

Abstract Title Page
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Title:

Results from a Randomized Efficacy Trial of Cognitive Tutor Geometry

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Abstract Body
Limit 5 pages single spaced.

Background/context:

Description of prior research and/or its intellectual context and/or its policy context.

This study aims to help address a need for information about efficacious mathematics curriculum and instruction at the high school level. Data from national and international studies, including the National Assessment of Educational Progress (NAEP), show very low mathematics proficiency rates for high school students. Many educators recognize a need to improve mathematics achievement through interventions such as new curriculum materials or instructional approaches, however they lack rigorous evidence on efficacy. By providing such information, this study can help guide educators in selecting the most promising materials.

Purpose/objective/research question/focus of study:

Description of what the research focused on and why.

The purpose of the study is to evaluate the efficacy of the Cognitive Tutor Geometry curriculum by Carnegie Learning Inc., using randomized controlled trials.

Setting:

Specific description of where the research took place.

Baltimore County Public Schools (BCPS) is in the urban fringe of Baltimore, serving students from a wide range of racial/ethnic and socioeconomic backgrounds. The district has 25 high schools, with a total enrollment of about 32,000 students.

Population/Participants/Subjects:

Description of participants in the study: who (or what) how many, key features (or characteristics).

In BCPS, minority enrollment is 39% and low-SES enrollment is 17%. Eight schools are included in the study sample. In participating schools, students enrolled in the standard geometry classes meeting the study's scheduling requirements were included in the random assignment process, regardless of grade level or other student characteristics. The study involved about 2,000 students, although only a portion of the students met all eligibility requirements and completed both pre- and post-testing.

Intervention/Program/Practice:

Specific description of the intervention, including what it was, how it was administered, and its duration.

The Cognitive Tutor Geometry curriculum was selected for study because it has shown promise in quasi-experimental studies; and because a related curriculum for Algebra I had significant positive effects in a randomized field trial (Morgan and Ritter, 2002). The curriculum is designed to promote understanding of geometric concepts and principles, and to enhance abstract and spatial reasoning skills. Students spend 40% of their class time using individualized tutorial software built on a detailed computational model of student thinking, and 60% in classroom activities that involve teacher-guided group work and problem solving. Teachers receive four days of training, a set of teacher training materials, and a teacher text.

Research Design:

Description of research design (e.g., qualitative case study, quasi-experimental design, secondary analysis, analytic essay, randomized field trial).

Two participating teachers in each school taught geometry concurrently during two distinct class periods. During the earlier class period, one was selected randomly to use the Cognitive Tutor Geometry curriculum and the other used the school's existing geometry curriculum. During the later period, the teachers switched curricula. For both periods, students enrolled in geometry were randomly assigned to experimental or control classes.

Data Collection and Analysis:

Description of plan for collecting and analyzing data, including description of data.

The main outcome measure was the district's required final exam, which include both multiple-choice and extended-response items. The ETS end-of-course algebra exam was administered as a pretest. The study also gathered data on other student outcomes that may influence long-term student achievement, such as mathematics confidence and attitudes. To monitor implementation fidelity, the study conducted three site visits per year, observing each class, including computer lab classes. Control classrooms were also each observed three times. Observations followed a rubric modeled after guidelines the developer uses to support implementation, which cover important elements of the instructional design. During these visits, teachers were interviewed about implementation and instructional practices.

Analyses used hierarchical linear models for test scores and generalized linear mixed models for dichotomous outcome measures, accounting for classroom period differences and teacher effects. Data from observation rubrics were synthesized into three scales of implementation for use in modeling the relationship between implementation and student outcomes. Qualitative analyses of site visit data also were used to interpret the observed treatment effects.

Findings/Results:

Description of main findings with specific details.

The study found a significant negative effect of treatment on student achievement (standardized effect size of -0.25, $p < 0.05$). This result is robust to alternative model specifications. Implementation data do not suggest that failure to implement the intervention curriculum explains the student achievement findings. The inquiry-based approach prescribed by the curriculum was unfamiliar to students and teachers, and our qualitative results suggest this may have impeded learning. The study design does not enable distinguishing the effects of the tutorial software from other aspects of the curriculum.

Conclusions:

Description of conclusions and recommendations of author(s) based on findings and over study. (To support the theme of 2009 conference, authors are asked to describe how their conclusions and recommendations might inform one or more of the above noted decisions—curriculum, teaching and teaching quality, school organization, and education policy.)

The results of this study do not find positive effects of the Cognitive Tutor Geometry curriculum in this school context. It is not clear how much the challenge students and teachers faced in learning with an inquiry-based approach contributes to this negative finding. It is also

unclear whether those challenges are localized to the schools in the study. This could potentially limit the generalizability of these results. On the other hand, the results do contradict quasi-experiment studies that found large positive effects, and may suggest that randomized controlled trials can eliminate biases of other methods.

Appendixes

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Appendix A. References

References are to be in APA format. (See APA style examples at the end of the document.)

Morgan, P., & Ritter, S. (2002). An experimental study of the effects of Cognitive Tutor Algebra I on student knowledge and attitude. Pittsburgh, PA: Carnegie Learning, Inc.

