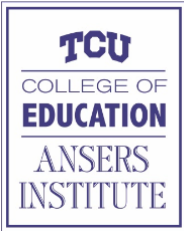



Study 1: Evaluating the Effectiveness of the Math Learning Companion: An Online Mathematics Curriculum for Students with Learning Disabilities

NCSER Project Directors Meeting – March 6, 2013

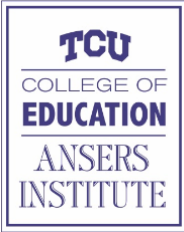
Lindy Crawford, Ph.D. and Kristina Higgins, Ph.D.
Texas Christian University



+ The Math Learning Companion (MLC)

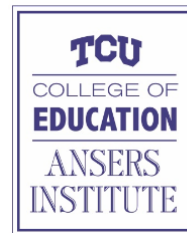


- Computer-based supplemental instruction program for mathematics
- Grades 3-8
- Includes 7 subject areas with 73 unique lessons that align with the Core Curriculum Standards
- Designed for students who are underperforming in mathematics



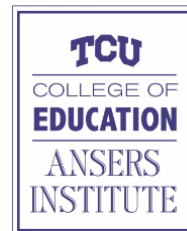
+ Study 1: Purpose

- Evaluate the overall impact of MLC on students' mathematical understanding.
- Understand the relationship between the time students are spending in the lesson and the quiz, and the subsequent impact on students' mathematical understanding.



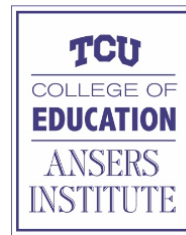
+ Research Questions

- Question 1: In which areas are students improving their mathematical understanding?
- Question 2: How are students spending their time in the program across different lessons?
- Question 3: What are the relationships between students initial fluency scores, different use of time, and their gains in mathematical understanding?
- Question 4: In what way does the number of times a student repeats the lesson and the quiz impact their gains in mathematical understanding?



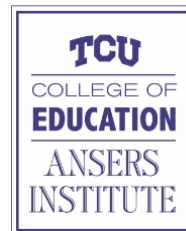
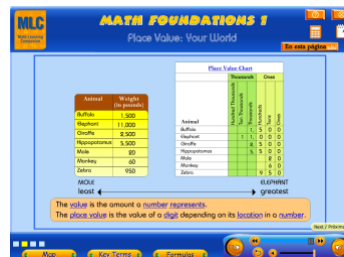
+ Participants

- 55 students from 5 schools in the Dallas/Fort Worth area.
- 37 students in sixth-grade; 18 students in seventh-grade
- Mean age = 11.43 (Range 10 to 14)
- 38 students attended private schools focused on educating individuals with learning differences; 17 students attended public school and received special education services
- 24 students exhibited a single disability or disorder, whereas 31 students had 2 or more disabilities or disorders.
- 42 students had a primary classification of specific learning disabilities, including disorders of written expression, LD in mathematics, and LD in reading
- Other primary disability categories included ADHD, ASD, Speech, and Intellectual Disabilities



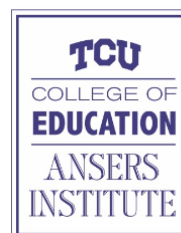
+ Curriculum A - 4th grade level (N = 25)

- | | |
|---|---|
| <ul style="list-style-type: none"> ■ Math Foundations 1 <ul style="list-style-type: none"> ■ Place Value ■ Addition and Subtraction ■ Multiplication ■ Division ■ Fractions ■ Decimals and Money ■ Measurement ■ Geometry | <ul style="list-style-type: none"> ■ Math Foundations 2 <ul style="list-style-type: none"> ■ Place Value ■ Fractions and Decimals ■ Addition and Subtraction ■ Multiplication ■ Division ■ Perimeter and Area ■ Geometry |
|---|---|



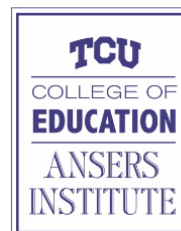
+ Curriculum B - 6th grade level ($N = 30$)

- Math Foundations 2
 - Fractions and Decimals
 - Factoring
- Math Foundations 3
 - Exponents and Prime Factorizations
 - Add and Subtract Fractions
 - Geometry
- Numbers Make Sense
 - Add and Subtract Fractions
 - Ratios and Proportions
 - Using Exponents and Scientific Notation
- Algebra
 - Interpreting Graphs
 - Patterns and Equations
 - Relationships
 - Proportional and Non-Proportional Relationships
- Data Analysis
 - Data Collections and Organization
 - Central Tendency
- Geometry
 - Triangles



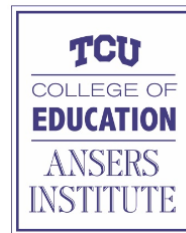
+ Measures

- MLC Specific Pre and Posttest (proximal measure)
- Key Math – 3 (Connolly, 2007) given before and after the intervention (distal measure)
 - Numeration (All)
 - Geometry (Curriculum A)
 - Measurement (Curriculum A)
 - Algebra (Curriculum B)
 - Data Analysis and Probability (Curriculum B)
- CBM Math Fact Fluency
- Oral Reading Fluency (DIBELS)



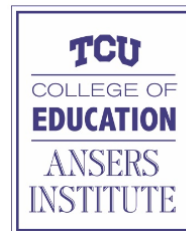
+ Methods

- Students were assessed on their prior mathematical knowledge using the program-specific MLC pretest and their general mathematical understanding using the Key Math – 3 and CBM math fact fluency tests. Students were also given a measure of oral reading fluency.
- Students completed 15 lessons in the MLC program over the course of 20 weeks based on their instructional level (determined by pretest scores and teacher confirmation).
- Students were then re-assessed using the MLC posttest and the Key Math – 3 to measure gains in mathematical understanding over the course of the intervention.



+ Data Analysis

- **Question 1: In which areas are students improving their mathematical understanding?**
 - Paired-sample *t*-tests were conducted to determine increases in mathematical understanding over the course of the intervention.
- **Question 2: How are students spending their time in the program across different lessons?**
 - Descriptive statistics were used to illustrate differences in the use of specific lessons.



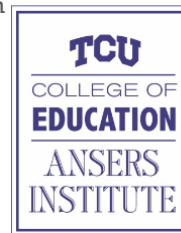
+ Data Analyses

- **Question 3: What are the relationships between students' initial fluency scores, different use of time, and their gains in mathematical understanding?**

- Correlations were performed to examine the relationships between students' amount of time spent in different parts of the program and students' gains in mathematical understanding.

- **Question 4: In what way does the number of times a student repeats the lesson and the quiz impact their gains in mathematical understanding?**

- Independent sample *t*-tests were used to determine mean differences in students' gains in mathematical understanding based on the number of times a student took the quiz.



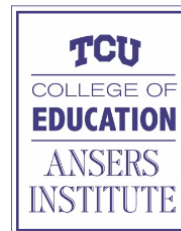
+ Initial Analyses

- Students were dichotomized into two groups based on their primary disability category:

- Specific Learning Disability: $n = 42$
- Other Primary Classification: $n = 13$

- Independent sample *t*-tests were conducted to determine if mean differences existed between these groups on math fact fluency, oral reading fluency, time spent in the lesson and quiz, and gains in mathematical understanding.

- No specific mean differences were found, thus the data were combined for further analyses.



+ Results – Paired-sample *t*-tests

■ Whole Group

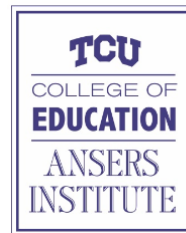
- MLC Pre/Post Gains – $t_{(54)} = 10.846, p < .001, d = 1.49$
- KM Numeration – $t_{(52)} = 4.896, p < .001, d = .67$

■ Curriculum A

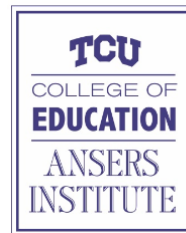
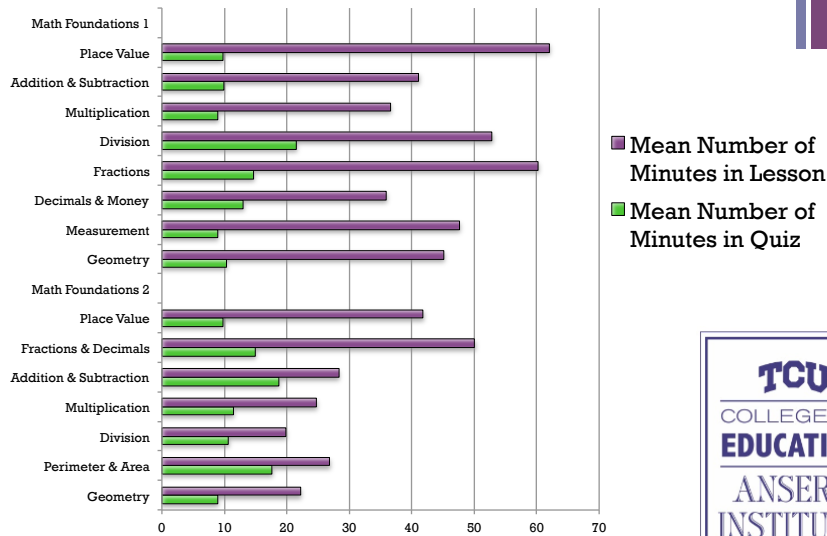
- KM Geometry – $t_{(24)} = 2.663, p < .02, d = .53$
- KM Measurement – $t_{(24)} = 1.346, p < .20, NS$

■ Curriculum B

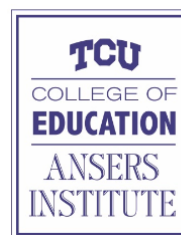
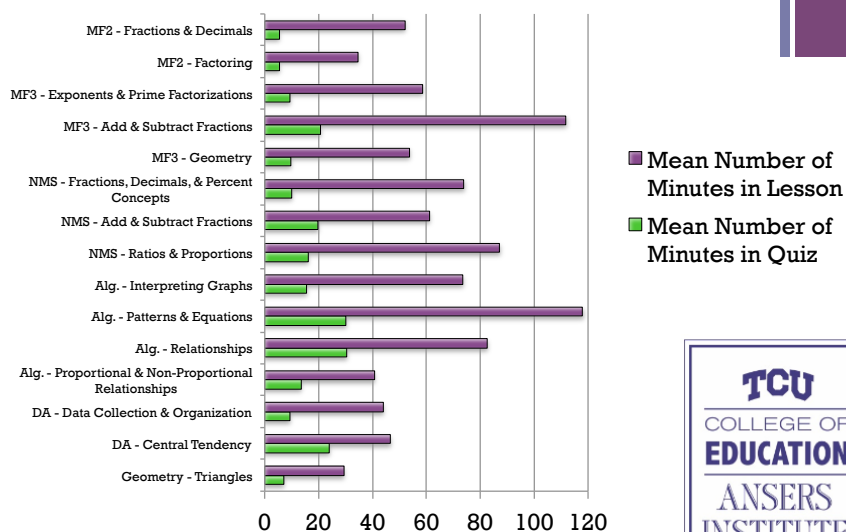
- KM Algebra – $t_{(27)} = 2.623, p < .02, d = .48$
- KM Data Analysis and Probability – $t_{(27)} = 3.006, p < .001, d = .60$



+ Minutes Spent in Curriculum A

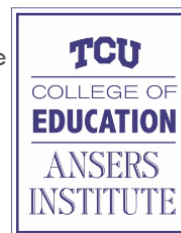


+ Minutes Spent in Curriculum B



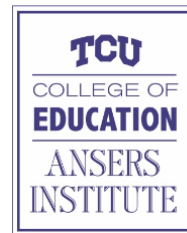
+ Results – Correlations

- Students who spent a smaller proportion of their time in the quiz were more likely to have higher initial oral reading fluency ($r = -.36, p < .01, d = .77$) and subtraction fluency ($r = -.37, p < .01, d = .79$)
- Students' gain scores on the MLC pre and post-tests were moderately correlated with their initial math fact fluency:
 - Addition: $r = .39, p < .01, d = .85$
 - Subtraction: $r = .32, p < .02, d = .68$
 - Division: $r = .34, p < .02, d = .72$
- Gains on the Key Math – 3 subtests were not related to students' initial oral reading fluency or math fact fluency scores.
- No significant relationships were found between the time students spent in different parts of MLC and their gains in mathematical understanding on any of the Key Math – 3 subtests or the MLC pre and post-tests.



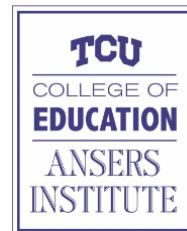
+ Independent Sample t -tests

- Students were dichotomized into two groups based on whether or not they took the quiz for each lesson once or more than once.
- Independent sample t -tests examined the mean differences in gains in mathematical understanding.
- No significant mean differences were found.



+ Conclusions

- Students are gaining both specific knowledge and general mathematical understanding from the MLC program.
- Students working below grade level spent more time in Fractions & Decimals than any other unit, which aligns with the National Math Panel's (2008) assessment that fractions are the most important foundational skill which is currently underdeveloped among students.
- Students working at the Grade 6 level spent more time in Fractions and Decimals for their foundational skills, and in Algebra's Patterns and Equations. This also aligns with the National Math Panel's (2008) focus on understanding the critical foundations of Algebra as essential for student success in this subject.



+ Conclusions

- The overall gains in mathematical understanding are not related to the amount of time the student spends in the lesson or the quiz or the number of times the student repeats the lesson and takes the quiz.
- Only program-specific gain scores are related to previous mathematical fact fluency; general mathematical understanding is not related to students' previous fact fluency or oral reading fluency.
- Study 2 examines other factors that may contribute to students' gains within the program.

