Effects of Computer-Assisted-Instruction On Different Learners

Patrick L. Traynor

The purpose of this study was to determine how computer-assisted-instruction improves student performance among various types of students. 161 middle school students of various program types: special education, non-English proficient, limited English proficient, and regular education, completed instructional units using a computer program, CornerStone. Regular education students were found to have made greater pretest-posttest gains than special education students using an ANCOVA test, $F(1, 156), 0.95, = 15.59, p < 0.0001$. Collectively, the students showed significant pretest-posttest gains, $t(160), 0.95 = 6.02, p < 0.0001$ using a dependent $t$-test. The direction of future research was suggested based on the results.

There is no doubt that technology has become incorporated into our school systems. Computers are used not only as a means of helping schools analyze data, but also have become a pervasive tool toward optimizing student learning. For example, students are regularly using the Internet to gather and assimilate information for use in research assignments. They are preparing “electronic” presentations using computer presentation programs and LCD projectors. They are using word processing programs to create various reports. Students are even using spreadsheets to increase their experiences with mathematical concepts. In addition, many schools have incorporated interactive computer-assisted-instruction into their program to provide students opportunities to master specific educational objectives or standards.

Review of Pertinent Studies

Computer programmers have been able to create computer-assisted-instruction programs that have served to increase student learning by affecting cognitive processes and increasing motivation. Current research shows the mechanisms by which computer programs facilitate this learning: (1) personalizing information, (2) animating objects on the screen, (3) providing practice activities that incorporate challenges and curiosity, (4) providing a fantasy context and (5) providing a learner with choice over his/her own learning.

Personalizing information allows computer-assisted-instruction to increase learner interest in the given tasks (Padma and Ross, 1987) and increase the internal logic and organization of the material (Anderson, 1984; Ausubel, 1968; Mayer, 1975; Rumelhart and Ortony, 1977). New information can be more easily integrated into existing schema if a student's name or other familiar contexts appear in a problem.

The animation of objects involved in the explanation of a particular concept, for example, Newton's First Law of Motion, increases learning by decreasing the cognitive load on the learner's memory thereby allowing the learner to perform search and recognition processes and to make more informational relationships (Reiber, 1991).

Computer-assisted-instruction increases motivation by providing a context for the learner that is challenging and stimulates curiosity (Malone, 1982). Activities that are
intrinsically motivating also carry other significant advantages such as personal satisfaction, challenge, relevance, and promotion of a positive perspective on lifelong learning (Keller and Suzuki, 1988; Kinzie, 1990).

A fantasy context increases learning by facilitating engagement (Parker and Lepper, 1992; Malone, 1982). Fein (1981) and Signer (1987) have also found, apart from using computer programs, that involvement in fantasy is often highly intrinsically motivating.

Providing students with choice over their own learning provides learner-controlled instruction, which contributes to motivation. Increased motivation in turn increases student learning (Kinzie, Sullivan and Berdel, 1988). Also, program-controlled instruction, as opposed to learner-controlled, may get in the way of the learner by requiring the learner to study all of the given subject matter rather than only the elements the learner needs (Mayer, 1964). Further, learner-controlled instruction makes it possible for individuals to make certain choices in an activity and to affect certain outcomes. As a result, the individual feels competent and self-determining, and the activity has greater personal meaning and intrinsic interest (DeChamis, 1968; Lepper, 1985). Tennyson (1980, 1981) found learner control to be instructionally effective when individuals were given advisement on their performance in relation to program criteria. Further, learner control results in more positive attitudes toward the instruction (Fry, 1972; Hurlock, Lahey, and McCann, 1974).

While the factors contributing to learning using computer-assisted instruction have been well established in the literature, there is a lack of data based research showing the impact of computer-assisted instruction on various types of students. With the diversity of student bodies increasing across America's schools, schools have students that belong to various types of programs including special education programs, English learner programs, transitional English learner programs in addition to the regular instructional program. Therefore, this paper serves to answer the question, How does computer-assisted instruction improve learning among various types of students?

This study predicted that a computer-assisted-instruction program that incorporates one or more of the five mechanisms identified above, would have a significantly positive effect on student learning regardless of program type. However, due to the varied needs of students, the study predicted that the computer-assisted instruction would affect the different groups of students differently.

CornerStone

A computer-assisted-instruction program that incorporates some of the above mechanisms is Skills Bank CornerStone produced by The Learning Company. This program provides instruction in four main courses: reading comprehension, reading vocabulary, language arts, and math. Each course has three difficulty levels: A, B, and C. Level A is reported by the maker to offer instruction at the third and fourth grade levels. Level B is reported to offer instruction at the fourth and fifth grade levels, and level C, the seventh and eighth grade levels. Each course within each level consists of four to seven subject areas. For example, the language arts course consists of four subject areas: capitalization, punctuation, word usage and spelling. The math course consists of five subject areas: understanding numbers, using whole numbers, using decimals, using fractions and percents, and working with data. Each subject area consists of 10 to 20 lessons.

After taking a pretest in a certain subject area, for example, in capitalization in the language arts course, a student progresses through 10 to 20 relevant lessons. The program can assign which lessons the student should take based on need, or the teacher can allow the student to choose. The learner
completes the lessons at his/her own pace. There are four to five parts to each lesson. First, the student receives instruction on the learning objective. Second, the student practices the learning objective. Next, the student takes a brief quiz on the content. If the student misses questions on the quiz, s/he is taken back to the content related to the missed questions for a brief review. Finally, the student is provided more practice on the objective in a challenging fantasy context via a game.

The fantasy context, or games in the program, consists of requiring the learner to correctly respond to a previously practiced problem in a limited time. For example, at the end of some lessons, the learner takes the character of an explorer in search of King Tut's treasure. The learner controls the movements of the explorer on the screen. The explorer (learner) must travel through a series of tunnels and break through certain walls to get the treasure. To break through a wall, the computer program poses a question the learner practiced earlier in the lesson and the learner must respond correctly. In other lessons, the learner takes the character of a baseball player who needs to hit a ball that is pitched. To hit the ball, the student must correctly respond to problems during the time between the moment the ball leaves the pitcher's hand and the moment the player (learner) must strike the ball. The student controls the speed of the ball. The goal for the student is to earn as many hits as s/he can before the time expires. After completing all of the lessons in a given subject area, the learner takes a posttest that consists of the same content and format as the pretest.

The middle school selected is a seventh and eighth grade middle school that offers a computer-assisted-instruction class that utilizes CornerStone. For each course within CornerStone, the teacher has all students progress through all lessons in a sequential order. Students work on each course (language arts, math, reading comprehension, or reading vocabulary) once or twice per week. That is, all students work on the language arts course on Mondays, the math course on Tuesdays, reading comprehension on Wednesdays, and reading vocabulary on Thursdays. On Fridays, students are given a choice of courses over which to work.

Thus, the program and class offer three of the five mechanisms mentioned above that contribute to increased learning using computer programs: (1) providing practice activities that incorporate challenges and curiosity (2) providing a fantasy context and (3) providing the learner with choice over his/her own learning (choice on which program to work on Fridays and choice of pace at which to work).

Method

The Sample

Bloomington Middle School was chosen because it offers a computer-assisted-instruction class that utilizes CornerStone for student instruction. Approximately 210 of the school's 625 students were scheduled into this computer-assisted-instruction class the first semester. Elective classes include, in addition to this computer-assisted-instruction class, art, technology, band, and AVID (a special course for improving average to high performing students who would otherwise be at-risk of dropping out of school prior to completing high school). At this particular middle school, if a student did not choose band or AVID, the student would be scheduled into the computer-assisted-instruction class, technology, or art. Students' schedules change every semester.

161 of the 210 students who were enrolled in this course comprised the sample. These students were those who completed the pretest and posttest for the capitalization subject area within the language arts course. This subject area was chosen because it contained the most pretest and posttest scores, N = 161. The students were categorized into one of four groups depending on the type of
instructional program in which the school placed them: (1) special education, (2) sheltered English immersion (non-English proficient), (3) transitional English immersion (limited English proficient), and (4) regular education. As shown in Table 1, 16 students were in the special education group, 10 were in the sheltered English immersion group, 32 were in the transitional English immersion group, and 103 were in the regular instruction program.

Data Analyzed
The data included pretest and posttest scores from approximately one month after the start of the first semester to the end of the first semester (approximately 70 days). Due to delays in setting up the program during the first month of the first semester of school, student data was not recorded until after the first month. After the first month, students were instructed to enter their own user identification number. This required the students to start at the beginning of the program and work sequentially through the lessons. The computer program allowed for storage of all student data including pretest and posttest results.

All students were started at level B, the fifth and sixth grade level. The students that the teacher judged were experiencing difficulty were moved to level A. Students that finished level B during the course of the semester were moved to level C. Thus, most participants used the program at level B.

Thus, the data that were analyzed for this study included the pretest and posttest scores for the capitalization subject area for all students in level B who completed both the pretest and posttest for capitalization. The type of instructional program in which the school placed the students was also used.

Statistical Tests and Instruments
A comparison of pretest and posttest scores was made for all students and a comparison of pretest and posttest gains was made among the types of student programs. Thus program type was the independent variable and pretest and posttest scores for the students was the dependent variable.

The study identified a potential problem with using the pretest and posttest scores. There may have been a substantial correlation between pretest scores and posttest scores. That is, pretest scores per se may have been a good indicator of pretest and posttest gains. It is reasonable to expect, for example, that students with low pretest scores will tend to make greater absolute gains from the pretest to the posttest than students with high pretest scores who have less room for absolute gains. Therefore, a test that could control for the possible regression effects between pretest scores and posttest scores was needed.

<table>
<thead>
<tr>
<th>Program Type</th>
<th>n</th>
<th>Mean Pretest</th>
<th>Mean Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>16</td>
<td>43.12</td>
<td>48.44</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>48.60</td>
<td>60.60</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
<td>51.06</td>
<td>63.91</td>
</tr>
<tr>
<td>4</td>
<td>103</td>
<td>57.83</td>
<td>67.50</td>
</tr>
</tbody>
</table>

Note: 1 = special education; 2 = sheltered English immersion; 3 = transitional English immersion; 4 = regular education.
Thus, the ANCOVA test was performed for comparing the pretest and posttest gains among the different groups of students. The ANCOVA equated the groups of students based on pretest scores. A computer program called SAS was used to run the ANCOVA with the Tukey method of multiple comparisons to determine if a difference in pretest and posttest gains existed among the groups of students and to identify the specific groups of students that differed.

Also, a dependent t-test was performed with the SAS program for the 161 students who comprised all program types to determine if the computer-assisted-instruction program, CornerStone, made a significant contribution toward overall student learning.

Results

Since the purpose of the study was to measure how computer-assisted-instruction improved various types of students, the null hypotheses for this study were: (1) computer-assisted-instruction using Skills Bank CornerStone has no impact on student learning and (2) there is no difference in the amount of learning that occurs among special education students, sheltered English immersion students, transitional English immersion students, and regular education students. That is, (1) $H_{01}: \mu_1 = \mu_2$, where $\mu_1$ is the mean of the overall pretests of all students in the study and $\mu_2$ is the mean of the overall posttests; and (2) $H_{02}: \mu_1 = \mu_2 = \mu_3 = \mu_4$, where $\mu_1$ = the mean of special education students’ gains, $\mu_2$ = the mean of sheltered English immersion students’ gains, $\mu_3$ = the mean of transitional English immersion students’ gains, and $\mu_4$ = the mean of regular education students’ gains.

Since the computer-assisted-instruction program, CornerStone, did incorporate three of the mechanisms that have been shown to increase learning, the alternative hypothesis to the first null hypothesis was $H_{11}: \mu_1 \neq \mu_2$.

Also, since special education students have an identified learning disability with a tendency to learn at slower rate, if not given an appropriate intervention, this group was predicted to have significantly lower pretest to posttest gains than other groups. Similarly, one can make the same argument for the sheltered English immersion students and limited English immersion students. Thus, the alternative hypothesis for the second null hypothesis was $H_{12}: \mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4$.

The dependent t-test showed a significant difference between pretest and posttest scores for the entire sample, $t_{160} = 6.02$, $p < 0.0001$. The mean pretest score was 54.4, the mean posttest score was 64.5. The standard deviation of the pretest to posttest gain scores was 21.1. Therefore, the null hypothesis, $H_0: \mu_1 = \mu_2$, was rejected in favor of the alternative hypothesis: $H_1: \mu_1 \neq \mu_2$. Students overall scored significantly higher on the posttest than the pretest using the computer-assisted-instruction program, CornerStone.

The ANCOVA test with the Tukey method of multiple comparisons showed that there were significant differences between $\mu_1$ and $\mu_4$, the special education and regular education groups respectively, $F_{1,9}, 0.95 = 15.59$, $p < 0.0001$ (See Table 2). There were no significant differences among the other groups. Therefore, the null hypothesis, $H_{01}: \mu_1 = \mu_2 = \mu_3 = \mu_4$, was rejected in favor of the alternative hypothesis, $H_1: \mu_1 \neq \mu_2 \neq \mu_3 \neq \mu_4$. There was a significant difference among the groups of students in pretest and posttest gains using the computer-assisted-instruction program, CornerStone. Special education students did not show as great of gains as regular education students in pretest and posttest scores using the computer-assisted-instruction program.
### Table 2

**ANCOVA Summary Table for Study Investigating the Relationships between Program Type and Pretest and Posttest Gains**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Program Type</td>
<td>4</td>
<td>24020.10</td>
<td>6005.25</td>
<td>15.59*</td>
<td>0.29</td>
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<tr>
<td>Within Groups</td>
<td>156</td>
<td>6097.06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>160</td>
<td>84118.06</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. N = 161.
* p < 0.0001

### Discussion

**Findings**

The results indicate that the computer-assisted-instruction program, CornerStone, increased overall student learning, \(160, 0.95 = 6.02, p < 0.0001\), as measured by pretest and posttest gains for all types of students in the study: (1) special education, (2) sheltered English immersion (non-English proficient), (3) transitional English immersion (limited English proficient), and (4) regular education. Also, the results show there was a significant difference in the pretest and posttest gains of special education and regular education students, \(F_1, 156, 0.95 = 15.59, p < 0.0001\). The results show no other significant differences among the other possible combinations of pairs of program types in which students were placed.

Since three of the five identified computer-assisted-instruction learning mechanisms were present in the computer-assisted-instruction program used, the increased learning found in this study is consistent with the literature. Again, the three mechanisms inherent in this program and used in this course were (1) providing practice activities that incorporate challenges and curiosity, (2) providing a fantasy context and (3) providing the learner with choice over his/her own learning (choice on which program to work on Fridays and choice of pace).

### Direction of Future Research and Practice

The results indicate that the computer-assisted-instruction program increased overall student learning. Since the program incorporated only three of the five identified mechanisms of computer programs that have been shown to increase student learning: (1) providing practice activities that incorporate challenges and curiosity, (2) providing a fantasy context and (3) providing the learner with choice over his/her own learning, student growth comparisons among the various types of students could be made using a computer-assisted-instruction program that incorporates the remaining two mechanisms, (1) personalizing information, and (2) animating objects on the screen.

Also, a more invasive study could increase the generalizability of the results. For example, a control group could be used against which all other groups and the total experimental sample could be compared. Also, students could be more randomly selected to represent the general population or at least a school’s population more accurately.

As mentioned above, the overall increased learning found in this study is consistent with current research. Therefore, the program used in this study, CornerStone, or programs that incorporate the components of computer programs that have been shown
to increase student learning, should be considered by educators whose goal is to increase student mastery of specific objectives.

Also, with no additional interventions given to special education students, differences in the amount of learning between special education students and regular education students could be expected as children in the former group have an identified learning disability and need intervention. The special education students in this study received no additional assistance in using CornerStone. Perhaps discrepancies found in learning between the two groups could be eliminated by incorporating the other mechanisms of student learning mentioned above or by intervening in other ways.

References


