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ABSTRACT

Each year at the Greater Lawrence Technical School (Massachusetts), students are identified who lack the necessary basic skills to successfully complete a typical high school program. This problem led to the development of an alternative instructional program designed to accomplish remediation in the basic skills using computer-based instruction. The Greater Lawrence program is designed to promote and foster individual, independent growth and skill accomplishment for secondary students in the skills of mathematics and reading. The purpose of this study was to evaluate and review the appropriateness of the reading and math program in terms of its impact on the reading or math scores for those students assigned to the developmental skills lab. The study was conducted to determine the extent to which the degree of use of the computer-based instructional program affected groups of students on standardized achievement measures. Progress for each student was calculated on a pre-post test gain basis. The mean normal curve equivalent gains on reading comprehension and mathematics from pretest to posttest was statistically significant. This alternative supplementary approach to provide reading and mathematics instruction at the secondary level demonstrates improvement in relevant test scores on standardized achievement tests. Particularly positive were the mathematics achievement gains. This report provides the results of the program's evaluation. (Contains over 50 references.) (Author/MDH)

EVALUATION OF READING AND MATH PROGRAMS

Evaluation Study of the Curriculum System

GREATER LAWRENCE TECHNICAL SCHOOL

OCTOBER 1988

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ABSTRACT

Each year at the Greater Lawrence Technical School, students are identified who lack the necessary basic skills to successfully complete a typical high school program of studies. Such students consistently fail to meet agreed upon standards as measured by state mandated basic skills examinations or other standardized tests of achievement in their school subjects. This persistent problem led to the development of an alternative instructional program designed to accomplish remediation in the basic skills using computer-based instruction. This approach to basic skills remediation uses the power of computer technology to provide instruction, tutorial help, and drill and practice on the basic skills in math and reading. The Greater Lawrence program provides an intensive approach with one-to-one attention in developing each student's program of learning. Other common features include consistent reinforcement and feedback about performance for both the teacher and the student.

The Greater Lawrence program is designed to promote and foster individual, independent growth and skill accomplishment for secondary students. The school's efforts are aimed at enhancing student achievement in the skills of reading and mathematics. This evaluation and review examined the reading and math program at the Greater Lawrence Technical School. The purpose of the study was to assess the appropriateness of the program in terms of its impact on the reading or math scores for those students assigned to the developmental skills lab. The study was conducted to determine the extent to which the degree of use of the computer-based instructional program affected groups of students on standardized achievement measures.

The IDEAL curriculum and computer system is a computer-based instructional system used to reinforce skills in reading and mathematics. The evaluation reported here provides information regarding its effectiveness at the secondary level. The general design of the evaluation was to compare students on achievement gains using school year 1987-88 standardized test results. Study participants included Chapter I teachers and other faculty and students in grades 9 and 10. To measure academic progress students took standardized pre- and posttests in reading or mathematics. The Stanford-TASK is a standardized achievement instrument that is used for this purpose covering objectives for both reading (TASK-R) and mathematics (TASK-M). This report reviews the instructional impact of the program and procedures for data analysis are described along with results.

The present study made use of achievement scores from the 1987-1988 school year and traced the progress of secondary students of two groups receiving either remedial mathematics or reading instruction. The school employs a four level tracking system to group students of different ability levels. Generally, students in track four (lowest ability) are assigned by class to the computer instruction lab based on test scores on the Differential Aptitude Test (DAT); many are also assigned to Chapter I remedial instruction programs for developmental reading and math.

Progress for each student was calculated on a pre-post test gain basis. The mean normal curve equivalent (NCE) gain on reading comprehension from pretest to posttest was statistically significant. The mathematics gain from pretest to posttest was also statistically significant. These gains exceeded expectation by more than a quarter of a standard deviation unit and, therefore, may also be considered as "educationally significant." Results showed significant gains for students in math and reading.

This alternative supplementary approach to provide reading and mathematics instruction at the secondary level demonstrates improvement in relevant test scores on standardized achievement tests. Particularly positive were the mathematics achievement gains. This report provides the results of the program's evaluation (over three-quarters of a standard deviation unit).

Computer-based instruction involves the student interacting with a computer along with teacher supervised instruction for reading or mathematics. The teachers reported favorably on the use of the computer as a motivating learning tool. The computer also provides an instructional management system that links the diagnostic items and teaching modules for use by the high school mathematics and reading laboratory so that each student is working with appropriate lessons. Teachers presented a diagnostic math test at the beginning of the year to ascertain entry levels for each student in the mathematics curriculum. Two emerging forces can help to provide a sound basis for the introduction of these teaching tools into the secondary curriculum: (a) inexpensive, cost-efficient processing power to provide the necessary instructional information for decision making; and, (b) growing understanding of the cognitive tasks required in the curriculum. This program at the secondary level has further provided evidence to encourage course development and demonstration. The computer-based instructional component assists teachers in reexamining the basic skills curriculum in light of changes brought about by the introduction of these new tools. This system contains instructional components of areas that educators traditionally consider important to the learning process.

EXECUTIVE SUMMARY

EVALUATION OF READING and MATH PROGRAMS

Evaluation Study of the Curriculum System

The Greater Lawrence Technical School addressed student basic skills attainment in the computer-based instructional lab. The school began installation and implementation of this program at the beginning of the 1987-1988 school year. This study reviews achievement of student skills through the implementation of a standardized testing program evaluating the basic skills remediation program with use of the accompanying management information system within the microcomputer network. The Merrimack Education Center conducted this comprehensive evaluation of the IDEAL Learning program in the setting of this secondary school. Adequate provisions were made to identify conditions of the study to put primary focus on student achievement variables.

Evaluation Questions. The following were the main evaluation questions in this study:

1. What affect does the formal instructional program IDEAL have on achievement scores of students at the end of one year of the program? for reading? for mathematics?

2. To what extent does the intervention provide skill remediation for low achieving students who would typically be identifed for basic skills remediation by the state test of basic skills?

3. Is supplementary instruction (with reinforcement drill and practice) related to the level of gains for classroom/ computer-aided instruction?

In answering these major questions, the purposes of this report and the program described here are to:

(a) understand what the data show about the performance of students in the reading and math areas;

(b) understand the program design and how computer-based instruction helps the achievement of students;

(c) make inferences regarding what interventions are best undertaken with computer-based instruction that would yield the greatest benefit for some investment of resources.

Because these microcomputer systems are relatively new, there yet exists little documented evidence of their effectiveness. School systems must make decisions on the basis of developer's claims rather than research or proven practice. These new basic skill programs, with goals and objectives in the major curriculum areas, must be carefully evaluated; and, these new curriculum strands must also be viewed in the larger context of the secondary school where their impact can be reviewed in relation to other approaches that have been used traditionally for these same purposes.

Therefore, the evaluators conducted the study to determine whether the instruction for reading and mathematics provided to track 4 students (lowest ability level) in the school results in a detectable effect on student academic growth. As part of a regular assessment program conducted by the Greater Lawrence Technical School, test scores were analyzed and were duly reported by the teachers to mark student progress. The students are compared to similar groups of students who took the test as reported by the publisher in the norms booklet (a norm-referenced model). Criterion-referenced test scores were gathered and recorded by the teachers using the a teacher made test of mathematics to determine a functional level for each student when entering the computer-based curriculum. Functional levels were also determined for reading when students were entered into the IDEAL's curriculum on the microcomputer for their instructional lessons.

In this study, a set of class test scores was examined from the school district's records and reviewed as they relate to the reading and mathematics program. Data reported in this evaluation study are from the developmental program featuring reading and mathematics at the secondary level. The district compiled test scores for several subtests during the fall of 1987 that were used in the evaluation along with the posttests in spring of 1988. These data, compiled by the teachers and entered into the management information system in the lab, were used to perform computer analyses.

Basically, the testing data are of two types: the percentile scores showing mastery for the reading or the math test is the first type of data collected. Using the school's testing schedule, entry level data were compiled for each student in the program. The sampling of students used in this study for reading was small covering a portion of the student body at grade 9 who were assigned in track 4 over a school year but who were not assigned to Chapter I remedial instruction. The data set for mathematics was larger covering grades 9-10. Test scores collected and compiled were the total reading, total math, verbal, numerical ability, basic skills math, basic skills reading, and a teacher-designed criterion referenced test. Additional information on students in the remaining tracks (grouped by ability in tracks) was compiled only on the fall pretest.

Literature Pertaining to Secondary Achievement

Factors related to achievement have been extensively studied and reported in the research literature. MEC has extensively studied basic skills intervention programs for more than a decade and performed a thorough review of the topic for this study with the purpose of setting a context of variables, those considered as possible correlates of achievement.

National reform literature and mandates for effective schools continue to emphasize that basic skills in reading and math need to be provided at the secondary level for students of all abilities. As early as 1979, the Massachusetts Department of Education undertook an objective statewide assessment to determine if students are mastering basic reading and math skills. While achievement at the elementary grades is consistently rising, nationwide, older students do not necessarily develop the higher level skills without a program aimed at these higher order tasks. Assessment statewide is accomplished through the implementation of a testing program intended to provide an objective overview of the extent and nature of student achievement in these critical skill areas and content areas of reading and the practical applications of math skill.

Computer-aided systems to remediate basic skills have been available for over a decade. Evaluation studies have shown impressive results with consistent achievement test gains that are sustained. These computer managed programs go beyond the delivery of educational programs through a regular or traditional classroom dependent upon paper and pencil instruction.

In the past, all large computer systems required the power of a mini-computer such as the Data General Nova IV or other mainframe for adequate storage space and processing capacity. Advances in technology have recently led to the development of less costly, micro-based basic skills remediation products such as the one recently installed in the Greater Lawrence Technical School. These microcomputers have more capability than the earlier school machines when effectively used in a networking arrangement offering easy access to large hard disc storage devices (as opposed to floppy discs that must be constantly re-cycled and re-entered into the microcomputer). These advances in the power of technology have allowed the developers to produce basic skills remediation packages that are comparatively within the financial reach of most typical public schools in Massachusetts.

There are several factors that are implicit in the computer-based instructional process. The review and discussion of this project with teachers determined that the curriculum is related to areas that educators traditionally consider important to the learning process.
Like their larger predecessors (minis and maxis), these microcomputer systems with hard disc "file server" offer a variety of curriculum in the key areas such as mathematics, reading, and communication skills that can be focussed on the remedial programs of individual students.

A number of studies have described factors such as general intelligence level that is apparently related to students' school achievements. No IQ scores were available for these students; however, we were able to use the DAT-VR (verbal) a stand-in for IQ because it is well-known to correlate to "g" factor of intelligence. The Task-M and Task-R were used to measure achievement in mathematics and reading respectively. They were readministered in the spring at the end of the school year and this provides a measure to compare the student's DATVR and numerical ability in the fall battery used to estimate "ability/capacity" for each student when assigned to a track.

Students' attitudes towards school and success are variables recognized to likely influence level of achievement in reading and math. Also, student behavior ratings as assigned by teachers have a high relationship to achievement and are often significant when assigning pupils to tracks. DAT scores at the Greater Lawrence Technical School were used to assign students to tracks, have high ratings indicating self-reliance and cooperativeness along with other motivational variables assigned to higher tracks. These are also predictors of intelligence and aspects of achievement. In many studies such as this one, it has been found that a critical variable is the teacher's belief that the students are the most critical agents in their own learning. This is reinforced by their selection of independent computer-based activities for their curriculum program at the secondary level. The teachers' degree of belief in the importance of independent learning and studying has been found to contribute substantially to the differentiation of assignments to different classes. The recommendations of the teachers are highly correlated with the teacher's belief that the student will do well. The lower expectations of the teachers for a portion of the student body may become the Rosenthal-Jacobson self-fulfilling prophecy. Learning process variables that are important at the secondary level include student attitudes toward school and continuing education; teacher attitudes and respect for students as learners; and, student and teacher beliefs that learning is occurring and can succeed.

Another variable, which is an aspect of "locus of control", related to differences in performance has been reported in the literature as "the degree to which the student felt that s/he was responsible for his/her own successes and failures in school." The provision of appropriate kinds of experiences, student support and guiding by their teachers, has been shown to be enhanced with adequate resources. Several other variables have been identified in the literature as differentiating various pairs of comparison groups.

There may be common factors that exist which can help to explain why some students are doing better over and above the instructional program. For example, do aspirations of parents provide a more supportive background despite their student's innate capacity? Do their teachers hold higher expectations for them or make special efforts to overcome some of the learning deficiencies? Do the students assigned to higher tracks than track 4 have certain traits or personality characteristics, or are they merely more or less "intelligent"? The answer is a complex mixture of factors and these factors should be further studied as the school considers programs or other school supportive services.

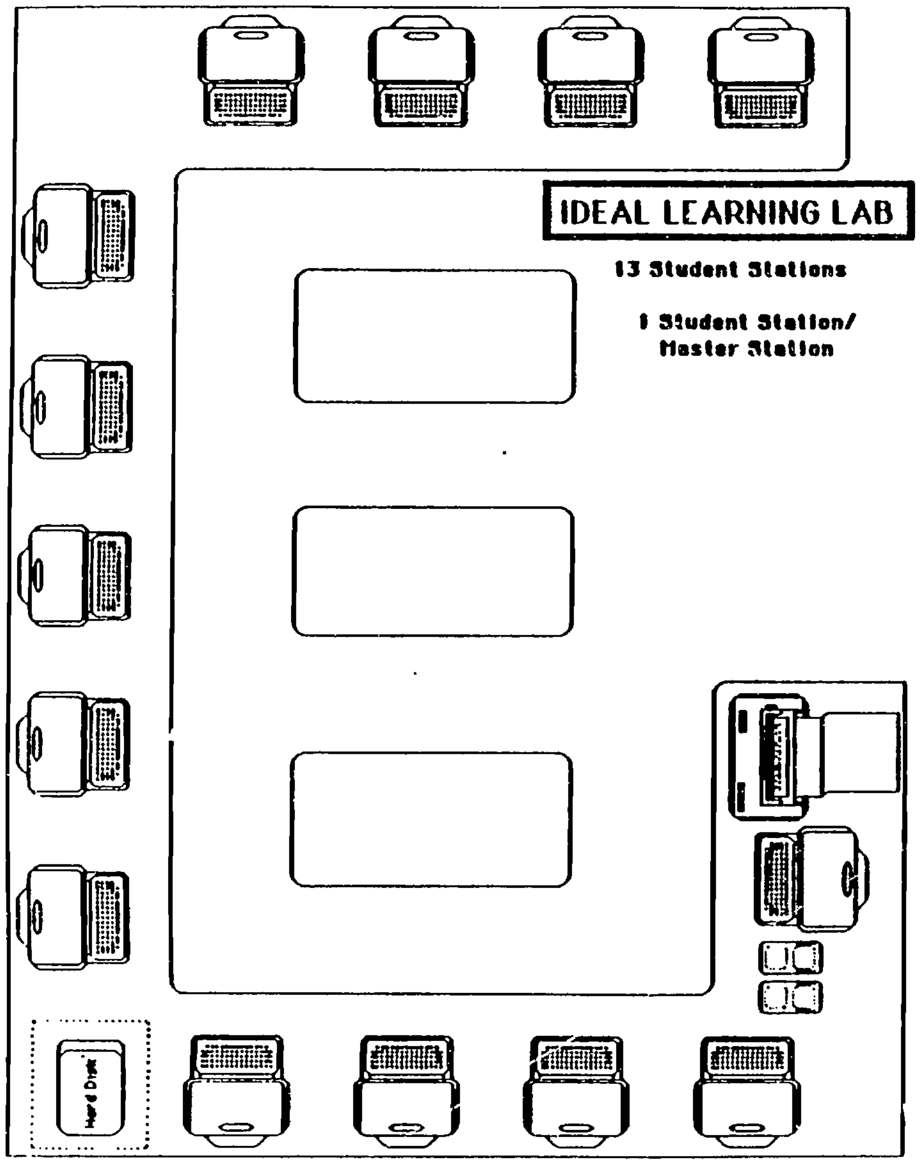
In national research studies, there is a general trend for achievement scores to be higher as the frequency of reported recreational reading (books read) increases and as the parental reinforcement of reading occurs in the home. This is indicative of the "practice makes perfect" rule.For this reason, we reviewed the data collected on the Massachusetts Assessment of Basic Skills.

Because of its ability to record and represent process (e.g., mathematics problems, etc.) the computer provides a powerful, motivating tool for focusing the student's attention directly on the steps or process of thought in working out a math problem. It is possible to capture the processes by which the student performs the work:

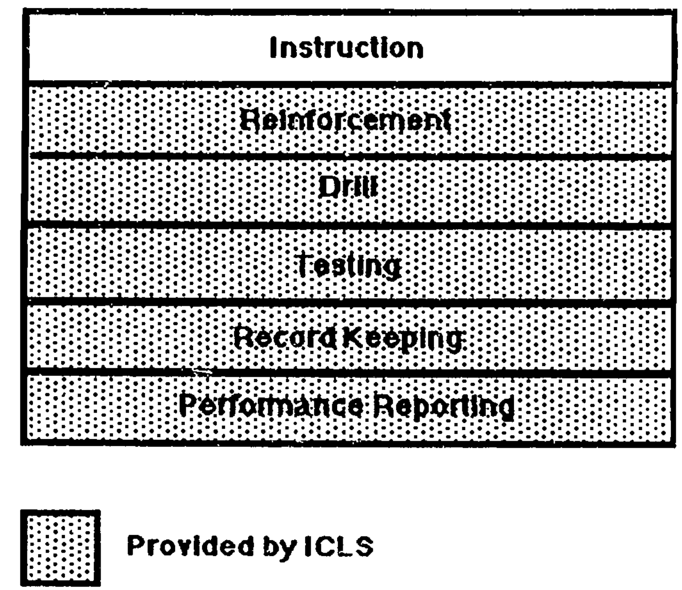
> This process trace or audit trail can become a useful object of study for students trying to improve performance. Reflection is important to learning because it is possible to reconfigure a process representation so that students can see separate aspects of the process together and can view the process itself from perspectives not seen before. (Bolt, Beranek Newman)

Impact and Implications. Of significant interest in this study were the procedures for curriculum management, staff training, and student/teacher feedback provisions. Teachers considered several factors when setting up the lab as they explored concepts crucial to development of this new computer-based learning environment. Teachers were instructed to focus on the process and the product and the computer's ability to record the students' demonstrated skills and academic achievement. Cognitive and pedagogical issues were considered relevant to the learning environment. While working with the curriculum and devising an entry level test, the math teachers focused on issues and concerns identified on the impact of this curriculum system for their general education program and the specific skills to be taught. Faculty worked with Merrimack Education Center staff to determine the implications of this computer-system on their approaches to learning and teaching together with ways in which to accommodate the changes in educational practice required that would result from the application of a "new generation" of tools using technology. Teachers worked through inservice education to determine how they would adapt the approach to specific learning and specific learners. (Figure 1 depicts the lab set-up.)

FIGURE 1



Ideal Learning
INSTRUCTIONAL MODEL



1. REINFORCEMENT- on computer
2. DRILL
   a) On computer
   b) Worksheets
3. TESTING
   a) Can be customized
   b) Computer scored
4. RECORD KEEPING
   a) Reinforcements completed
   b) Drill with score
   c) Testing with score
5. PERFORMANCE REPORTING
   a) By Student
   b) By class
   c) By school
   d) By test- Item analysis by item/by objective

Evaluation Design Model

In this evaluation of the IDEAL implementation at Greater Lawrence, a pretest - posttest, norm-referenced design was employed. Because all students of a similar ability use the IDEAL computer-based program, it is difficult to locate appropriate control or comparison groups as it is not always wise to establish a "waiting list"; thus, comparisons are made with the publisher's established norms. Those students participating in the current computer-aided program were chosen according to the same standard criteria (and testing data) that are generally used in secondary schools to establish this type of remedial class or for identifying students in need of remediation.

For this current cohort of students the study reports test results for the Stanford TASK-M and TASK-R to determine student progress from pretest to posttest. The normal curve equivalent is the statistic used for this comparison and this NCE score (on a standard Z scale) is used to compare with the data available from the publisher on the norming population.

The model selected allowed direct comparison of net learning gains within this particular year. The statistical techniques of analysis of variance (IBM-PCANOVA) to assess the homogeneity of groups and analysis of DAT-M were used to examine ability/capacity levels of incoming students in grade 9. All data will be maintained in a computer data base so that future studies, of a longitudinal nature involving greater numbers of students in several schools, can be prepared in future school year comparison.

The design for this evaluation is snown in Figure 2*. Data analysis were prepared to compare trends in these data for students attending the Greater Lawrence Technical School and to draw direct implications for this type of remedial program in reading and mathematics.

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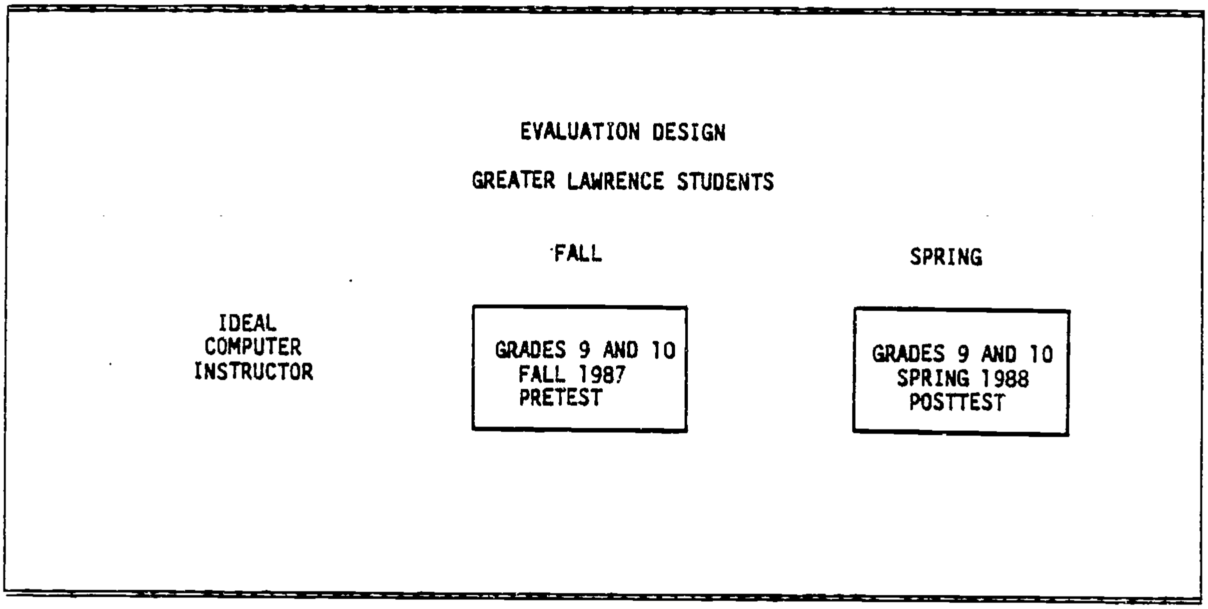
*This is Model A as developed by RMC Corporation for the U.S. Office of Education.

Figure 2

Data Collection Design



Study Activities

The present study made use of achievement scores from 1987-1988 school year. The study described in this report traced the progress of 9th and 10th grade students of two groups receiving either remedial mathematics or reading instruction. Generally, students in track four are assigned to the computer instruction lab for remedial math instruction programs or developmental reading and math. In specific terms, this study attempted to:

(a) follow the progress of students in grades nine and ten with test scores at the beginning and end of the school year;

(b) describe the levels of achievement in reading and mathematics;

(c) identify any subtests that might differentiate between the groups of students who received the computer-based instruction (e.g., math, reading, basic skills, numerical ability, etc.).

The students in the lab received tests as part of their achievement testing at the end of the school year, making it possible to identify a variety of subgroups such as students who remained in either the high or low scoring group on the tests as they attended the high school classes. The instruments used to gather quantitative data for the evaluation of this program are reliable and valid. Use of the Stanford (Task-M and Task-R) achievement test, with common norms across several years, permits comparison of students in this school with other typical secondary students who took the Stanford as part of the sample for norming the test. The normal curve equivalent (NCE) is the score used to make this comparison over the testing periods.*

Findings from this study comparing groups of readers and math students assigned to different instruction using the computer lessons are reported here and we have offered some suggestions concerning factors that might account for a group's differential performance. Variables on which the groups were measured included reading and math achievement, number of skills mastered in the criterion-referenced (levels) test.

Basically, the evaluation model looked at the pretest and posttest mastery scores for the reading and math subtests. Using the DAT entry level scores are collected on each student in the junior high school in the spring of each school year. The Stanford TASK achievement test is administered at the beginning of the freshman year in the Greater Lawrence Technical School and again at the end of the school year; this provides a measure of total reading and math (TASK-R and TASK-M). Meanwhile the DAT, given only once at pretest, provides a score for numerical ability and verbal reasoning.

Data Collection and Analysis

As part of the school's assessment program to determine the effectiveness of instruction, test scores were compiled on standardized achievement measures. The Merrimack Education Center reviewed and analyzed these test scores for students who had remained in the reading program or math group for the full year. The outside evaluators reviewed the data and verified descriptive and inferential statistics. The outcome measures were the reading achievement test and the math subtest appropriate for this evaluation. The comparison of test scores from fall to spring for the student participants in grades 9 and 10 were analyzed from tests administered over the school year that were indicative of program impact. Stanford TASK Levels I and II A were used. The evaluation procedure for this report is summarized as follows:

1. Standardized achievement test data were reviewed; t-tests for correlated data (matched pre and posttest scores) were used to determine gains.

2. T-tests for correlated data were used to determine gain in the subtests (i.e., total reading, math). Data analysis was conducted in accordance with the norm-referenced Model A, as promulgated in the national Chapter I evaluation effort of recent years.

3. The matched pair students t-test is equivalent to a one-way ANOVA (analysis of variance) and was used to determine if gains were significant.

Because the students were all pre-selected for tracks in the vocational program, it was impossible to do a "tight" research study with control groups. The two instructional groups (reading/math) differed markedly from the general student population in that their DAT test scores were lower to begin with. These students could be expected to perform very differently on a standardized reading or math test given at the end of the 8th grade. It was hoped that, by monitoring the progress of several of these groups over the 9th or 10th grade year and examining aspects of their performance, some clues about performance and levels of reading/math achievement might be found. The study results are viewed to determine the:

1. pattern of achievement gains by subject area

2. relative magnitude of gains expressed in NCEs

Data Collection Sources

Students are given a standardized achievement test to determine students' current math and reading levels. The Stanford TASK achievement test is a widely used instrument with high validity and reliability that measures relatively important educational goals for both reading and math. All scaled scores and raw scores were converted using the norms booklet and the norm referenced model employing national norms as a comparison for this report.* Each of the skills of the math levels program was also examined as to the increase or decrease in the individual student's test scores over the time span of one school year when students took a teacher made test for IDEAL Levels.

The individual curriculum components for reading and mathematics are analyzed on NCE or percentile score gains and they are analyzed for significance using difference of means tests (t-test) for matched pairs. Individual test items cumulate to make a composite score of Reading and Math on the Stanford TASK. Thus, the achievement scores represent several different curriculum objectives; among these are:

1. Comprehension of what is read
2. Vocabulary development
3. Mathematics computation
4. Mathematics problem solving

Teachers have examined the tests and the curriculum to review their stated curriculum objectives. Teachers indicate that comprehension receives major emphasis in the reading program. Teachers express satisfaction with student achievement on the reading objectives, and overall performance on achievement tests. A teacher-made test was designed as a diagnostic measure to determine entry level placement for students in the computer instruction math lessons; a math levels test (correlated to their achievement of objectives) was administered in the spring of the school year to determine growth in the curriculum. (See Appendix.)

The population of students tested was large because the DAT is initially given to all freshman students from all feeder schools. The average scores of the 9th grade (entering freshmen) were at the 27th percentile in math, indicating that the students are scoring lower than the typical student in a general education program.

The Normal Curve Equivalent is the standardized score (z-score) used for the analyses in this report.* The norm referenced design assumes that pupils will tend to hold their percentile rank from year to year unless their curriculum is modified in an instructional program. Therefore, an increase in rank on the percentile scale, reflected on the NCE scale, is evidence of the benefits of an instructional program. For example, if students score at the 20th percentile in the fall, then their spring score will be compared to the score equivalent of 20th percentile students on the spring norms. Assessment of the program's impact can then be interpreted on the percentile scale and the NCE scale. NCE's are normal curve equivalents; this NCE scale closely matches the percentile distribution, hence has some of the qualities of interpretation inherent in percentile scores. However, the scale is also an equal interval scale and can be used in arithmetic calculations, while percentiles cannot. The NCE scale permits percentile scores from any norm-referenced test to be transformed to an NCE equivalent score. Scores can then be aggregated across grades 9 and 10 to determine the overall impact of the program. Whenever the NCE gain is greater than zero it means that the students profited from participating in the program.

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*NCE's are Normalized Standard Scores with a mean of 50 and a standard deviation of 21.06. The NCE scale is an equal interval scale unlike the percentile scale and so they can legitimately be aggregated and averaged. NCE scores are generally considered to provide the most comparative information in equal units of measurement.

RESULTS OF ANALYSES

The outside evaluators reviewed the achievement test results and verified scores on tests as sources of data for this report. Outcome measures included the Stanford TASK R and TASK M reading and math. Using the test data, the evaluators were able to compare measures of reading and math on the standardized test administered. Data compiled at the school were used for analyses performed in this report.

The test results indicate that a typical student in this school scores below the national average (50th percentile) in reading and math. The average overall achievement, as indicated by the test, is approximately 25th percentile for both reading and math.

In the present study, groups of test scores were compiled according to the instructional groupings of the school for the reading or mathematics program. These students were identified as fair or poor in their reading and math skill development according to test scores and their assignment to track four. Tests were given at the end of their eighth grade year and students consequently assigned a track; then the lowest performing students are assigned to either the reading program or the math program or both. These students were followed throughout the year by their teachers and then some additional posttesting was completed, in the hope of finding common areas that would indicate on the subtests any differences in reading or math achievement for these pupils assigned to different classes.

It was expected that the results of these comparisons would on the whole be similar, because many of the same students remained in track four and were administered both pre and posttests. It was thought, however, that differences in patterns of test scores might emerge for grades 9 and 10 analyses because of the greater general maturity of the students as well as the instructional program. (Degree of independent learning success is thought to be developmental). Also, it was hoped that the instructional treatment would be a predicting factor for greater achievement when the student had been assigned to the developmental skills classes using the microcomputer.

In order to determine whether significant gains were made on total scores, the pretest and posttest (fall to spring) NCE scores were examined on the subtests. A preliminary run on testing data for all students in the total population wa prepared (N= 155). Descriptive statistics on the DAT (basic descriptive information) including means, medians, and standard deviations were obtained for tne total group of students and for the sub-groupings (track 3/4 assigned students).

The general student body had higher capacity to begin with and this must be taken into account as the data are analyzed. For example, the average or typical student scored as much as 10 percentile points higher (on the percentile scale) than the group assigned to reading and as much as 15 %ile points higher on the math test. The students in the computer-based instructional program are indeed in need of remediation and need the extra supplementary assistance provided by the computer.

All analyses herein described involved the use of Normal Curve Equivalent Scores (NCE's)*. At each measuring point, each student's NCE was recorded. For the presentation of tables, these NCE's have also been converted into percentile rank. These conversions were performed by table lookup procedures. Only the NCE scores were used for statistical analyses because they alone allow near complete flexibility in assembling groups for analysis.

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*If a student does gain on the NCE scale, it can be stated that: s/he gained more than one year's growth in the school year; and, s/he improved her/his ranking among peers relatively in an upward direction.

READING

Reading items on vocabulary and comprehension are gathered into one composite score for reading on the Stanford TASK-R subtest. All students taking the reading program were gathered for analyses when both pretest and posttest scores were available (N= 24). Data for student achievement on reading are shown in Table 1 for 9th grade students assigned to the reading lab. Achievement tests (Stanford TASK) are designed to give evidence of how much a particular student has learned. They are designed and given for the purpose of rank ordering students in comparative achievement.

Evidence of the impact of the school's program, through data collected on reading, is displayed showing that gains were made on the reading test administered in the spring of grade 9, after students completed the year's program of studies. These data represent pre- and posttest scores on the same students at the beginning and at the end of grade 9. Means and standard deviations were computed for the students attending the lab and the differences of the test scores from pre to post (fall to spring) on the reading subtest were then assessed by means of a t-test. The test publisher's norms were the reference for "expected end-of-year reading performance" and this was compared witn "actual end of year performance" on the percentile scale and the NCE scale.

Table 1

READING -- Stanford TASK-R

All Students with both Pretest and Posttest Results - Grade 9

Fall Grade 9 . . . . .to Spring Grade 9

	Pretest	Posttest	Gain*
Students in reading Lab N = 24	13%	20%	+7% points

Assessment of the impact can be gained from examining the percentile scores in Table 1 or the NCE scores in Table 2. Percentiles are used in norming tests to display the scores of all persons taking the tests during the period of standardizing the instrument. This allows the reader to examine the results of achievement tests according to whether or not they correspond with the large numbers of persons who took the test in the developmental stages and to draw conclusions related to achievement. Favorable results were found for the students in reading and this can be readily seen by examing the gain column. In other words, the student growth rate was faster than these same students had previously demonstrated. In this case, the students as a group would be considered to have performed better than expected. From examining Table 1 it can be seen that there is evidence that the support offered by this secondary school supplements the student's instructional program and is effective in accelerating the student's progress, thus compensating for his/her previous low achievement level.

Total reading for the students completing developmental reading at the Greater Lawrence Technical School showed an overall gain for this composite of the subskills in reading of seven percentile points (+7%). An increasing percentile rank from pretest to posttest is indicative of a faster growth rate than students had previously demonstrated. Without this supplemental instruction, these students would be expected to remain at the same level with respect to the test publisher's norm group.

NCEs are derived from the percentile scale in look-up charts supplied by the publisher. The NCE scale is a relatively "new" scale developed and disseminated by the U.S. Office of Education. According to OE, "if the average relative performance of the students in the spring testing is better than their average relative performance in the fall testing, then the percentile of the average posttest achievement score would be at a higher level than the percentile of the average pretest achievement score. Thus, for students who are participants in the computer-based instructional lab, the norm-referenced model presumes that a better-than-expected performance is attributable to the effects of the instructional program. Within this framework the treatment effect attributed to the lab program is the observed post test performance minus the expected no-treatment post test performance. The norm-referenced model is presented in terms of achievement scores that have been transformed from raw scores to percentile equivalents and then to NCE scores.

Generally, the typical student in the remedial lab reduced the number of incorrect items on the reading subtest. Table 2 indicates that a typical student in the reading program started out with a mean of 26 NCE at the beginning of the school year and scored 32 NCEs on the posttest in the spring at the end of grade 9. For all students in the data file for grade 9 who attended reading classes and used the microcomputer, the mean NCE rose +6 points on the NCE scale. For example, the typical student in the developmental reading program moved ahead in rank order six places from pretest to posttest.

Therefore, in this sample the students assigned to reading outpaced the students in the norming population test score when they had completed grade 9 on the the computer-based instructional practice. It is especially significant noting that the reading students start out lower than the 25th percentile to begin with, and thus have a harder hurdle to improve their rank placement; many students (21% of the remedial reading students) by the end of the year make a quartile shift into the 2nd quartile from the first. Regardless of the fact that the students assigned to reading are generally of lower capability (DAT Battery* 24% for reading students as opposed to 39% for all students), these reading students showed a gain of +6 NCEs whereas the typical student in the norming population would be expected to remain at the same score or percentile level from fall to spring.

A students t-test was conducted to determine if the gain proved to be significant with this statistic. The reading analysis was performed using the students t-test to evaluate statistical significance. Table 2 presents the data for the students t-test. The pretest to posttest statistic for the reading students was 4.847 indicating this was highly significant especially for the small number of students attending reading (only twenty four with matched pre and post tests). The level of

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*DAT verbal score is used here to substitute for IQ because none was available and verbal ability is a good measure of "g" or general ability.

significance was calculated to be less than <.0005 interpreted as a difference that would not be obtained by chance alone in more than 2,000 replications of the study. Students show gains in total reading on the NCE scale and their average gain (+6) approximates half the standard deviation of either testing (pre/post). For example, the gain of seven percentile points is greater than the standard deviation of 13 on the pretest and is also greater than the posttest standard deviation of 12. Gains of even one quarter of one standard deviation are considered "educationally significant." Also, the fact that the standard deviation dropped from 13 to 12 is also educationally important showing that the variability in the group was "tightened up" due to the instructional program.

Thus, we can conclude that the student does gain and it can be stated that s/he: (a) gained more than one year of growth on the reading test; and, (b) improved his ranking among his peers by 6 steps (changed upward 6 places).

Table 2

READING -- Stanford TASK-R

All Students with both Pretest and Posttest Results - Grade 9

Fall Grade 9 . . . . .to Spring Grade 9

Data File: GR. LAW. READ

Paired Samples...

Variable:	Column 4	Column 5
Mean:	26.027	31.807
Std. Deviation:	13.368	11.993
Paired Observations: 97		

t-statistic:	-4.847	Hypothesis:
Degrees of Freedom:	96	Ho: $\mu 1 = \mu 2$
Significance:	0.000	Ha: $\mu 1 \neq \mu 2$

According to the U.S. Office of Education, even a one point gain on the NCE scale* is significant and, for this size population (twenty-four students) the point gain is quite significant. Statistical analysis of t-test (difference of means test) between pretest and posttest NCE means on the total reading score was statistically significant, in a positive direction. Thus, the comparison is significant showing positive gains and the differences between the means (fall to spring) were significant on the subtest at the end of Year 1.

It can be concluded that program changes made with the installation and implementation of computer-based instruction using microcomputers with a file server (hard disc as opposed to floppy disc drive) have impacted on the scores resulting in the gain of +6 NCEs for the typical student who was assigned to the reading lab. Observable progress with students is recorded by classroom teachers as the students accomplish more of the reading objectives on the microcomputer. This is noted by the teacher-selected objectives and discussion of issues with the teacher as well.

We can make the inference that the instructional program in reading is maintaining student skills and that more skills and objectives in the school's curriculum are added when additional supplementary instruction is offered through computer-based instructional lessons. Thus, the school's curriculum is having a differential effect on the students of varying capacity and on those students in tracks 3 or 4 assigned to the reading lab. In similar studies conducted at the secondary level using CAI, MEC has noted that students often take two years to show a reading gain when such a new program is initiated. Indeed, often students at the secondary level actually go down in their reading score from grade to grade.

When we look at track four students (the lowest performing) assigned to reading classes, there is a significant gain of +6 NCEs or +7 percentile points. Students get additional test items correct on the post test (compared with fall) and enough additional items to push them

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*Gain of +9 NCE points represents +11 raw score points; represents increase of 13% in terms of raw score points.

to a higher percentile. The students undoubtedly answered a few more items correctly on their 9th grade posttest than they did on the pretest, enough to increase their percentage score (and consequent NCE score). It takes about seven or eight more correct answers to raise their score 1 or 2 NCEs.

By definition and the criterion of selection, students assigned to a remedial lab do not make sufficient gains in their regular classroom. They have a history of being unable to achieve within one year of their grade level on standardized tests and sometimes are unable to achieve anything but chance scores. Because these students do not learn incidentally, learning opportunities must be structured to their specific individual needs with sequentially-based instruction such as that provided in the computer-based lab. For example, it can be seen using the pretest data that in many cases remedial students had in the past progressed at the rate much lower than 0.1 grade equivalent (GE) per month since their pretest scores were substantially below the expected norms in both reading and math (in the 20th percentile range).

The review of the test indicates that the curriculum may be missing some highly relevant skills, often referred to as the reading/study skills, and these must be taught directly and cannot be left for students to attain on their own if they do not receive advanced intruction appropriate for secondary level students. The assumption is that all students need additional instruction in advanced reading/study skills. Students scoring in the upper range of the test norms (above 40th percentile) may have less to gain from the developmental reading program because they have higher scores to begin with. The implication here is that students at grade 9 need more advanced reading skills for independent learning. In addition, the students attending other tracks (1, 2, 3) should not be deprived of this opportunity but efforts should be considered that would provide skills in a flexibly scheduled "skills center" where students attend for a portion of a semester (long enough to develop the missing skills but not necessarily of a semester-length).

MATHEMATICS

When all students in grades 9 through 10 having math pretest scores are aggregated, the mean score obtained for the total math implies a somewhat higher level than for those students assigned to track four. The math percentile for the overall student body is at the 27th percentile whereas for the track four students it is closer to the 15th percentile. It will be recalled that these students are generally performing lower to begin with. Indeed, they typically test, on the average, approximately 15 percentile points lower than the students assigned to a general/regular curriculum in the secondary school. By definition and pre-selection, track four contains those students who scored lowest on the entry level testing for numerical ability.

Assessment of the impact can be gained from examining the NCE scores in Table 3. This allows the reader to examine the results of achievement tests according to whether or not they correspond with the large numbers of persons who took the test in the publisher's norming sample. Favorable results were found for these mathematics students who attended the computer lab and this can be readily seen by examing the gain column. In other words, the student growth rate was faster than these same students had previously demonstrated. In this case, the students as a group would be considered to have performed better than expected. There is evidence that the support offered by this secondary school supplements the student's instructional program and is effective in accelerating the student's progress, thus compensating for his/her previous low achievement level.

Total math for the students completing instruction in the math lab at the Greater Lawrence Technical School showed an overall gain for this composite of the subskills in math of seven percentile points (+7%) on the Stanford TASK-M. An increasing percentile rank from pretest to posttest is indicative of a faster growth rate than students had previously demonstrated. Table 3 presents the NCE data for mathematics. There were 98 students in the grade 9 data base assigned to computer-based instruction who had both a fall and spring test (paired). These students scored, on the average, 29 NCE on the math TASK-M pretest and 34 NCEs on the TASK-M posttest showing a gain of +5 NCE points. The

Table 3

Students Assigned to Math

Pretest and Posttest Results Grades 9 and 10

Fall Grades 9-10 . . . . to Spring Grades 9-10

Data File: GR. LAW. GRADE 9

Paired Samples...

Variable:	Column 1	Column 2
Mean:	28.752	33.965
Std. Deviation:	12.072	13.219
Paired Observations: 98		

t-statistic:	-5.076	Hypothesis:
Degrees of Freedom:	97	Ho: $\mu 1 = \mu 2$
Significance:	0.000	Ha: $\mu 1 \neq \mu 2$

Data File: GR. LAW. GRADE 10

Paired Samples...

Variable:	M PRE NCE	M POST NCE
Mean:	24.800	35.127
Std. Deviation:	12.297	12.196
Paired Observations: 52		

t-statistic:	-6.674	Hypothesis:
Degrees of Freedom:	51	Ho: $\mu 1 = \mu 2$
Significance:	0.000	Ha: $\mu 1 \neq \mu 2$

fifty-two students in grade 10 also gained rising from an NCE of 25 to an NCE of 35, or an average of +10 NCE points. Students in grades 9 and 10 in the baseline year (this first year of offering computer-based instruction in the developmental lab) went up and the tenth grade students gained dramatically. This is a higher gain than is usually reported for grade 10 students as many of the motivating factors of attending a "new school" increase scores for grade 9 students but scores in grade 10 tend to level off and, indeed may even go down. The fact that this program was able to show gains at both grades 9 and 10 is meaningful.

The 150 students in the computer math lab (grades 9-10) went up an average of 7 NCEs as shown in Table 4. Table 4 shows NCE gain for all students with pre and posttest data in year 1 on the mathematics subtest (150 students). Even one NCE gain can be interpreted as a significant rise in the score.

Table 4

1988 -- Stanford TASK-M

All Students with both Pretest and Posttest Results - Grade 9

Fall . . . . to Spring

Students		Gain
Grade 9	N = 98	+ 5
Grade 10	N = 52	+10
	N = 150 Total	+6.7, on average

The analysis of math scores concluded with the student's t-test to determine if gains proved to be significant. The analysis was performed using the student's t-test to evaluate statistical significance. The pretest to posttest statistic for grade 9 was 5.076 and for grade 10 was 6.674 indicating statistical significance, especially for grade 10. The level of significance was calculated to be less than $<.0005$ interpreted as a difference that would not be obtained by chance alone in more than 2,000 replications of the study. The t-test computed for both grades 9 and 10 shows that the differences are significant and that the math students do benefit from their classes for computer-based instruction. Math students of lower capacity visibly go up in tnis computer-based program and t-tests indicate a significant difference.

The computer lab students show gains in mathematics on the NCE scale (average gain +7) -- a gain that is more than half of the standard deviation of either testing (pre/post). Gains for both 9th and 10th grades greatly exceeded a quarter of a standard deviation unit, and thus, should not only be considered statistically significant, but also educationally significant as well. For example, the tenth grade gain of ten NCE points is greater than half the standard deviation of 12. Gains of even one quarter of a standard deviation are considered "educationally significant." It can be concluded that program changes made with the installation and implementation of computer-based instruction using microcomputers in the math lab impacted on the scores resulting in the gain of +7 NCEs for the typical student. Observable progress with students is recorded on the corvus (hard disc) as the students accomplish more of the mathematics reading objectives on the microcomputer. We can make the inference that the instructional program in math is maintaining student skills and that more skills and objectives in the school's curriculum are achieved when additional supplementary instruction is offered through computer-based instructional lessons.

When we look at track four students (the lowest performing) assigned to math classes, there is a significant gain. Students get additional test items correct on the posttest (compared with fall) and enough additional items to push them to a higher percentile. The test form changes between grades 10 and 11 so that the posttest norms used for the sophomores are essentially based on a different testing population. Also, this is the year when dropout rates are higher because students turn sixteen.

We can conclude that the student does benefit from his/her math instructional program and it can be stated that s/he: (a) gained more than one year of growth on the reading test; and, (b) improved his/her ranking among his/her peers by 7 steps (changed upward 7 places).

Stanford Diagnostic

For some students (117) in the mathematics program, test data from the Stanford Diagnostic Test were available. The Stanford is a reliable instrument used for measuring the magnitude of student progress attributable to a remedial program. The expected percentile standing of the students on the posttest is compared to their percentile rank on the pretest to determine if there is a positive sign of achievement during the school year; and, if there were no remedial program in place, the average percentile is expected to be equal in value from fall to spring.

The Stanford provides for each student a percentile score or standard of relative rank based upon the student population test performance in relation to the norm group. The expectation of the NCE score is that, if everything is equal, the NCE score would not change from one time period to another and, if it does, the intervening program treatment has had some effect.

The Stanford Diagnostic Test yields raw scores, which are then converted into standard scores, percentiles and NCEs. The NCEs are then used to compare the participants' achievement test scores from fall to spring. This is the norm-referenced model used throughout this report. The basic assumption of the norm-referenced model is that students as a group will tend to maintain their relative rank or percentile standing over the course of a school year.

Table 5 includes the mathematics scores for grades 9 and 10 students on the Stanford Diagnostic when paired fall-spring test scores were available. In this case, the students as a group would be considered to have performed better than expected if the percentile rose from pretest to posttest and this is determined to be a result of the remedial program in the computer math lab.

The table shows that there was a position change in NCE scores for the student, on the average, for this subtest. Students rose approximately +9 NCE points on the Stanford Diagnostic Test. The results reported in Table 5 are based upon all useable data when there was a valid pretest and posttest for students who remained in the program during the school year. There were 117 students who attained mean gain score of 18 NCEs on the pretest and 27 NCEs on the posttest administration of the Stanford. The student's t-test was computed at 9.441 indicating a significant gain.

Table 5

MATH -- Stanford Diagnostic

All Students with both Pretest and Posttest Results -- Grade 9-10

Fall . . . . to Spring

Data File: GR. LAW. GRADE 9

Paired Samples...

Variable:	Column 7	Column 8
Mean:	18.321	26.465
Std. Deviation:	12.058	12.737
Paired Observations: 117		

t-statistic:	-9.441	Hypothesis:
Degrees of Freedom:	116	Ho: $\mu 1 = \mu 2$
Significance:	0.000	Ha: $\mu 1 = \mu 2$

Examination of the NCE scores and the percentile scores is a major way of analyzing the gains made by these students as a result of their math program. An increasing percentile rank from pretest to posttest is indicative of a faster growth rate than students had previously demonstrated. The actual gain and the direction of the pre/post score difference are noted by examining these NCE gains.

Students in this program include low-achieving students, defined as those in the lowest achievement quartile. This is evident from examining the test scores for those students selected by the criterion of low performance on the DAT (generally from track three or four). The mathematics students at the Greater Lawrence Technical School scored in the percentile range from 10 to 18% on the pretest. By the spring of tne year, after their computer mathematics lessons, students had increased their percentile rank (and corresponding NCE) and were scoring in the twentieth- to thirtieth percentile range. This pattern is similar to that noted for the Stanford TASK-M and thus provides further evidence to substantiate the claim that this computer-based instructional program is of great value to the students.

IDEAL Teacher-Made Test

The teachers prepared a teacher-made criterion referenced test to match their curriculum and to be used for determining the student's entry level when placement is provided within the computer curriculum.

The students in grade nine and grade ten took the teacher-made pretest and were then entered into the placement for remedial or developmental instruction in the math lab. At the end of the program's first year, the students took the teacher-made posttest. The ninth grade students, on average, scored at the 51% level on the pretest and then scored 58% on the posttest showing a 7 point gain on the percentile scale.

The tenth grade students scored an average (mean) of 52% on the pretest with a corresponding 61% on the posttest. This indicates 9% gain on the percentile scale. Data analysis was then completed with the students t-test with significant results for both grade nine and grade ten as shown in Table 6.

The fact that students show a gain from pretest to posttest is highly significant because these are the objectives, with criterion-referenced test items, that the teachers deem to be educationally meaningful for their curriculum. Achievement of the students assigned to math, thus increased on three different measures, the teacher-made test, the Stanford Diagnostic and the Stanford-TASK-M.

It is informative to note that the students who scored lowest on the DAT test, and thus thought to be of lower capacity/ability, were assigned to the lab for this supplementary instruction. Thus, the computer-based curriculum is proving to be appropriate with secondary level students showing these types of needs and performing in the lowest quartile of their class. Students made gains on both the reading test and the math test when the Stanford (alternate form/level) was readministered at the end of the school year. These students are indeed benefitting from the school's program and curriculum. The achievement measure indicates that students are showing progress on the skills that teachers believe are most important for reading.

Table 6

Students Assigned to Math Lab

Pretest and Posttest Results Grades 9 and 10

Fall Grades 9-10 . . . . to Spring Grades 9-10

Data File: GR. LAW. GRADE 9

Paired Samples...

Variable:	IDEAL PRE	IDEAL POST
Mean:	51.331	57.534
Std. Deviation:	18.799	12.653
Paired Observations: 118		

t-statistic:	-3.443	Hypothesis:
Degrees of Freedom:	117	Ho: $\mu 1 = \mu 2$
Significance:	0.001	Ha: $\mu 1 \neq \mu 2$

Data File: GR. LAW. GRADE 10

Paired Samples...

Variable:	IDEAL PRE	IDEAL POST
Mean:	51.960	60.960
Std. Deviation:	14.777	13.242
Paired Observations: 75		

t-statistic:	-5.771	Hypothesis:
Degrees of Freedom:	74	Ho: $\mu 1 = \mu 2$
Significance:	0.000	Ha: $\mu 1 \neq \mu 2$

Shift in Rank Placement

One criterion of a successful reading or math program is its ability to move students out of lower quartiles in comparison to the national norms on the SRA Test. Data were examined to review how many students actually shift this rank placement; the shift into another quartile (e.g., from the 24th percentile or 1st quartile to above the 25th percentile or into the 2nd quartile) is significant growth at the secondary level in reading or math. Movement out of the 1st quartile indicates that the lower performing students on the pretests move up in rank in comparison to national norms for the Stanford TASK.

Descriptive statistics on the tests showed that the students are changing relative to rank placement from fall to spring. A noticeable positive shift of the distribution of students is apparent in the data. Some students maintain their rank in their group/class (because in essence the standard is raised for 10th grade). The fact that students are doing as well or better on the posttest (better than expected in contrast with the national norms) indicates that pupils who met the objectives of the school's instructional program benefitted from the individualized attention provided in the program and the school-wide goal of basic skills. Those students in the first quartile shifting into the second quartile accounted for a smaller percentage who made gains; whereas some students shifting from the second quartile into the third quartile showed exceptional achievement.

In the grade 9 math data base, as many as 17 students moved ahead in a quartile shift; this represents 17% of the matched set of students with data for both pre and posttesting. On the Stanford test, about 31% of the students in grades 9-10 make a quartile shift. In grade 10 students moved ahead in rank placement representing 27% of the data file.

Differential Assignments

When some students were assigned to math and some were assigned to reading, the NCE gains were as shown in Table 5. The students assigned to the reading program (N = 24) are making a gain of +6 NCEs (from a mean of 26 to a mean of 32 NCEs). The students assigned to the math program are making a gain of +7 NCEs on the average. These data would seem to indicate that the computer-based instruction that was instituted helps to raise the reading comprehension and the mathematical skills for the students enrolled. Thus, something different has occurred to help increase student scores and it can be inferred that it was the instructional program using computers for skills practice and application.

SUMMARY

Growth in achievement from the fall of 1987 to the spring of 1988 has been reviewed by the evaluators. The achievement for the students was, by definition of the program selection criteria, below average on the pretesting during the fall of 1987 (i.e., below the 40th percentile).

The purpose of the analysis of the achievement data is to determine whether the treatment produced achievement gains in excess of those observed in the sample when the test was normed. This NCE model (known as Model A) compares students who received instruction to the test norms for the national norming population. The basic assumption of the norm-referenced model is that students as a group will tend to maintain their relative rank or percentile standing over the course of a school year. If the average relative performance of the students on the spring testing is better than the average relative performance on the fall testing, then the program is determined to have a positive impact on student achievement.

Whenever the evaluation shows an NCE gain greater than zero, it means that the students profited from participating in the project. In general, the larger the NCE gain, the more efffective the remedial instruction. Because large numbers of student scores are needed to actually document that a gain is occurring (thirty students or more) the reading scores are to be read with caution and larger groups of students will be needed to generalize for the ninth grade program.

NCE scores are used for this evaluation to look across the grades 9-10 in the mathematics program to determine overall impact of the program. When examining the overall change in scores for all grades (9-10) a gain score, on the average, of +7 NCEs across all students is quite respectable and is educationally as well as statistically significant. Typically, a school might expect that students would gain 5 to 7 NCEs in the elementary program; to gain this much on the NCE scale in the secondary school is particularly meaningful.

Scores on the NCE scale were significantly higher for the spring administration of the Stanford Tests. This can be readily seen by examining the pre-post gains on each table showing a +5 NCE gain in reading and an average gain of +7 NCE in math. This represents outstanding progress. Pre-posttest scores were available for 130 students served in mathematics who took the TASK-M but only twenty-four students in reading who took the TASK-R. In addition, test scores (paired) were available for 117 students on the Stanford Diagnostic Math Test who showed an average gain of +9 NCEs.

The gains in the Greater Lawrence program are substantially above the expected progress for students and are highly commendable, especially in this their first year of the computer-based instruction in the lab. Other factors are brought into the inferences for this project and for students served and these include test taking skills, the fact that ninth graders are entering a school that is "new" to them as well as being vocational in orientation, and the fact that 10th grade students have been in the program for two years, attitudes of the students and the teacher-student relationship, as well as the relationship of the curriculum in the computer lessons to the test.

It is recommended that the staff examine these remaining factors and begin to get a handle on the variables as they pursue the depth of this quality instruction that is being offered to their secondary students. In particular, the selection and administration of ample testing, to measure all of the objectives for this curriculum, would be recommended. In the 1988-1989 school year, reading teachers have been assigned to the reading lab instructional period to work with the lowest performing students. This will prove to be a valued asset to the program.

There is evidence of direct student gains in both reading and mathematics attributable to the provision of this computer-based instructional program. Substantial gains were achieved in mathematics on the Stanford Diagnostic Test and the Stanford TASK-M. In other words, the student growth rate was faster than these same students had previously demonstrated. Student gains offer evidence that the instructional support provided by the teachers in the computer laboratory successfully impacted achievement scores. The positive findings reported in these achievement gains were substantiated by teachers and the program director noting that students had made significant progress.

When gain scores can be analyzed for over 130 students in a grade span of two grades, which is the case in the math data presented, the number of students increases making the score reported one that is highly reliable. Therefore, when standardized tests can be used, the "tighter" the evaluation design. Based on the testing data, student progress, and on-site observations, it can be concluded that the Greater Lawrence program made a significant impact on the level of student achievement during the 1987-1988 school year. The test results summarized here demonstrate that the program was highly successful. Based on the findings derived from this report, it can be concluded that the program made an excellent impact on the level of student achievement. The analyses carried out and reported were intended to test whether the program produced achievement gains and the results support this conclusion. The Greater Lawrence program is an exceptionally fine instructional program and the staff can feel assured that their efforts are well worthwhile. The director and the faculty can be pleased with the success of this program.

Conclusions based on this study indicate that instructional microcomputing using a system such as IDEAL's computer-based instructional components can be a valuable educational tool. Additionally, it is believed that affective factors, such as motivation and self-esteem, are enhanced and this makes for a prevalent concept of success at the secondary level where traditionally morale is often low because of student's assigned to "track four" not showing repeated attempts at progress but sinking back into the mire of despair. In the computer-based instructional component, more applications and concentrated practice can be regarded as essential and the time and intensity of instruction, when increased, should continue to show advancing gains. An option at this time is to add an additional test that would serve diagnostic-prescriptive purposes in addition to the teacher-made test. This test should have separate subtests for concepts, applications, and numerical computation. There is a need to seek out more answers to this question of how the instructional program has a differential impact on students of varying capacities, abilities and interests. The students of lower capacity are assigned to the reading program and math program.

Installation in Greater Lawrence was important to initiate early summation in order to gain an indication as to whether the installation was in fact making a difference for students. To accomplish this, the Massachusetts Department of Education Division of Occupational Education provided a small grant ($5,000) to examine data in a pre-post basis to determine if any gains were achieved in the first year. What is not covered in this study are any kinds of formative evaluation data examining elements of scheduling, organizing, time on task, and longitudinal study information using control groups. Results from this study make a case for now suggesting that a more comprehensive study follow this preliminary intervention project to emphasize scores for students in vocational education.

The first year of this math program for the students of lower capacity demonstrates evidence of a positive effect. Continuing reading and math into a second year will prove most valuable. Certainly, the Stanford test gets harder and it takes more correct answers, on more sophisticated items, to get the same percentile score in later grades. By continuing to adapt the curriculum at 9th grade it would be possible to continue to show growth on the Stanford-TASK. The state's basic skills test alone is inadequate to measure the sophisticated reading/study skills and mathematics applications. Continued use of the Stanford TASK and the Stanford Diagnostic Tests is recommended to continue monitoring this program.

The teachers reported favorably on the use of the computer as a motivating learning tool. The computer also provides an instructional management system that links the diagnostic items and teaching modules for use by the high school mathematics and reading laboratory so that each student is working with appropriate lessons. Teachers presented a diagnostic math test at the beginning of the year to ascertain entry levels for each student in the mathematics curriculum. Two emerging forces can help to provide a sound basis for the introduction of these teaching tools into the secondary curriculum: (a) inexpensive, cost-efficient processing power to provide the necessary instructional information for decision-making; and, (b) growing understanding of the cognitive tasks required in the curriculum. This program at the secondary level has further provided evidence to encourage course development and demonstration. The computer-based instructional component assists teachers in reexamining the basic skills curriculum in light of changes brought about by the introduction of these new tools.

The inclusion of microcomputers in an instructional lab setting at the secondary level and the use of instructional microcomputing is extremely effective as an adjunct to the instructional program and methods of the secondary school. Instructional computering using a computer-based system for mathematics and reading are demonstrated here to be valuable educational tools and most effective as an approach to the secondary curriculum.

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APPENDIX A

APPENDIX A

GREATER LAWRENCE REGIONAL VOCATIONAL SCHOOL

MATHEMATICS - JUNE 1988

			PRE-TEST			POST-TEST			
GRADE	TEST	N	MEAN RAW SCORE	PERCENTILE EQUIVALENT	NCE	MEAN RAW SCORE	PERCENTILE	EQUIVALENT	GAIN/LOSS NCE
9	Task-M	98	21	16%	28.75 (13)	26	22%	33.96 (13)	+ 5
9-10	Stanford Diagnostic Blue	117		7%	18 (12)		14%	26.5 (13)	+ 9
10	Task-M Level I-A	70	19	13%	26.2 (13)	18 Level II-A	25%	35.7 (13)	+10

APPENDIX B

MATH 6

TEST 18

1.) Write the numerals for the following: Don 't forget Commas.

Three Hundred forty-seven thcus :nd, twenty

a. 347,020

b. 347,200

c. 347,000,020

d. 347,000,200

e. None of the Above

2.)

Round 47,268 to the nearest thousands place.

a. 40,000

b. 50,000

c. 47,300

d. 47,000

e. None of the Above

3.) Find the sum.

235 + 422 =

a. 576

b. 657

c. 756

d. 567

e. None of the Above

4.) Find the sum.

4,593
5,784
1,629

a. 101,896

b. 10,006

c. 21,006

d. 60,021

e. 12,006

5.) Find the difference for each of the following problems.

349 - 24 =

a. 25

b. 373

c. 365

d. 325

e. None of the Above

6.) 7,414 - 398 =

a. 7,184

b. 7,016

c. 7,812

d. 7,114

e. None of the Above

7.) Multiply

568
x 7

a. 1,275 c. 3,985 e. None of the Above

b. 3,646 d. 3,976

8.) 625
x37

a. 23,125 c. 22,125 e. None of the Above

b. 672 d. 24,225

9.) Divide

7)245

a. 35 c. 138 e. None of the Above

b. 30 d. 5

10.) 93)26,587

a. 275 R 82 c. 287 R 62 e. None of the Above

b. 285, R 72 d. 285 R 82

11.) Which of these numbers are divisible by 3?

a. 29 b. 141 c. 271 d. None of these

12.) Name the next multiple of 5 in this series:

115 , 120 , 125

a. 120 b. 50

c. 130 d. 75

13.) Which number is divisible by 9?

a. 14 b. 22 c. 19 d. 54 e. None of these

14.) Which number is a multiple of 10?

a. 125 b. 130 c. 142 d. None of these

15.) Which of these numbers is prime?

a. 72 b. 23 c. 9 d. 55 e. None of these

16.) Which of these numbers is composite?

a. 7 b. 25 c. 11 d. 31 e. None of these

17.) What are the common factors of 16 and 24?

a. 1, 2, 4, 8
c. 1, 8, 16, 24
b. 1, 4, 16
d. 2, 4, 6

18.) Find the next multiple in the series for the factors 3 and 5 ?

15, 30, ?

a. 60
c. 10
b. 45
d. 25

19.) What fraction is equivalent to ½?

a. $\frac{3}{9}$ b. $\frac{3}{6}$ c. $\frac{3}{4}$ d. $\frac{3}{12}$

20.) $\frac{4}{5} = \frac{16}{?}$

a. 10
c. 20
b. 15
d. 25

21.) $\frac{75}{5} =$

a. 25
c. 30
b. 15
d. None of the Above

22.) $\frac{5}{6}$? $\frac{7}{9}$ a. < b. > c. =

23.) Simplify: $\frac{18}{45}$

a. $\frac{6}{15}$ b. $\frac{5}{9}$ c. $\frac{2}{5}$

d. None of the Above

24.) Add + Simplify if possible

$\frac{3}{10} + \frac{5}{10}$

a. $\frac{4}{5}$ b. $\frac{2}{10}$ c. $\frac{8}{20}$ d. $\frac{4}{10}$

25.) Add + Simplify if possible:

$\frac{1}{6} + \frac{3}{18}$ a. $\frac{6}{18}$ b. $\frac{2}{3}$ c. $\frac{9}{18}$ d. $\frac{1}{3}$

26.) Find the difference, simplify if possible:

$\frac{5}{6} - \frac{4}{6}$ a. $\frac{1}{6}$ b. $\frac{2}{6}$ c. $\frac{1}{3}$ d. None of the Above

27.) $\frac{8}{9} - \frac{4}{5}$ a. $\frac{1}{9}$ b. $\frac{4}{45}$ c. $\frac{3}{45}$ d. $\frac{1}{15}$

28.) Express these fractions as mixed numerals in lowest terms:

$\frac{54}{10}$ a. $6\frac{1}{5}$ b. $50\frac{4}{10}$ c. $5\frac{2}{5}$ d. $5\frac{4}{10}$

29.) Add and Simplify if possible:

$5\frac{1}{3} + 6\frac{3}{5}$ a. $11\frac{3}{5}$ b. $12\frac{1}{2}$ c. $11\frac{4}{5}$ d. $11\frac{14}{15}$

30.) Find the difference and simplify if possible:

$8\frac{5}{6} - 3\frac{1}{6}$ a. $5\frac{4}{6}$ b. $5\frac{2}{3}$ c. 12 d. $5\frac{5}{6}$

31.) $113 - 78\frac{18}{20}$ a. $34\frac{1}{10}$ b. $34\frac{2}{20}$ c. $35\frac{1}{10}$ d. $35\frac{2}{20}$

32.) $9\frac{1}{4} - 6\frac{1}{2}$ a. $2\frac{1}{4}$ b. $3\frac{1}{2}$ c. $3\frac{1}{4}$ d. 2 3/4

33.) $\frac{3}{5} \times \frac{2}{3}$ a. $\frac{6}{15}$ b. $\frac{5}{8}$ c. $\frac{5}{15}$ d. $\frac{2}{5}$

34.) $\frac{2}{3} \times 14$ a. $9\frac{1}{3}$ b. $\frac{28}{3}$ c. .8 d. None of these

35.) $6\frac{1}{3} \times 4\frac{1}{5}$ a. $26\frac{9}{15}$ b. $27\frac{7}{15}$ c. $26\frac{3}{5}$ D.. None of These

(continued)

36.) What is the Reciprocal of : 6

a. $\frac{1}{6}$ b. $\frac{6}{1}$ c. 61 d. None of these

37.) Divide, then Simplify if possible.

$\frac{4}{6} \div \frac{2}{3}$ a. $\frac{4}{4}$ b. $\frac{26}{1}$ c. 1 d. $\frac{12}{12}$

38.) $4 \div \frac{1}{8}$ a. $\frac{1}{32}$ b. 32 c. $\frac{4}{8}$ d. $\frac{1}{2}$

39.) $6\frac{1}{8} \div 3\frac{1}{2}$ a. $2\frac{1}{4}$ b. $\frac{9}{4}$ c. $\frac{49}{8}$ d. None of these

40.) Write the decimal numeral for the following numbers.

forty - five and two hundred sixteen thousandths.

a. 45,216 c. 45.00216

b. 45.216 d. $45\ \frac{216}{1000}$

41.) Write >, <, or = in the blank.

5.56 ---- 5.568 a. > b. < c. = d. None of the above

42.) Find the sum or difference for each of the following problems.

95.3
+6.4
----

a. 10.007 b. 100.07 c. 101.7 d. 10.007 e. None of the Above

43.) 96.8
- 44.6
----

a. 52.2 b. 14.14 c. 141.4 d. 5.22 e. None of the Above

44.) Find the product for each of the following decimal problems.

.96 x 58.1 a. 55.776 b. 67.7 c. 5.5776 d. 557.76 e. None of the Above

(continued)

45.) Find the quotient for each decimal problem. Be sure to place the decimal point properly into quotient.

15|4.50

a. .30

b. 3.0 d. 03

c. 30 e. None of the Above

46.) Find the quotient for each decimal problem. Be sure to place the decimal point properly into quotient.

.06|.12

a. 3

b. .03 d. .002

c. .02 e. None of the Above

47.) .41|25.584

a. 5.113 c. 51.1 e. None of the Above

b. 62.4 d. .624

48.) Write a fraction for the following decimal numbers.

.6

a. $\frac{6}{10}$ c. $\frac{6}{100}$ e. None of the Above

b. $\frac{3}{4}$ d. $\frac{6}{1}$

49.) Change the fractions to decimal numbers. If the decimal is repeating, show this with the proper symbol.

$\frac{3}{11}$

a. $\overline{.3}$ c. $\overline{2.73}$ e. None of the Above

b. .311 d. $\overline{.27}$

MATH 6

(continued)

50.) Change the fraction to a decimal number and round to the nearest hundredth.

$\frac{6}{7}$

a. .75 b. .86 c. .85 d. .851 e. None of the Above

51.) Change the fraction to a decimal number, and round to the nearest thousandth.

$\frac{5}{11}$

a. .455 b. 2.2 c. .46 d. .454 e. None of the Above