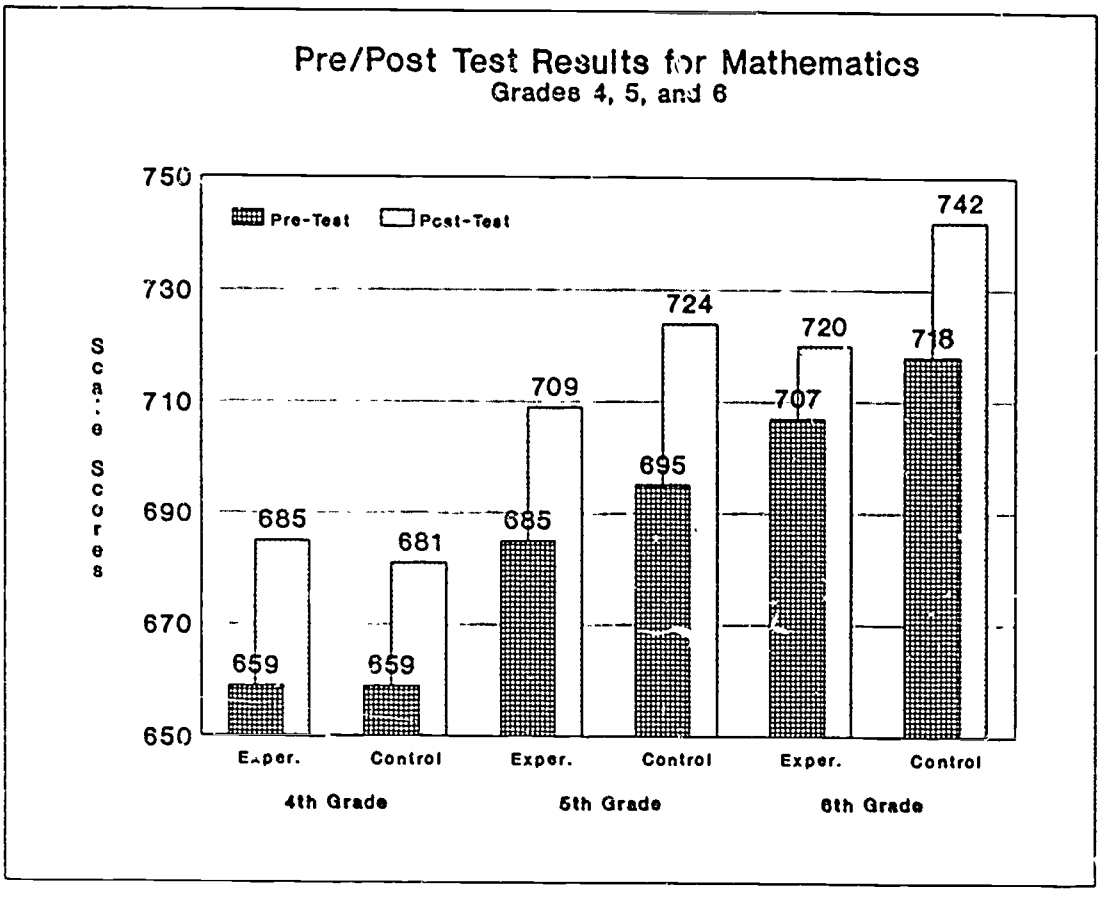
CTBS: Although preliminary comparisons of pre- and post-test results

showed that all but one group showed greater gains than expected (from 4 to 20 scale score points), there were no significant differences by treatment. A significant difference was found in mathematics for race, with whites performing better than minorities in all categories. Analyses of the reading component of the CTBS show mixed results. Students, especially those in the lowest quartile, made overall improvement. Results, however, were not significant between the treatment groups except for whites in reading comprehension.

Analyses of these test results were conducted using scaled scores as the basic unit since they allow for comparisons across grade levels. Figures 1 and 2 depict the pre/post-test results for each treatment.

[INSERT FIGURES 1 AND 2 HERE]

Table 1 shows the difference between actual scaled score gains and expected gains based on the pre-test. The expected gains were calculated by using the pre-test standard scale score to determine percentile rank based on fall norms. Based on the equipercentile assumption, students are expected to remain in the same relative ranking from fall to spring; and, thus, this percentile was used to determine the "expected" standard scale score from the spring norm tables (U.S. Department of Health, Education, and Welfare, 1975).


Pre/Post Test Results for Mathematics
Grades 4, 5, and 6
Pre-Test
Post-Test
Scale Scores
750
730
710
690
670
650
685
681
709
724
720
742
659
659
685
695
707
718
Exper.
Control
Exper.
Control
Exper.
Control
4th Grade
5th Grade
6th Grade

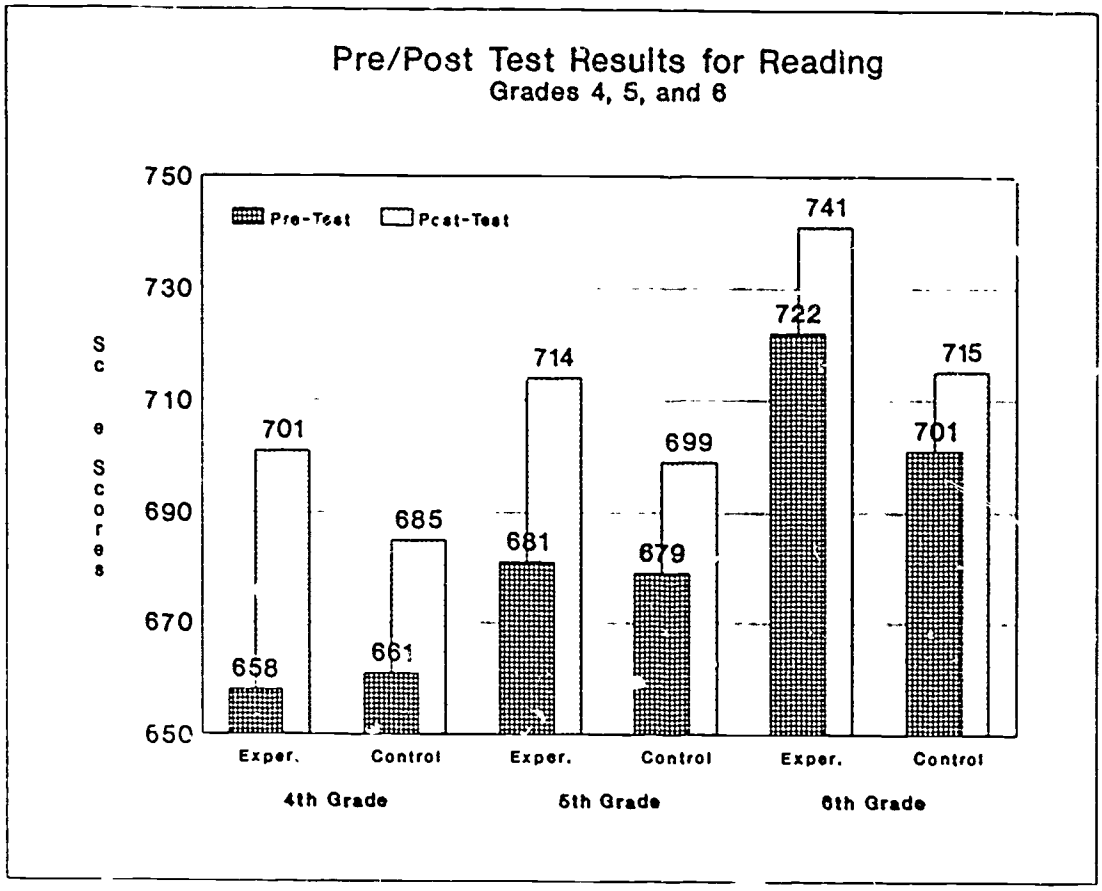

Pre/Post Test Results for Reading
Grades 4, 5, and 6
Pre-Test
Post-Test
Scores
750
730
710
690
670
650
658
701
661
685
681
714
679
699
722
741
701
715
Exper.
Control
Exper.
Control
Exper.
Control
4th Grade
5th Grade
6th Grade

Table 1

Comparison of Difference Between Expected and Actual Post-Test Scaled Scores for Mathematics and Reading Tests by Grade Level and Treatment

Grade/Treatment	Mathematics	Reading
4 Mathematics	+8	-14
4 Reading	+6	+6
5 Mathematics	+15	+11
5 Reading	+10	+15
6 Mathematics	+6	+14
6 Reading	+7	+11

According to these results, all groups except the fourth grade group which had the mathematics treatment scored higher than expected on both subtests of the CTBS based on their pre-test scores. The fourth grade mathematics group scored lower than expected on the reading subtest. There were no significant differences between control and experimental groups, except for fourth grade reading.

DISCUSSION OF RESULTS

WHAT IS THE MATCH BETWEEN THE FOLLOWING CHARACTERISTICS OF THE ESC EDUCATIONAL SYSTEM AND CURRENT LEARNING THEORY?

Sound Curriculum: The ESC curricula were designed according to the most current educational thinking. The mathematics curriculum is based on the recommendations of the National Council of Teachers of Mathematics (1980) and the reading curriculum on the recommendations of the National Assessment of Educational Progress (1985). By addressing the recommendations of these two groups as the curricula were developed, ESC laid the foundation for a sound, meaningful program. The developers of the lessons were established

professionals in the field who organized the units into the discrete, hierarchical objectives promoted as basic to sound curriculum development.

As reported by the National Center for Educational Computing (July, 1988), "software can enhance the educational process most if it is being synchronized with curriculum that is being used in the school district." Because of the high match with this particular school system's objectives (89%), and, more importantly, because teachers recognized the match and were, thus, more inclined to view the lab as beneficial, the effect on learning was likely positive.

Motivation: Students like ESC and the experiences they have had with the system. They find it fun yet educational, challenging but not frustrating. They wish they could go to the lab more often and stay longer, and they definitely want the lab to remain at Denbar. Teachers' observations and comments confirmed the students' feelings, and they named motivation as one of the benefits of using the system. This increased motivation may be the result of the organization and presentation of the ESC lessons, may be caused by the use of the computers themselves, or may be because the rest of the school day is excessively routine and unstimulating. Although the source may be unattributable, the increase in motivation was present and most likely had a direct or an indirect effect on the students and their achievement by increasing their interest, concentration, and opportunities for learning.

Active Learning: Observations in the lab showed that students were actively engaged in interacting with the computer programs. This engagement, however, may have been superficial since students admitted to not always reading the screens, not using the review feature, and often just guessing so they could go on. Although the ESC system does provide some aspects of

learner control (the review feature, speed changes, and opportunities to choose whether or not to repeat an activity), the students need to be taught how to use these features effectively and then monitored as to this use. Such instruction and followup monitoring would provide the instructional support necessary to guide students to "mindful" control of their own learning (Shavelson & Salomon, 1985; Kinzie, 1988).

Multi-media Approach: Another very positive factor in providing students with increased learning opportunities is the variety of activities and presentations through which the ESC objectives are presented. Animation, voice, graphics, and other features of ESC are appealing to the students and help them focus on learning. Teachers generally felt these features contributed to increased learning and named them as a benefit of the system. Students generally liked the special features on the ESC system. Although the multi-media approach seems beneficial because the variety should reduce rote learning and, thus, boredom, this factor could have posed difficulty for those students who cannot move easily among multiple methodologies. Some students could have focused more on what they were "doing," rather than what they were "learning."

Individualized Instruction/Management: Student histories indicate that the ESC programs contain little branching and individualization in terms of a program adapted to the needs of the student. Almost all students go through an identical sequence no matter what their response patterns. In addition, teachers made few changes in the programs of their students. The ESC programs do not have sufficient branching to provide the individualization needed to meet all a student's needs. Although the sequence of instruction is similar for all students, at least it is adapted to the level and pacing needs of each

student. In addition, because the computer controls most assignments, the constraints on teachers of time and organizational management are eliminated, liabilities often mentioned as a hindrance to effective use of computers (Cosden et al., 1987; Semmel, 1987).

Feedback: The review of the ESC software programs showed that a variety of feedback procedures were employed: simple yes/no, yes with a reinforcement of why correct or some additional information, no with an indication of the error, and a no with a branching to a mini-lesson. Students generally felt that the computer gave them helpful explanations when they were wrong. In most instances this feedback appeared to be presented in a manner that would be effective. However, students often were given a false sense of their success because of the way correct responses were scored. Students agreed that the computer often said "Good Job" when not deserved, and teachers mentioned this factor as a limitation to the system. This problem of "inflated reporting" occurs because students are able to guess, often without a noticeable penalty.

Time on Task: Whenever, this researcher was in the lab, she saw students enter the lab quickly and almost immediately become engrossed in what they were doing. Thus, the engagement criterium in Fisher's definition of Academic Learning Time (Fisher et al., 1980) is met. However, the second part of the definition requires that the student be engaged at a level that will yield a high success rate. The results of the BSI analyses showed that many students may not have been working at their instructional level. This, coupled with the problems described in the section on feedback, indicates that the records of individual students should be further analyzed to determine the effect of "misplacement" on testing results.

HOW WAS THE ESC SYSTEM IMPLEMENTED IN THIS PARTICULAR ELEMENTARY SETTING?

Overall the ESC system and the Tandy network of computers were reliable. Downtime was minimal. When the lab operator did experience some difficulty with several of the ESC programs, she was able to get immediate assistance through the telephone in the lab. Besides the reliability of the equipment, another reason few problems existed is students are kept so busy in the lab that they do not have the time nor the inclination to "fool around" with the equipment. Such behavior is also hampered by the dedicated presence of the lab operator and teacher.

Generally, teachers were positive about both the training and ongoing support provided by ESC and their school system. Structured time to look at and discuss the programs and how to interpret and use the information on the various reports is needed, however, if teachers are to maximize the effectiveness of the system. Teachers rarely sat down and went through the various programs themselves. Without this background information, they cannot easily integrate the ESC lessons with those in the classrooms; they cannot anticipate difficulties students might have and, thus, better prepare the students for those particular programs; and they cannot offer productive ongoing assistance. In spite of good intentions, teachers did not find the time to sit down and preview all the programs.

Most of the teachers did not feel going to the lab was disruptive to their instructional program. Although mention was made about fragmentation, ESC was looked upon as a "worthwhile intrusion." Teachers seemed willing to work out their concerns rather than suggesting that the program is too intrusive. Since teachers are the prime implementors of any educational

innovation (McLaughlin, Berman, and Marsh, 1978), such reactions to computer use can be viewed as positive.

The teachers admitted to few changes in their classroom instructional program because of the use of ESC. Part of this may be lack of experience with the system and its programs. Another reason may be that they were unsure of what kind of changes and how many they were allowed to make because of the research project. A third reason might be that, as with the introduction of any new program, participants have certain stages they must go through before full integration is possible (Loucks & Hall, 1979). In the interviews, however, there were indications that teachers were thinking of ways to use ESC more effectively next year.

Several teachers commented in the interviews that their students look at the lab as a separate activity. This may be a direct reflection of the minimal coordination that the teacher does between classroom and the lab or the lack of interest many teachers demonstrated by their behavior in the lab. As pointed out (Cosden et al., 1985), teachers need to maintain an active presence since they, not the software, make the distinction between students who are working and those who are not. Students need to see the use of the lab as an integral part of their classroom learning. Students need to be monitored as they are using the lab to minimize guessing, to demonstrate teacher interest, and to enable teachers to give ready assistance. In addition, teachers need to discuss the programs and the reports with the students, thereby giving them essential feedback on their performance.

WHAT IS THE EFFECT ON THE ACHIEVEMENT OF STUDENTS USING THE SYSTEM FOR MATHEMATICS OR READING INSTRUCTION?

BSI

Concern was expressed by the teachers that the BSI is not a reliable placement test. If the BSI does not yield an appropriate placement for the students, educational opportunities are not maximized. If students are placed too low, they run the risk of being bored and becoming careless in their responses. This is in addition to not being able to increase their learning. If students are placed too high, they may have skipped skills or concepts basic to their current lessons and may become frustrated. In either case, students are not working at their instructional level and cannot make expected progress.

CTBS

Two analyses of the results of the CTBS showed promise. First, all but one group did better than expected on the post-test, regardless of treatment. Reasons for a lack of difference are discussed later; however, the improvement demonstrated by most groups is worth noting. The one group that did not perform as expected was the fourth grade group who had the mathematics treatment. That group scored fourteen points lower than expected in reading, while the reading experimental group scored six points higher than expected. No reason for such a discrepancy could be determined; however, it can be hypothesized that the difference is the result of the ESC reading curriculum.

Second, the results of the quartile distribution analyses conducted on the scores of only the students who had each treatment showed promise for particular groups of students. Students in the bottom quartiles in both treatment groups, but especially for reading, made substantial gains from pre- to post-tests (greater than might be expected, including the effects of regression to the mean). Often teachers do not work with students at their instructional level, especially if they are far below grade level. The fact

that students were able to work at their own level in the lab (up to four levels below their grade level) may have contributed to these changes.

Several factors related to the design of the ESC programs could have contributed to few statistically significant results. These include the BSI, the feedback structure, and ESC's reliance on teacher management.

As explained in the previous section, the BSI may not provide an accurate measure of students' abilities. If students are misplaced in the sequence of programs, progress may be hindered. The test results of the experimental group would reflect this misplacement. Even if placed at the correct level, students may not make maximum progress because, based on the way the system is structured. they automatically are assigned all units. Instructional time is lost as students complete a unit containing objectives already mastered.

In addition, as students are working through the various programs, they may be given a false sense of their achievement when they are "rewarded" for guessing, and may, thus, be less motivated. This problem of lack of appropriate feedback is compounded if teachers do not monitor students' results and recycle the students through programs or units in which they did poorly. If skills or concepts that were to be mastered in those units are needed for subsequent units, the problem increases.

Finally, a number of students scored at the highest level on the initial BSI. These students, therefore, were cycled through lessons that, rather than being instructional, may have only provided practice for skills and concepts already known. Thus these students' post-test scores could not be expected to be markedly different from their pre-scores.

Implementation factors that could have contributed to the achievement

results are: the one year time span, the differences among teachers both in the way they integrated lab learnings with classroom work and in their classroom teaching, and the lack of monitoring of the students by some teachers and of some teachers by the administration. These factors are discussed below.

This was the first year of the program. Students were expected to learn both the system and the content during this period. Although these students had worked with computers before, this was their first experience with a system that required input through the mouse, as well as through various types of keyboarding responses. In addition, since the lessons were written by different programmers, types of responses varied. Content, in many cases, was new to the students, especially in the higher ordered thinking skills. Students were entering a K-6 program at a high level without the benefit of the skill-building that should have occurred through the earlier levels.

Teachers' inexperience could have had an impact also. It was not until mid-year that it was determined that the computer system was not designed to make decisions regarding students' programs, i.e., to not move them forward if they had difficulty with a particular unit. Since teachers were not familiar with all the programs, they were unable to anticipate problems and prepare their students for these difficulties or to effectively integrate ESC with their classroom teaching.

The second area under implementation relates to individual differences among teachers. Teachers are individuals whose teaching reflects their individuality. Some may have enjoyed going to the lab more than others or may have taken the responsibility of the lab more seriously. Thus, special efforts could have been expended in the subject areas of their lab assignment.

Differences also can be found in classroom teaching. Teachers may have put more effort into the control group subject area because they felt they needed to compensate for what they perceived as the extra attention given to the lab subject area. In either case, the results of the study may have been compromised.

The third area under implementation that could have affected the results is the lack of or inconsistent monitoring. As an innovation is being tried it is important that the technique or program be used as intended by the company and that such use not alter over the course of the study (Marshall, 1989). As is obvious from the discussion so far, the ESC program was not implemented according to all company specifications. These discrepancies occurred through misunderstandings, as well as the inevitable drifting of time and attention that can occur over time if implementation is not monitored periodically. Thus, some teachers were not reading and acting on the various reports, were not following prescribed procedures in the lab, and were not encouraged to maximize the integration between the lab and the classroom.

The third explanation for few statistically significant results is the inter-relatedness of the content of the two curricula. Although all classes (with the exception of the one fifth grade class) used either the reading or mathematics curriculum, both emphasize thinking skills and develop good test taking skills by stressing careful reading and attention to detail. In addition, reading skills are promoted through the mathematics curriculum, and several of the reading units contain mathematics concepts. Thus, it is possible that the learning that occurred as a result of the one curriculum the students were placed in transferred into the test results of the other curriculum.

Although precise reasons cannot be given for a lack of statistically significant differences between the results of the control and experimental groups, the above descriptions of interfering factors offer a viable explanation. Some can be controlled; others may be inevitable in a real-world setting. Because of this, practical significance or other issues may be more important and useful measures of the success of the program.

SIGNIFICANCE OF RESULTS

1. Because this study provides a more realistic assessment of the effects of ESC on the practices at this site and the effect of the system on the students and teachers, decision-makers interested in research on such a system can read this study assured that the results may more readily transfer to their own systems.

2. ESC incorporates in its design and implementation many concepts or ideas that learning theory says are important in education. ESC provides a structure through which individualized instruction is possible. As classes get more diverse, learning systems such as ESC will enable teachers to more easily meet the needs of these students. Students can be kept attentive and on task while the teacher works on a more personal basis with other students. They will do so because the programs are attractive, attention-focusing, and motivating.

3. Because ESC correlates their objectives with those of the school system, teachers are able to see the relationship between their classroom responsibilities and the work in the lab. Teachers should be more inclined to integrate lab work with their classroom instruction.

4. ESC is a relatively easy program to implement. Training is provided by the company. An aide manages the lab. Because all the programs are on CD

ROM and the system is networked, time is not wasted booting up individual programs on diskettes. A management program allows the aide to program an entire day so transitions between classes are almost transparent. Special teacher requests can be met easily. By removing all "housekeeping" and management responsibilities from the teacher, ESC increases the probability of acceptance of the lab by the teacher.

5. Although the comparison of the test results of the control and experimental groups did not yield statistically significant results, two other analyses may be of practical significance. First, all but one group did better than expected on the post-test, by as many as 20 standard scale points; second, students in the bottom quarter grouping had an average gain of over 100 standard scale points (approximatly two standard deviations) from the pre- to post-test. These two factors may be more important than the tests of significance, given the numerous extraneous variables which could have affected the results.

CONCLUSION

Integrated learning systems with both CAI and CMI components offer the educational advantage of sequential, basic skills curricula complemented by a method for monitoring individual students. The success of these integrated learning systems depends on the quality of each component. The evaluation of ESC focused on the curricular scope and sequence and its relation to the program in Denbar, how the management system was used by the teachers to assess student weaknesses and plan appropriate followup, general student and teacher reaction to using the system, and educational outcomes.

Overall, ESC measured up to the expectations in each of these areas. The curricula closely matched those the teachers were using; teachers and

students responded very favorably to the program; test scores indicated that students were learning; and, although the reports generated by the management system were not used as expected, they did contain the necessary information to make appropriate instructional decisions. In addition, the developers of ESC have responded very favorably to feedback from the school and are making needed adjustments to the system. The use of the ESC learning system has been a positive experience at Denbar, but its potential has not yet been fully realized. As teachers become more familiar with the system, they should be able to integrate its use with their classroom teaching more effectively; and as students begin to build on the skills being developed, their achievement scores should continue to improve. The program should remain at Denbar, but its implementation needs to be monitored to ensure that effective use continues to be maximized. In the meantime, results of this study are sufficiently positive to encourage other school systems to implement ESC and undertake and report on their own studies of its effectiveness, thereby increasing the body of research in the use of integrated learning systems in a school environment.

Contributor

Catherine Alifrangis is a special projects teacher in the Office of Research and Evaluation for Fairfax County Public Schools, Virginia. She received a Doctor of Arts in Education from George Mason University, Fairfax, Virginia. In addition to other research duties, Dr. Alifrangis is responsible for all technology evaluations in the school system. (Address: Fairfax County Public Schools, Walnut Hill Center--Office of Research and Evaluation, 7423 Camp Alger Ave., Falls Church, VA 22042)

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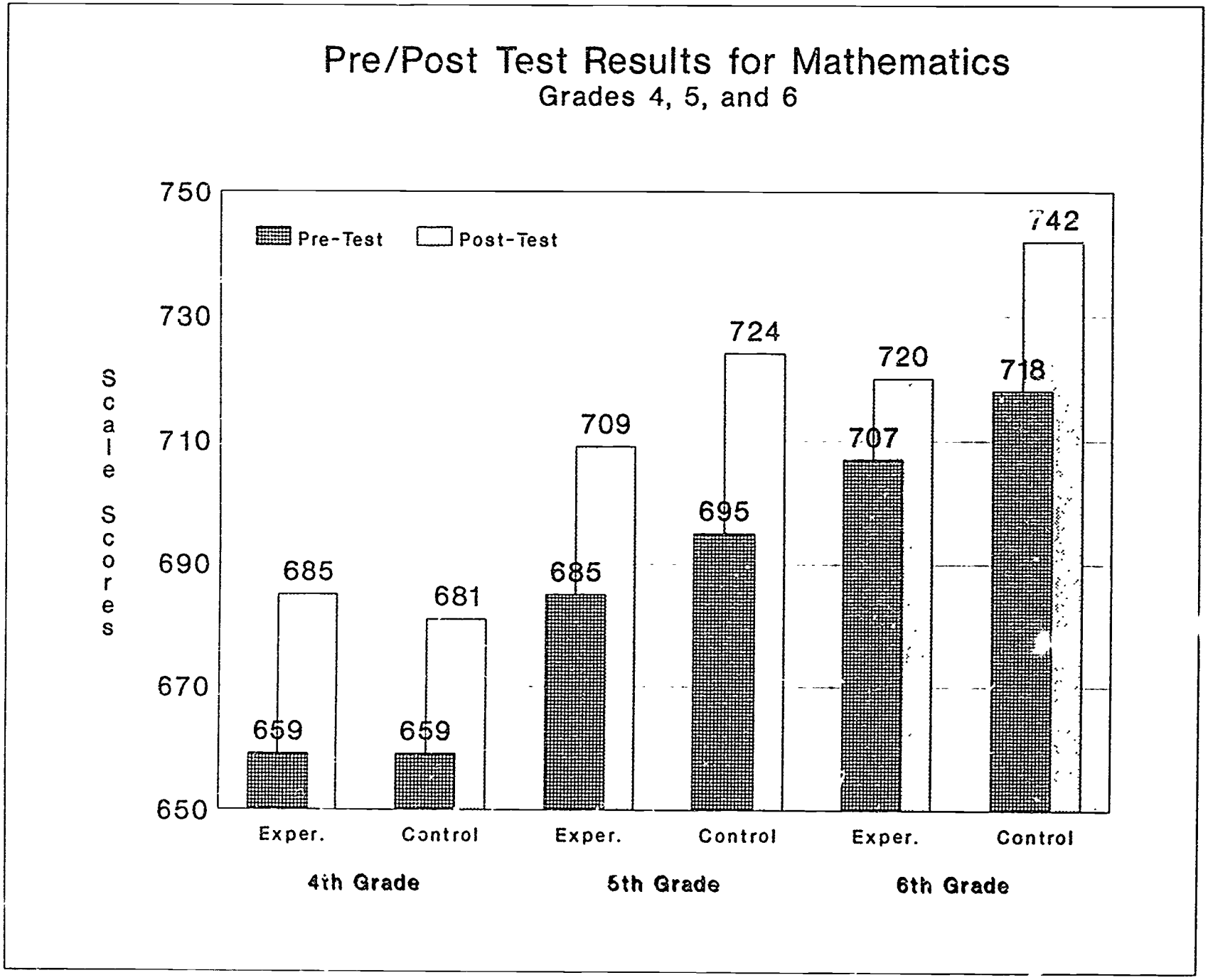
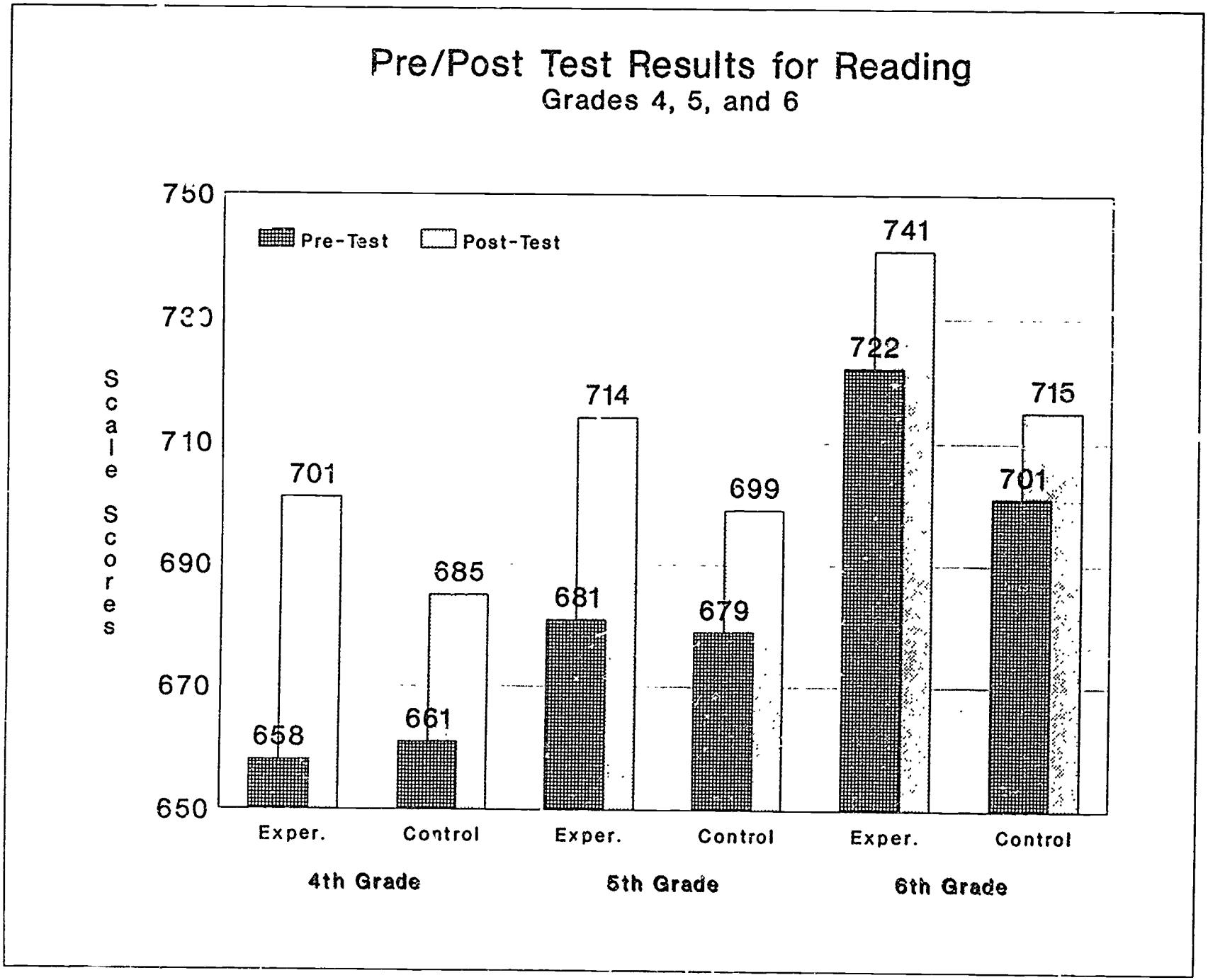

Pre/Post Test Results for Mathematics
Grades 4, 5, and 6
Pre-Test
Post-Test
Scale Scores
750
730
710
690
670
650
685
681
709
724
720
742
659
659
685
695
707
718
Exper.
Control
Exper.
Control
Exper.
Control
4th Grade
5th Grade
6th Grade


Pre/Post Test Results for Reading
Grades 4, 5, and 6
Pre-Test
Post-Test
Scale Scores
750
730
710
690
670
650
701
685
714
699
741
715
658
661
681
679
722
701
Exper.
Control
Exper.
Control
Exper.
Control
4th Grade
5th Grade
6th Grade

END

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