

Research Findings on the *Transition to Algebra* series

- Pre- and Post-Test Findings
- Teacher Surveys
- Teacher Focus Group Interviews
- Student Focus Group Interviews
- End-of-Year Student Survey

The following are highlights from the research conducted by the *Transition to Algebra* (TTA) project at EDC (Education Development Center, Inc.). Project research activities included analysis of formative data collected to inform improvements to the TTA materials, and analysis of summative data collected to investigate the impact of TTA on student outcomes. Data were collected from teachers and students in ten field test classrooms during the 2011-2012 school year. Included here are findings resulting from summative data analyses specific to an algebra assessment administered to classrooms using TTA in a ninth-grade algebra support class, and feedback from students and teachers who participated in using TTA during the 2011-2012 school year.

Transition to Algebra (TTA) was designed by EDC (Education Development Center, Inc.) with funding from the National Science Foundation.

For more information on the *Transition to Algebra* series visit **www.TransitiontoAlgebra** or call **800.225.5800**



TTA was designed as a full-year algebra support curriculum intended to be used concurrently with first-year algebra for underprepared students. The TTA curriculum was implemented in two Massachusetts high schools in 2011-2012, a total of ten field test classrooms. At one of the high schools, TTA was implemented in seven Grade 9 algebra support classes, each with a different teacher, and students were assigned to the TTA intervention based on their prior year's score on the Grade 8 Massachusetts Comprehensive Assessment System (MCAS) test in mathematics. Students who took the TTA intervention class also took a regular Algebra 1 class.

Summative Results

Data were analyzed to address the project's overarching summative research question: How much do achievement in algebra and attitudes toward mathematics change among TTA students over the course of the school year? The findings from our analyses of student outcomes on a pre-/post-algebra assessment that the TTA team assembled are:

- On average, students increased their total scores from 17.7 to 55.1 total points on the TTA pre-test and final exams, an average gain of 37.4 points. This shift is statistically significant and equivalent to an effect size of 1.9 or almost two standard deviations (SD) – a very large gain.
- Average gains were also statistically significant within every content area. Gains were largest for items involving area models – polynomials and factoring (2.17 SD), expressions and equations (1.56 SD), and graphs and tables (1.53 SD). The average score gain was smallest for items involving placement and order on the number line. At 1.08 SD, however, this gain still represents a large effect size.

Please note that these 2011-2012 school year findings were from classrooms implementing an earlier field test version of the materials. Subsequent revisions have addressed teacher and classroom feedback particularly on units 2, 3, and 8 which focused on number line, distance, and fractions and decimals content, and particularly placement and order on the number line. In addition, often field test teachers were not able to implement all twelve units of TTA, and in some classes, content from later units (including exponents) was taught briefly or not even taught to students. We would expect stronger results with the final TTA version.

Feedback from Students and Teachers

Project staff also analyzed formative data collected during the 2011-2012 school year including teacher surveys, a teacher focus group interview, student focus group interviews, an end-of-year student survey, and classroom observations. These data were analyzed to answer the two overarching research questions that guided the project's formative research efforts:

- *What are teachers' experiences implementing the TTA materials?*
- *What are students' experiences using the TTA materials?*

Included here are examples of the student and teacher feedback collected through the student survey, and the teacher focus group interview. See pages 4 and 5 for more detail including selected quotes from students and teachers.

- More than 50% of student respondents agreed or strongly agreed that overall, the TTA class helped to improve their understanding of algebra.
- More than 50% of student respondents agreed or strongly agreed that the TTA class strengthened their problem-solving skills by helping them learn how to approach unfamiliar problems and find different ways to solve mathematics problems.

Pre- and Post-test Findings from the TTA Assessment

During the 2011-2012 academic year, EDC researchers conducted a preliminary field study to explore algebra outcomes among ninth-grade students who were identified as underprepared for algebra and who enrolled in a supplementary algebra intervention class using the TTA curriculum. The students took this class alongside their district's standard Algebra 1 course. At the two Massachusetts high schools that participated in the study, 119 TTA students took both a TTA pre-test in September 2011 and a TTA final exam in June 2012. The pre-test and final exams had 48 items worth a total of 100 points, with 44 items that were identical between the exams and tested students' understanding of expressions and equations; area models – polynomials and factoring; decimals and fractions; graphs and tables; placement and order on the number line; distance and subtraction; and exponents.

On average, students increased their total scores from 17.7 to 55.1 total points on the TTA pre-test and final exams, an average gain of 37.4 points. This shift is statistically significant and equivalent to an effect size of 1.9 or almost two standard deviations (SD) – a very large gain. Average gains were also statistically significant within every content area. Gains were largest for items involving area models – polynomials and factoring (2.17 SD), expressions and equations (1.56 SD), and graphs and tables (1.53 SD). The average score gain was smallest for items involving placement and order on the number line. At 1.08 SD, however, this gain still represents a large effect size.

Table 1. Average points earned and gained on the TTA pre-test and final exams, all items and by content area (N=119)

Item content	Total possible points	Pre-test		Final exam		Ave. gain	Effect size (SD units)
		Ave.	SD	Ave.	SD		
All items	86	17.7	13.1	55.1	25.0	37.4	1.87
Area models - polynomials and factoring	22	0.7	1.8	12.4	7.4	11.7	2.17
Expressions and equations	30	6.1	5.7	17.3	8.4	11.2	1.56
Graphs and tables	15	3.0	2.8	8.4	4.1	5.4	1.53
Distance and subtraction	10	2.7	2.2	6.3	2.8	3.6	1.44
Exponents	7	0.6	1.0	2.9	2.0	2.3	1.43
Decimals and fractions	20	6.1	4.0	11.6	5.1	5.5	1.20
Placement and order on the number line	11	2.9	2.2	5.9	3.3	3.0	1.08

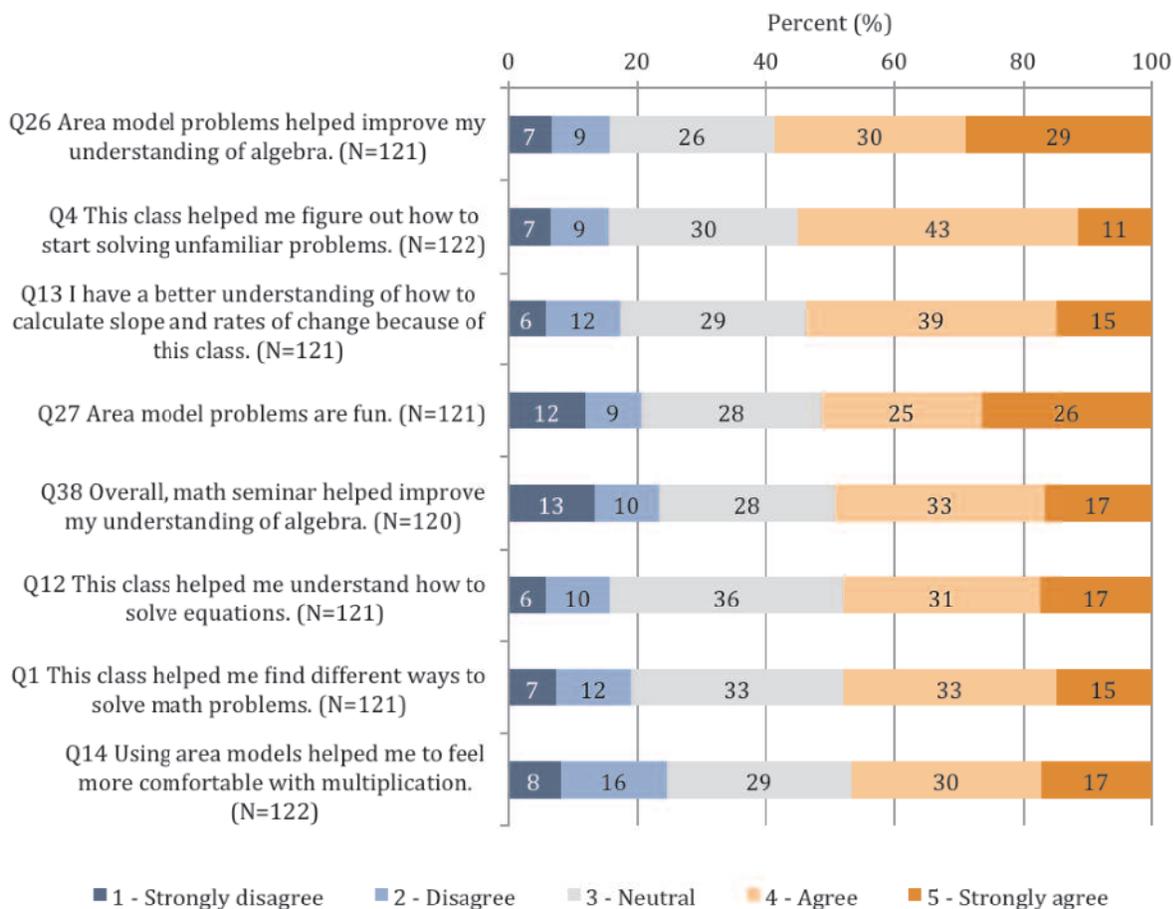
Notes: The TTA pre-test and final exam each had 48 items worth a total of 100 points. Of these items, 44 were identical between the two tests. These items covered the following content: area models - polynomials and factoring (7 items); expressions and equations (16 items); graphs and tables (5 items); distance and subtraction (7 items); exponents (6 items); decimals and fractions (10 items); and placement and order on the number line (5 items). Some items were included in multiple content areas. Average gains were calculated as the mean difference in pre-test and final exam scores. Effect sizes were calculated as Cohen's *d* and are measured in standard deviation units. Cohen's *d* statistics greater than 0.8 are considered large.

Feedback from Students and Teachers on *Transition to Algebra*

Feedback from Students

Students who participated in the TTA intervention class for the 2011-2012 pilot study completed an end-of-year survey with 39 Likert-type items that probed students' opinions about specific TTA activities and the class as a whole. Students found multiple aspects of the course helpful. More than 50% of respondents agreed or strongly agreed that overall, the TTA class helped to improve their understanding of algebra. More than 50% or more of respondents agreed or strongly agreed that the TTA class strengthened their problem-solving skills by helping them learn how to approach unfamiliar problems and find different ways to solve mathematics problems. Similar proportions said that the use of area models was particularly helpful for their understanding of algebra, and the class helped them gain a better understanding of slope and rates of change as well as solving equations (see Figure 1).

**Figure 1. Students' views of the TTA intervention class and TTA activities:
Most favorable aspects**



In March 2012, a small group of TTA students (N=7) participated in focus group interviews with EDC researchers. Feedback they provided about the course included the following statements:

- "I loved the puzzles."
- "I love mental math... It starts off the class great."
- On the class in general: "It helps you think in different ways, which allowed me to come up with more answers, and information."
- "I learn more in this class than I do in my Algebra class."

Feedback from Teachers

At the end of the 2011-2012 academic year, EDC researchers conducted a focus group interview with the ten high school mathematics teachers in Massachusetts who participated in the TTA pilot study. Below are some thoughts they shared about the TTA course and curriculum.

On how they would describe *Transition to Algebra*:

- *“For our kids it provides additional support in mathematics, and it tries to get kids to look at math in a different way than more traditional class courses for algebra.”*
- *“It helps the kids understand what algebra is conceptually versus just a bunch of rules that they have to apply at some point and these are the kids that struggle with how the rules go and what rules work in certain contexts.”*
- *“The purpose is not necessarily to build straightforward algebraic computation skills but it’s more to try to build students’ skills at intuitive thinking and logical thinking.”*

On their favorite aspects of *Transition to Algebra*:

- *“In general I have a lot of success with the curriculum. I think my favorite thing about TTA has been the improvement I see in my students in their algebra class and how they can take the material and transition it to what they need for algebra.”*
- *I think my favorite part of the activities that we do are the different styles of puzzles, because there’s lots of different ways to approach [them], and getting kids to think in interesting ways about mathematics, or just thinking in general, is a really nice approach that has helped out some of the students.”*
- *“I also really liked the mental math. And my students really enjoyed that. I’ve also been using it in my [regular] algebra classes. It’s been successful and they like it as well. So I’m able to take something from the program and use it elsewhere.”*
- *“I love the area models. I think I can take them into my honors classes, into the [regular] algebra classes, and the kids get them. [My TTA students] were teaching the tutors how to multiply using the area models, and I thought that was great. They learned a lot from that.”*
- *“My favorite part was the Explorations . . . because a lot of my students aren’t very strong algebraically with number sense. So while a lot of questions are hard for them, if it was more intuitive and they built it themselves using actual physical manipulatives, they were able to be successful, and actually be in the top of the class.”*