Cognitive Tutor® Algebra I

Program description
Cognitive Tutor® Algebra I, a full year course, delivers instruction in single variable data, simplifying linear expressions, mathematical modeling, solving systems with linear equations, problem solving using proportional reasoning, and powers and exponents. Students work at their own pace to develop problem-solving skills. The duration of each lesson can vary, depending on the length of a school's class period. Generally, three periods a week are spent using the Cognitive Tutor® Algebra I text for classroom activities, and two are spent in the computer lab using the Cognitive Tutor® Algebra I software.

Research
One study met the What Works Clearinghouse (WWC) evidence standards and one study met the WWC evidence standards with reservations. Together, the two studies included more than 800 ninth graders in more than 40 classrooms in Florida and Oklahoma. The studies examined the effects of Cognitive Tutor® Algebra I on students’ math achievement.1

The WWC considers the extent of evidence for Cognitive Tutor® Algebra I to be moderate to large for math achievement.

Effectiveness
Cognitive Tutor® Algebra I was found to have potentially positive effects on math achievement.

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<th>Math achievement</th>
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<td>Rating of effectiveness</td>
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<td>Improvement index²</td>
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<td>Range: –1 to +16 percentile points</td>
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1. The evidence presented in this report is based on available research. Findings and conclusions may change as new research becomes available.
2. These numbers show the average and range of improvement indices for all findings across the studies.
Additional program information

Updating previous report
This report updates the previous WWC report on Cognitive Tutor® that was released on the WWC website in December 2004. The report released in 2004 reviewed research on a variety of Cognitive Tutor® math programs. However, this report focuses on Cognitive Tutor® Algebra I.

Since the original review of Cognitive Tutor® was released in December 2004, the WWC has updated its evidence standards and developed peer-review procedures for adjusting such methodological flaws in studies as nonequivalent groups at pretest and a mismatch between the unit of assignment and the unit of analysis. These standards and procedures have been applied to all studies in this updated review.

Developer and contact
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Scope of use
Pilot implementation of the curriculum began in 1992 with 84 students in one school. As of December 2006, Cognitive Tutor® curricula, which include Bridge to Algebra, Algebra I, Algebra II, Geometry, and Integrated Math, have been used by more than 475,000 students in 1,300 urban, rural, and suburban school districts across the United States. In 2006, Carnegie Learning revised some of the instructional and technological aspects of Cognitive Tutor® Algebra I. According to the developer, no fundamental changes to the pedagogical approaches or content were made.

Teaching
Typically, three class periods a week are organized around textbook materials and small group activities. Teachers facilitate small group problem solving and whole classroom discussions. In the other two class periods, students work at their own pace to develop problem-solving skills by working on the computer with the Cognitive Tutor® Algebra I software. In the computer lab, teachers interact with students individually.

Carnegie Learning provides a four-day preservice training. In-service professional development is also available during the year. Teacher training for Cognitive Tutor® Algebra I (software and text) covers the philosophy and application of these products. The training sessions are conducted by Certified Implementation Specialists—current or former mathematics teachers who have completed in-depth training from Carnegie Learning’s staff of educators, technology specialists, and curriculum developers.

Cost
Cognitive Tutor® Algebra I is offered to schools as annual site license configurations. According to the developer, pricing per student starts at $58.80 for the full curriculum—software, books, and maintenance. Volume and term discounts are available. Professional development costs $600 per teacher attending a regional training site or $2,500 a day for onsite training.

Research
Five studies reviewed by the WWC investigated the effects of Cognitive Tutor® Algebra I. One study (Morgan & Ritter, 2002), which was reviewed in the original WWC report, was a randomized controlled trial that met WWC evidence standards. One study (Shneyderman, 2001), which is new to this report, used a quasi-experimental design that met WWC evidence standards with reservations. The remaining three studies did not meet WWC evidence screens.

Morgan and Ritter (2002) included 369 ninth-grade students in four suburban junior high schools in the Moore Independent School District in Oklahoma. Students in intervention classrooms used Cognitive Tutor® Algebra I, and students in the comparison group used McDougal Littell’s Heath Algebra 1, a traditional, teacher-directed curriculum. Students in the intervention and comparison groups attended the same schools and were taught by the same teachers.
Shneyderman (2001) included 439 ninth-grade students from six public high schools in Miami-Dade County, Florida, during the 2000-01 school year. The intervention group used the Cognitive Tutor® Algebra I textbook, classroom activities, and software. No information was provided on the comparison group other than these students did not use the Cognitive Tutor® Algebra I textbook and software. Students in the intervention and comparison groups attended the same schools.

### Extent of evidence

The WWC categorizes the extent of evidence in each domain as small or moderate to large (see the What Works Clearinghouse Extent of Evidence Categorization Scheme). The extent of evidence takes into account the number of studies and the total sample size across the studies that met WWC evidence standards with or without reservations. Only students who took both the pretest and posttest, found no statistically significant differences between the groups on either measure. Further, the average effect size across the two outcomes was neither statistically significant nor large enough to be considered substantively important according to the WWC standards (that is, at least 0.25).

In sum, one study showed statistically significant positive effects, and one study showed indeterminate effects in the math achievement domain.

### Rating of effectiveness

The WWC rates the effects of an intervention in a given outcome domain as positive, potentially positive, mixed, no discernible effects, potentially negative, or negative. The rating of effectiveness takes into account four factors: the quality of the research design, the statistical significance of the findings, the size of the difference between participants in the intervention and comparison conditions, and the consistency in findings across studies (see the WWC Intervention Rating Scheme).
Improvement index
The WWC computes an improvement index for each individual finding. In addition, within each outcome domain, the WWC computes an average improvement index for each study and an average improvement index across studies (see Technical Details of WWC-Conducted Computations). The improvement index represents the difference between the percentile rank of the average student in the intervention condition versus the percentile rank of the average student in the comparison condition. Unlike the rating of effectiveness, the improvement index is entirely based on the size of the effect, regardless of the statistical significance of the effect, the study design, or the analyses. The improvement index can take on values between −50 and +50, with positive numbers denoting results favorable to the intervention group.

The average improvement index for math achievement is +8 percentile points across the two studies, with a range of −1 to +16 percentile points across findings.

Summary
The WWC reviewed five studies on Cognitive Tutor® Algebra I. One of these studies met WWC evidence standards and another study met the WWC evidence standards with reservations; the remaining three studies did not meet WWC evidence screens. Based on these two studies, the WWC found potentially positive effects in the math achievement domain. The evidence presented in this report may change as new research emerges.

References
Met WWC evidence standards


Met WWC evidence standards with reservations


Additional source:

6. Lack of evidence for baseline equivalence: the study, which used a quasi-experimental design, did not establish that the comparison group was equivalent to the intervention group at baseline.

7. Lack of evidence for baseline equivalence: the study, which was reviewed as a quasi-experimental design, did not establish that the comparison group was equivalent to the intervention group at baseline. This study, which was designed as a regression discontinuity design, did not properly assign students at the cutoff grade.

For more information about specific studies and WWC calculations, please see the WWC *Cognitive Tutor® Algebra I Technical Appendices*. 