

**STAR Treatment Effect on Mathematics
Performance Levels of 2nd, 3rd and 4th Grade Students
Measured using the California Achievement Test Form 6
and the California Standards Test
2003/2004**

This is the second in a series of reports on the effect of using MIND Institute's Spatial Temporal Animation Reasoning (STAR) program to deliver mathematics training to 2nd, 3rd and 4th grade students. The first study was based on the results for the academic year 2002/2003.

Introduction

STAR games are a series of computer-delivered spatial-temporal reasoning (ST) mathematical puzzles. In order to solve them, a student is required to master certain sets of standards-aligned concepts. Hypothetically, a student's mastery of the STAR games at the student's grade level will be reflected in improved achievement on tests of mathematical competence.

The MIND curriculum also includes music training through piano keyboard for every participating student.

The results for the academic year 2003/2004 are very similar to prior results.

Methodology:

Over 4,000 2nd, 3rd and 4th grade students in 15 California elementary schools were included in this year's study. The treatment group consisted of 2,784 students from classrooms where the teacher volunteered to participate. The control group was composed of 1,591 students from non-participating classrooms. For all of the second grade students, this was their initial year in the program.

Reasonable experimental controls were implemented in the program.

- All classes consisted of heterogeneous groupings of students related to mathematics abilities.
- Because so many different classes were involved, the quality of mathematics instruction was assumed to be uniform throughout, as were all other extraneous school and classroom variables.
- Teachers for the treatment group were not provided additional time or incentives for teaching of mathematics.
- Participating students accessed the STAR games on computers as a component of their regular mathematics curriculum, while control group students were taught math using regular, established methodologies.
- The amount of time and effort spent on the teaching of mathematics was determined and controlled by the individual classroom teacher and was relatively uniform throughout.

The treatment group students were provided the STAR sequence of computer-delivered mathematical games appropriate for the grade level. Each game consisted of multiple levels of increasing difficulty or complexity. Each level consisted of multiple problems, and each play resulted in a score. A student was required to exhibit a mastery score at a level before moving on to a subsequent level. All attempts at a game within each level, whether successful or not, were automatically recorded for each student. Students were expected to complete all of the STAR activities for one grade level during the academic year.

All the students in the program were administered two tests of math competence, California Standards Test (CST) and the California Achievement Test, Form 6 (CAT6) in spring, 2004. The results of these tests were to be used as a summary indication of performance for the use of the STAR program.

The California Standards Test (CST) is a criterion-referenced test that produces an indication of mastery of math concepts appropriate for each grade level. Students are placed in one of five categories, based on performance (Advanced, Proficient, Basic, Below Basic, and Far Below Basic).

The California Achievement Test, Form 6 (CAT6) is a standardized test of math concepts appropriate for each grade level. It produces a set of scores based on individual performance compared to national standards. The scoring chosen for this study was the National Percentile Rank (NPR), which indicates what percentage of students scored lower than the individual. The students' NCE scores were averaged and that average converted to an equivalent NPR score for comparison of groups.

Data

STAR performance data was accumulated automatically from individual computers using a local data storage device and an Internet uplink to a server at the Mind Institute. For each participant, attempts and completions of an exercise were recorded. A game history for each student was produced showing the number of games, out of the year-long game curriculum, attempted and completed.

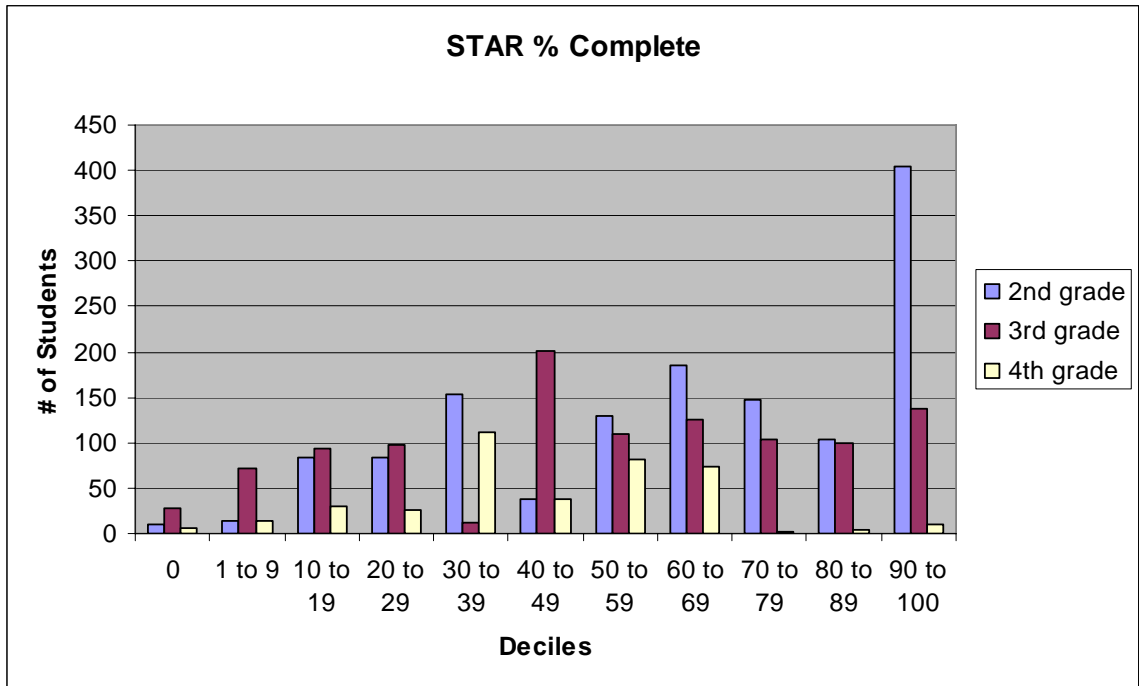
For each STAR participant, a percentage of games attempted or passed in the grade level curriculum was calculated (% STAR progress).

When summary test data became available in Fall 2004, the test results for each student (treatment and control groups) were imported into an individual student record. Students with No or Incomplete Test Records were eliminated from the study as were records of test data for treatment group students who had null STAR progress data. Test records for STAR participants were merged with % STAR progress data from STAR.

All treatment students did not complete the entire STAR exercises during the year as expected. (Exhibit A, below). Second grade students completed the most games, with

students averaging 66% completion in two sessions per week. By comparison, with one session per week, most 3rd graders completed more than half the exercises, but few 4th graders did so.

Exhibit A. Percent of STAR games completed, by grade level, treatment group

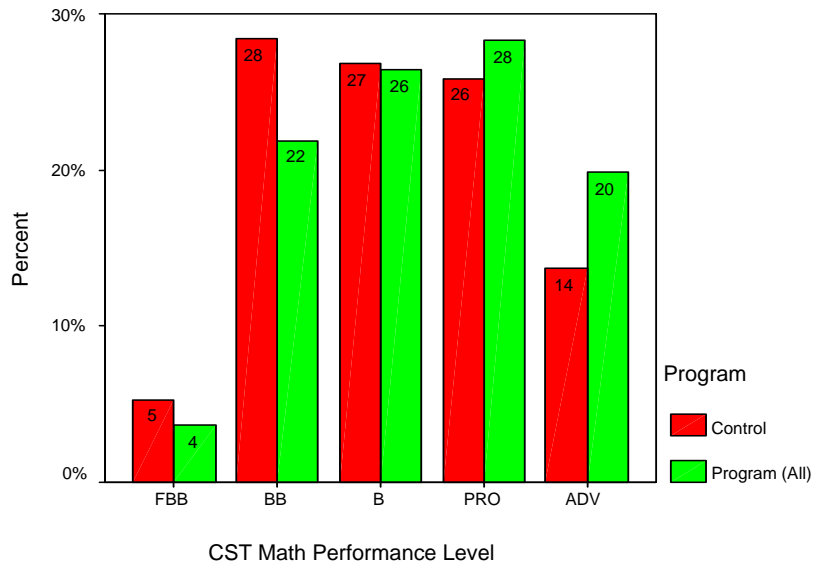


As in the prior year study, it was determined that students who did not complete at least 50% of the games exhibited little positive effect from the treatment. Therefore, for analysis purposes, treatment group students were divided into two categories, those that completed 50% or more of the games and those that completed 49% or less of the games.

Analysis

Hypothetically, if there was no effect of STAR participation on mathematics performance, then the two heterogeneous groups, treatment and control, would exhibit very similar scores on the two summary tests. Evidence suggests that test results for the two groups were significantly different, with the treatment group scoring significantly above the control group on both tests. For example, on the CST test, the percentage of treatment students rating Proficient and Advanced was 48%, compared to 40% of the control students. (Exhibit B, below).

Exhibit B. Percent of students placing in each CST category, treatment and control groups



California Standards Test (CST)

If STAR treatment had *no effect* on mathematics performance, then the three groups (control, <50% completion, 50%+ completion) should exhibit very similar test performance levels. Considering all three grade levels together, the students that completed 50% or more of the games scored significantly better than either the control group students or the students that completed less than 50% of the games. By comparison, the control group students and the students that completed less than 50% of the games exhibited very similar test results. (Note: Completion rate of STAR games was not an indicator of mathematics aptitude. If higher math aptitude students had completed more games, they would have been eliminated from the lower completion treatment group. This would have resulted in significantly lower test scores for the treatment group that completed less than half the games, which was not the case.)

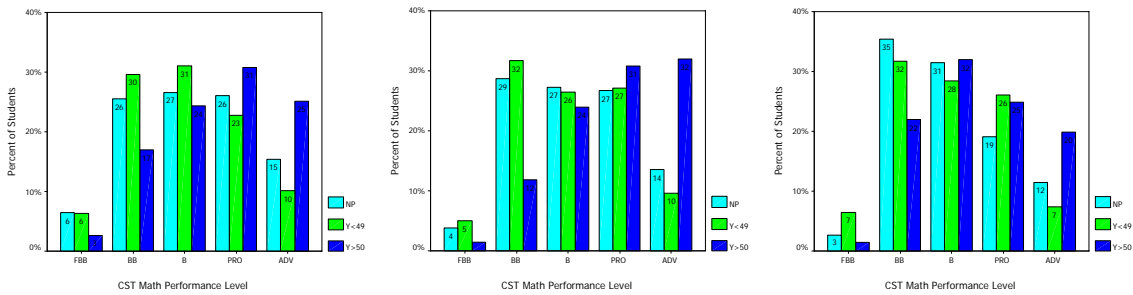
The second graders, who were in their first year in the program, exhibited significantly better performance on the CST than did their non-treated counterparts (Exhibit C.1., below). When the treated students who completed less than 50% of the games are removed from total population, the difference between treatment and control groups on the CST test are marked. Comparison of the relative performances of the control group students and those treatment students with less than 50% completion rates, illustrates that they are virtually identical.

CST results for the third graders in the program are very similar to those of the second graders. For many of these students, it was their second year in the program (Exhibit C2., below). Considering all the treated students together, they significantly out-performed their non-treated counterparts on the test. When the students that completed less than

50% of the games are eliminated from the population, the comparison with control group students is even more significant. Students in the control group and those treatment students with less than 50% completion rates produced very similar test results.

At the fourth grade level, so few students completed more than 50% of the games that results are somewhat inconclusive. But, indications are that students who completed 70% or more of the games received significant benefit when taking the CST test, as ten of the fifteen students were rated Proficient or Advanced, compared to only 33% of the control group students.

Exhibit C. CST performance results for grades 2,3& 4, treatment and control groups



California Achievement Test, Form 6 (CAT6)

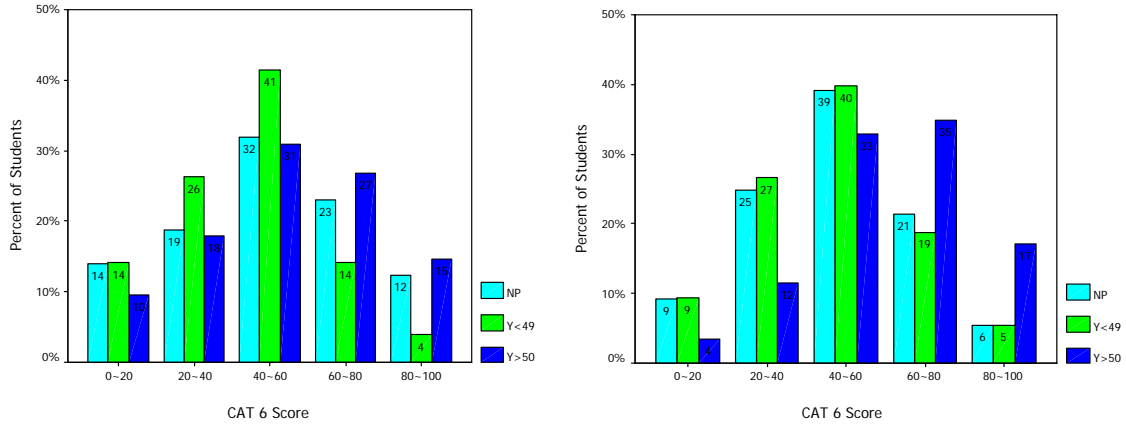
Results of testing using the California Achievement Test, Form 6 are similar to those for the CST examination, but not as significant. At all three grade levels, those students that completed 50% or more of the STAR games performed better on the CAT6 test in mathematics than did their minimally treated or non-participating counterparts. In general, the students that completed less than fifty percent of the STAR games did not perform as well as students in the other two groups.

At the second grade level, the high-completion STAR students also more frequently achieved in higher percentile rankings than did their not-participant cohorts (Exhibit D., below). The lower-completion STAR students did not perform as well as either of the other two groups.

In the third grade, students with 50% or more games completed performed significantly better on the CAT6 in mathematics than did either of the other two groups, placing a much larger percentage of students in the higher percentile rankings(Exhibit D., below). The lower-completion students achieved very similar rankings to the control group.

Too few fourth grade students completed 50% or more of the STAR games to support strong conclusions about the effect of STAR treatment on mathematics achievement. However students that completed more than 50% percent of the STAR games did place in the top rankings at a greater frequency than their counterparts in the other two groups.

Exhibit D. CAT6 performance results for grades 2 and 3, treatment and control groups



Conclusion

As in the 2002/03 trial under the same conditions, evidence is that *completion of 50% or more of the STAR games as part of the regular mathematics curriculum results in a significant increase in achievement scores on the CST and the CAT6 tests among elementary grade students.* Moreover, there seems to be some positive effect on test scores by completing less than 50% of the STAR games, but the relationship is inconclusive.