Using a Randomized Experiment in Maui Schools for a Local Evaluation of Cognitive Tutor® Empirical Education

Introduction.

This study is a Randomized Control Trial (RCT) conducted under the *Math Science Partnership Grant* at the request of the Maui Educational Consortium during the 2006-2007 school year. Maui sought scientifically based evidence for the effectiveness of Carnegie Learning's *Cognitive Tutor*® (*CT*) *Bridge* to Algebra program as part of the adoption process for pre-Algebra programs. This was a follow-on study to an RCT on the *CT* Algebra program that Empirical had conducted the previous year. Maui chose to test the *CT* program in part based on research showing substantially positive results in Oklahoma (Morgan & Ritter 2002). Empirical's *CT* Algebra study found less positive results overall and somewhat negative results for certified teachers. These results called for additional study within Maui's unique locale and ethnic make-up.

Research Questions.

- Do students using *CT* materials score higher on standardized math assessments, as measured by the Northwest Evaluation Association (NWEA) General Math Test, than those in a control classroom using the pre-Algebra curricula currently in place?
- Is *CT* is a teacher-friendly tool that can feasibly be used in this setting?
- Is there a differential impact on specific ethnic groups?
- Do uncertified teachers benefit more from *CT* than certified teachers?

Multiple Methods Approach.

Design:

- RCT with implementation observations
- Unit of randomization: Class
- Matched pair design with fair coin toss assignment
- Blocked by pairs of classes
- Participants: 5 schools, 32 classes, 12 teachers, 809 students

Data Sources:

- Demographics for teachers and students
- Standardized assessment outcomes
- 1.NWEA General Math Achievement Level Test (ALT)
- 2.Algebraic Operations sub-strand of NWEA General Math ALT
- Biweekly self-report teacher surveys
- Classroom observations
- Formal and informal teacher interviews

Analysis:

- HLM analysis controlled for pretest
- Ethnic background and teacher certification moderators

Findings

Main Impacts.

We found that most students in both CT and control groups improved overall on the NWEA General Math Test. We did not find a difference in student performance in math between groups. Our analysis of the Algebraic Operations sub-strand revealed that many students in both groups did not demonstrate growth in this scale, again with no discernible group differences. (Effect size = 0.04, *p* value = .65)

Moderating Effects.

Pretest (Algebraic Operations subscale):

For Algebraic Operations outcomes, we found a significant interaction between the pretest and CT: students scoring low before participating in CT benefitted more from the program's algebraic operations instruction than students with high initial scores. (p value = .02)



Teacher Certification (NWEA General Math ALT):

Following a suggestion by the district's *Math Science* Partnership consultant, we considered whether the impact of CT is differentially effective for students who had certified teachers versus those with uncertified teachers.

For this experiment, results indicate that there is a slightly negative effect for certified teachers and a strong positive effect for uncertified teachers on the NWEA General Math scale. (p value = .05)

However, we did not find a differential effect between certified and uncertified teachers with the Algebraic Operations subscale.

*The teacher effect was modeled as fixed; therefore, we cannot be certain that the interaction would be sustained if teachers were re-sampled. The p value for the interaction reflects our level of certainty for a sustained effect on re-sampling students for the same teachers.





Intervention/Implementation.

Intervention:

- *Cognitive Tutor*: a textbook and technology curriculum intended to improve student understanding of mathematical concepts.
- Ideal instructional use = 60% teacher facilitated collaboration of real-world problem solving activities from textbook
 40% using CGI software with individualized lessons

Implementation Challenges:

- Delayed start of program. By mid-September, 1/3 of the teachers reported that the *CT* textbooks had not arrived yet. 77% of teachers reported that they did not have adequate resources to properly implement the *CT* program (when surveyed in mid-September).
- Insufficient access to the computer and lack of technical support. 64% of teachers reported glitches in the *CT* software and other technical difficulties.
- Teachers reported a misalignment between *CT* content and state math standards in middle and high school.

Implementation Successes:

- Positive teacher attitude about *CT* overall. Teachers reported general ease of use of the *CT* program as well as positive interactions with all *CT* materials.
- Attitudes toward technology. Teachers reported a slight increase in confidence and comfort with the *CT* technology after having used the program for several months.
- Good student engagement. Teachers reported that the majority of the students were "very engaged" in the *CT* software.
- *CT*'s approach to collaborative learning. Teachers supported approach because it allowed students to share in their learning, utilize peer-teaching methods, and interact with one another.

Conclusion.

• Our goal: To provide the Maui School District with useful evidence for determining the impact of *CT* within the local setting

- No evidence of a positive impact of *CT* on student math achievement in general, but gains for previously lower-performing students on the algebra-related subscale
- CT was particularly beneficial for non-certified teachers
- Despite implementation challenges, teachers felt CT raised student engagement in math
- Because of the small number of participants, we consider these conclusions suggestive but not conclusive

For more information on the CT reporting, see the following works.
Zacamy, J., Miller, G. I., & Cabalo, J.V. (2008). A Description of Maui Educational Consortium's Implementation Practices of Carnegie Learning's Cognitive Tutor. Palo Alto, CA: Empirical Education, Inc.

Cabalo, J.V., Ma, B., & Jaciw, A. (2007). Comparative Effectiveness of Carnegie Learning's Cognitive Tutor Bridge to Algebra Curriculum: A report of a randomized experiment in the Maui School District.

(Empirical Education Rep. No. EEI_EdCT2-06-FR-Y2-O.1). Palo Alto, CA: Empirical Education Inc. October, 2007
Cabalo, J.V., Jaciw, A., & Vu, M. (2007) Comparative Effectiveness of Carnegie Learning's Cognitive Tutor Algebra I Curriculum: A report of a randomized experiment in Maui School District. Empirical Education Research Reports, Palo Alto, CA: Empirical Education Inc. May 29, 2007