

**STAR Treatment Effect on Mathematics  
Performance Levels of 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> Grade Students  
Measured using the California Achievement Test Form 6  
and the California Standards Test  
2002/2003**

## **Introduction**

Studies by the MIND Institute have indicated that elementary school students trained in spatial-temporal reasoning (ST) will improve in performance on mathematics tests. The MIND Institute has created a ST mathematics curriculum through patent-pending software called Spatial Temporal Animation Reasoning (STAR) to deliver math training. STAR presents the concepts in game format. STAR games are a series of computer-delivered ST mathematical puzzles that require the student to master certain sets of standards-aligned concepts in order to solve them. Becoming proficient in applying these non-verbal ST concepts to a variety of mathematical problems, the students enhance their ability to do mathematics. 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.

## **Methodology**

Over 6,000 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> grade students in 27 California elementary schools participated in a seminal study of the effect of using the STAR program to enhance mathematics performance during the 2002/2003 academic year. In general, the majority of students were identified as being from economically disadvantaged households. The treatment group consisted of 4,173 students from classrooms where the teacher volunteered to participate. The control group was composed of 1,546 non-participating students from the same grades and schools. All classes consisted of heterogeneous groupings of students related to mathematics abilities.

All participating teachers, and therefore their students, were self-selected for participation in the STAR program. Because so many different classrooms were involved in both the treatment and control groups, it is assumed that the quality of mathematics instruction was uniform across and between the groups. The application (time on task and pacing) of STAR instruction was controlled by the teacher. Because of limitation on computer access, the implementation practices for all participating students are assumed to be relatively uniform. Teachers for the treatment group were not provided additional time or incentives for teaching of mathematics. All other extraneous variables are assumed to be uniform across and between the two groups.

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 applied to math instruction in both groups was similar.

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 2003. 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 rated in 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.

## Data

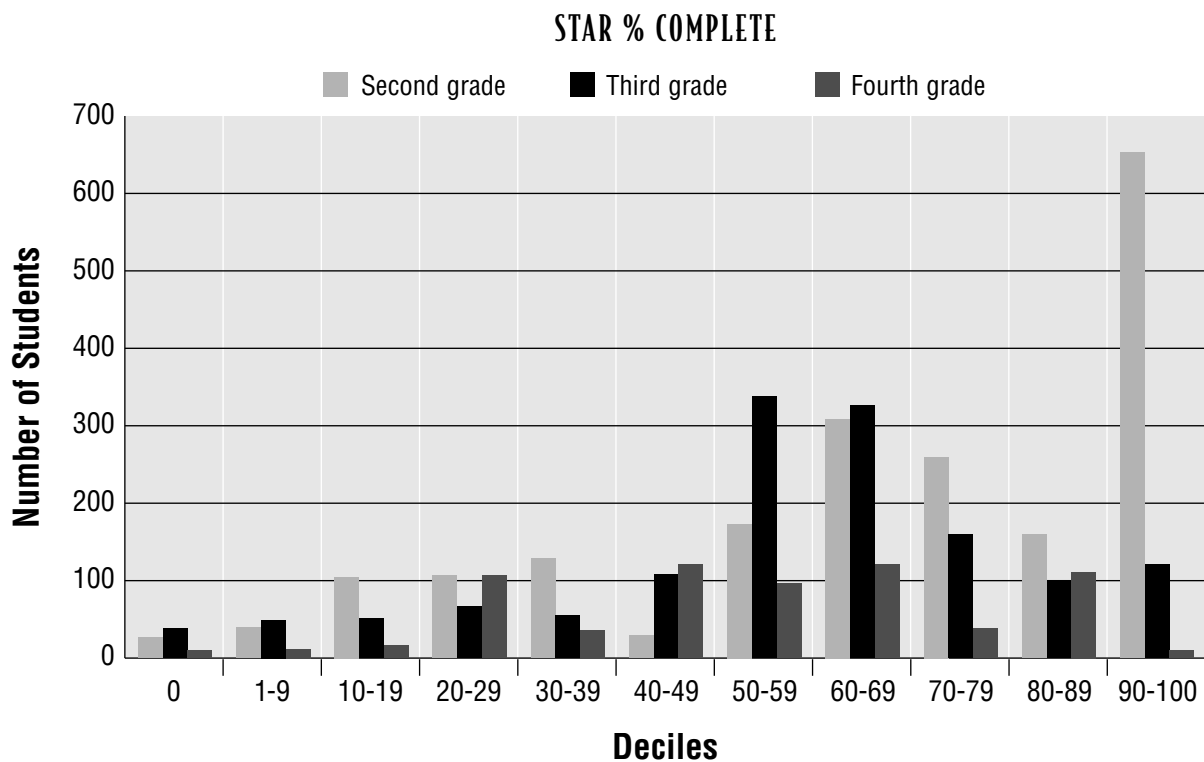
STAR performance data was accumulated automatically from individual computers using a local data storage device and an Internet uplink to a server at the MIND Institute. For each participant, attempts and completions of an exercise were recorded. A game history for each student was produced showing the 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 2003, 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.

Initial analysis of STAR participants' performances indicated that students who completed less than 50% of the exercises exhibited minimal treatment effect on summary test scores. Thus, treatment students were divided into two groups for analysis, those completing 50% or more of the STAR exercises and those completing less than 50% .

All treatment students did not complete the entire STAR exercises during the study (Exhibit G). Second grade students completed the most games, with students averaging 68.5% completion in two sessions per week. By comparison, most 3<sup>rd</sup> and 4<sup>th</sup> grade students completed between 50% and 60% of the on-line activities in one session per week.



## Analysis

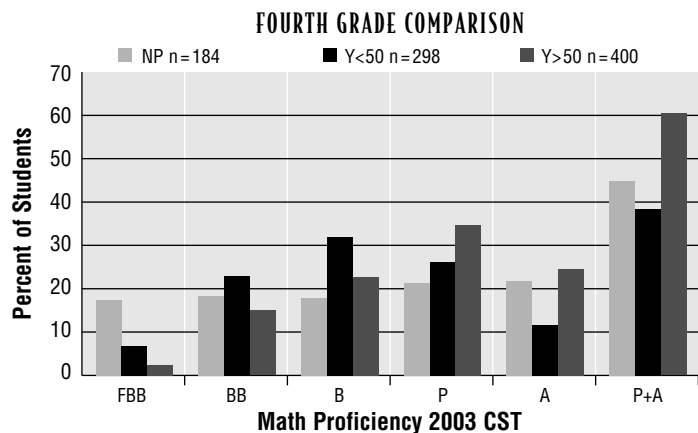
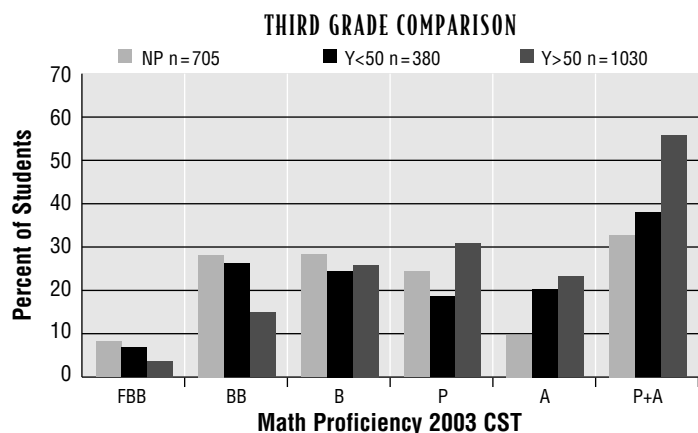
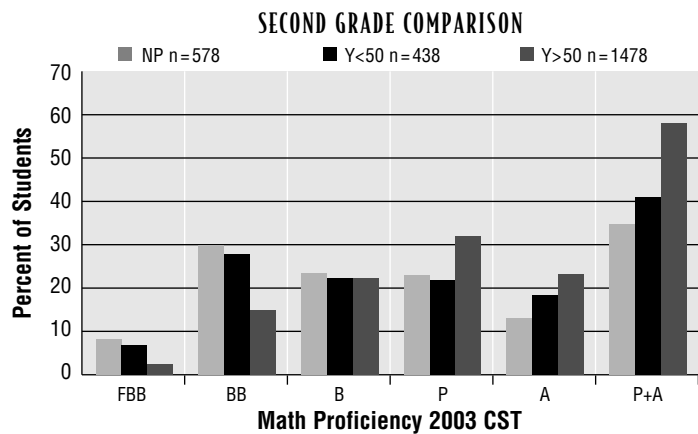
Hypothetically, if there was no effect of STAR treatment participation on mathematics performance, the two heterogeneous groups, treatment and control, would exhibit very similar scores on the two summary tests. Evidence suggests that the test results for the two groups were significantly different, supporting the conclusion that STAR treatment did affect performance on summary tests.

## California Standards Test

If STAR treatment had no effect on mathematics performance, then the three groups (control, less than 50% completion, 50% completion or greater) should demonstrate very similar distributions in competency levels on the criterion-referenced test. Performance by the control group established a standard of comparison for the other two groups.

In all three grade levels, students who completed 50% or more of the STAR games performed significantly better on the test in mathematics than did students in the other two groups (Exhibits A, B & C). About 60% of the >50% completion students at all three grade levels were ranked as being Advanced or Proficient, compared to approximately 40% of students in the other two groups. There is considerably less difference in ranking between the control group students and those students who completed less than 50% of the STAR exercises.

**It can be concluded from the evidence that there is a positive correlation between completion of a significant portion of the STAR exercises and performance on the criterion-referenced test in mathematics.**



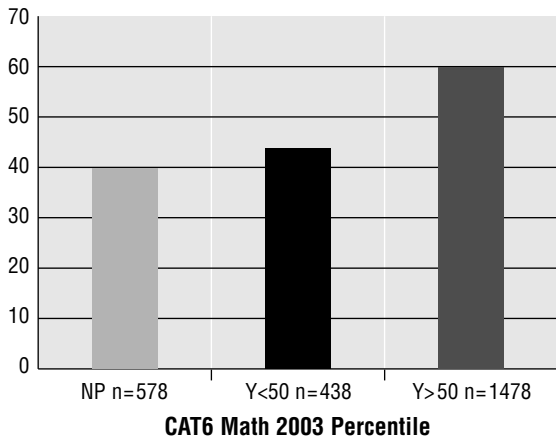
## California Achievement Test, Form 6 (CAT6)

If the STAR treatment has no effect on mathematics performance, then the three groups (control, less than 50% completion, 50% completion or greater) should demonstrate very similar distributions in competency levels on the standardized test. Performance by the control group established a standard of comparison for the other two groups.

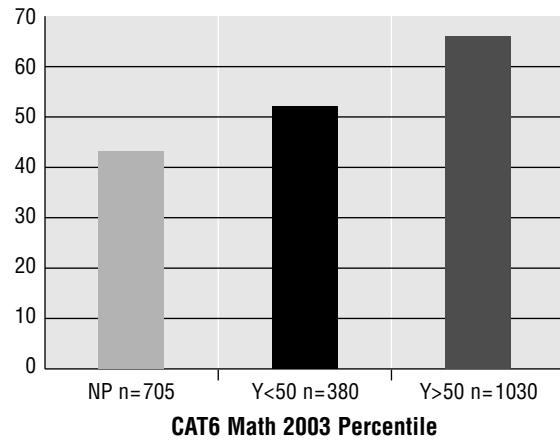
At all three grade levels, the students that completed 50% or more of the STAR exercises performed significantly better than either of the other two groups. Performance by the students who completed less than 50% of the games, though slightly better than the control group, was very similar to control group performance.

The difference in performance was most pronounced at the 3<sup>rd</sup> and 4<sup>th</sup> grade levels, where the >50% group averaged 23 percentiles above the average for the control group. The difference in performance at the 2<sup>nd</sup> grade level was an average of 20 percentiles greater than the average for the control group. All of these differences show a significantly better performance for the treatment group than for the control group.

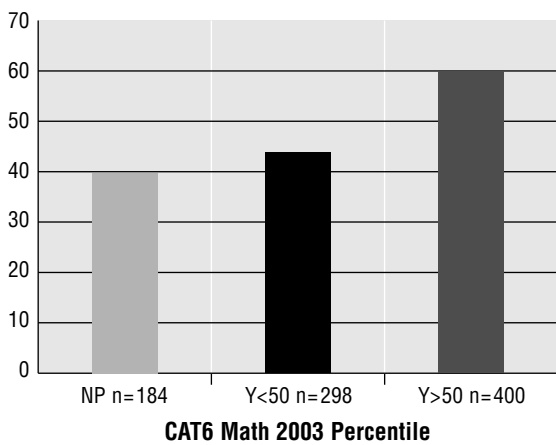
SECOND GRADE COMPARISON CAT6



THIRD GRADE COMPARISON CAT6



FOURTH GRADE COMPARISON CAT6



## Conclusion

Evidence suggests that there is a positive effect on mathematics performance on criterion-referenced and standardized test scores in 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> grade from completing more than 50% of the grade appropriate STAR activities as part of regular mathematics instruction. In addition, there tends to be some positive effect on subsequent test performance by completing less than 50% of the STAR activities as part of the regular mathematics instruction, but the relationship is not conclusive.

The strong association between successful completion of 50% or more of the STAR exercises and resultant higher performance on mathematical test is strengthened by considering the relative performance of those students who completed less than 50%. Students who completed fewer STAR lessons performed as well as or better on the tests than did the control group students. If lack of progress on the STAR program resulted because those students had lesser math abilities, then that group should have performed at a lower level than the control group (who were heterogeneous in makeup). In fact, the lower progress STAR students scored as well as, if not higher than, the control group students at every grade level.

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