University/School District Collaboration for Change: Houston's *Project CLEAR Algebra I*

National Council of Supervisors of Mathematics
Annual Conference April 7-9, 2003

Presenters

- Dr. Anne Papakonstantinou, Director, Rice University School Mathematics Project (RUSMP)
- Michelle Rohr, Houston Independent School District (HISD), Director of Mathematics
- Richard Parr, RUSMP Director of Educational Technology and Secondary Education
- Sherry Senior, HISD Assistant Director, Secondary Mathematics

Houston Independent School District

- Seventh largest school district in the United States with 210,000 students and 32,000 employees in 286 schools
- Ethnically diverse: 56% Hispanic, 31% African-American, 10% Anglo, 3% Asian and American Indian
- 79% Economically Disadvantaged

Houston ISD awarded the Broad Prize for Urban Education

- The largest in public education, the Broad Prize was created to reward educational innovation and improvement.
- HISD was awarded the inaugural prize for showing the greatest overall improvement in student achievement while at the same time reducing the achievement gap across ethnic lines and between high- and low-income students.

The HISD Algebra Initiative

- Supports administrators, teachers and instructional personnel in changing approaches to the teaching of algebra;
- Focuses on both instruction in the Algebra I course and on the algebraic concepts taught in previous grades;
- Implements the new Texas Essential Knowledge and Skills (TEKS);

The HISD Algebra Initiative

- Prepares students for the Algebra I End-Of-Course exam and for success in mathematics courses;
- Applies best teaching practices; and
- Helps teachers focus on teaching applications of concepts instead of low-level skills.

Algebra Initiative Recognition

The Algebra Initiative was cited by the National Staff Development Council in *What Works in the High School: Results-Based Staff Development* as one of the top two mathematics professional development programs in the United States for its impact on student achievement in the high school grades (Killion, 2002).

Why was RUSMP involved?

- HISD needed a collaborative partner.
- RUSMP offered:
  - Long-term relationship with HISD
  - Shared goals

What did RUSMP bring?

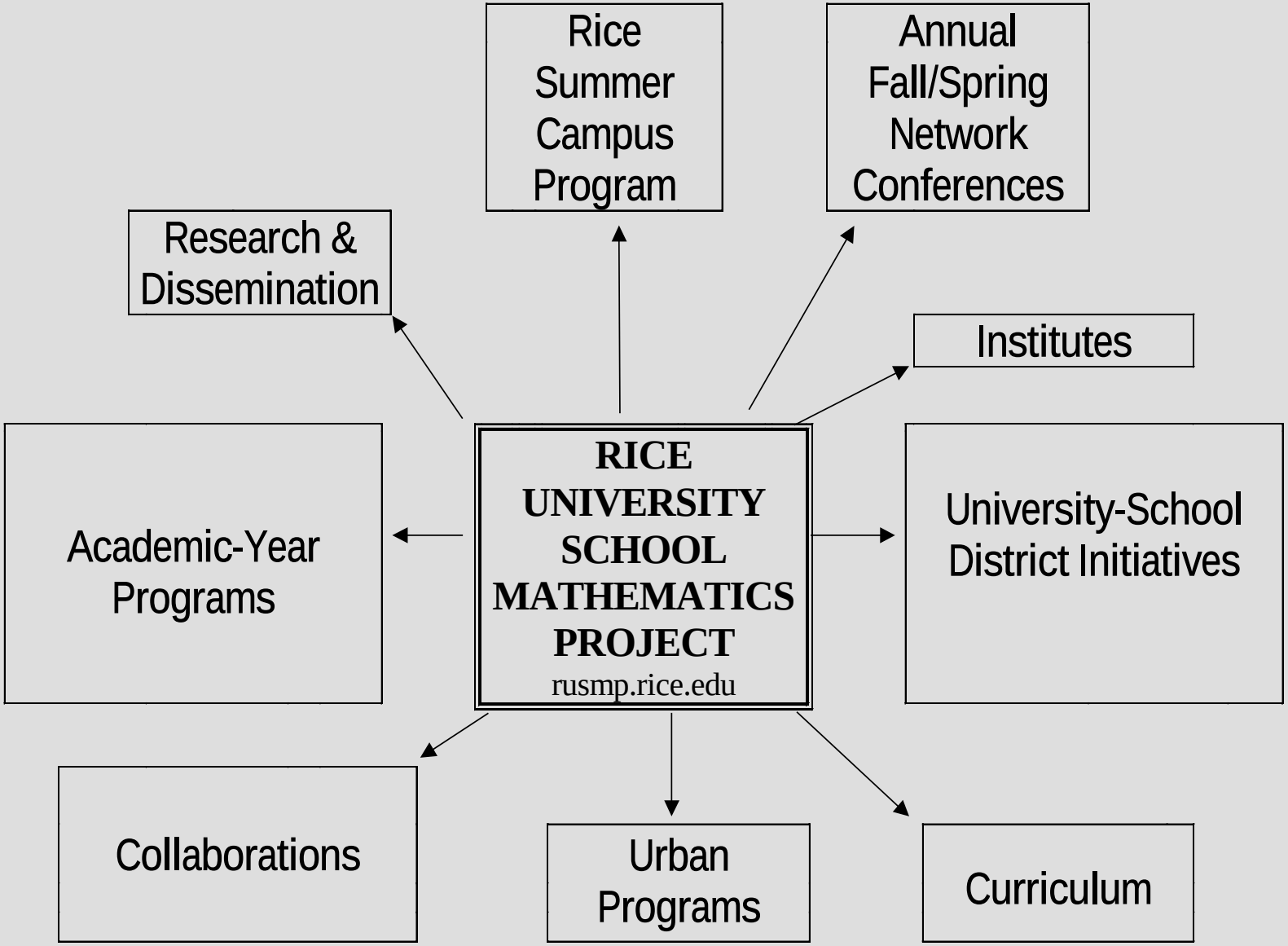
- Successful PreK-12 mathematics staff development program
- Algebra I concept sequence and syllabus
- Graduate course for Algebra I teachers

What did RUSMP bring?

- A philosophy for teaching mathematics that is conceptually-based and focuses on the learner
- Experience in supporting collaborative planning of teachers
- Learning Plans for each concept in the Algebra I course

Rice University
School Mathematics Project

What is the Rice University School Mathematics Project?


Rice Summer Campus Program
Annual Fall/Spring Network Conferences
Research & Dissemination
Institutes
Academic-Year Programs
RICE UNIVERSITY SCHOOL MATHEMATICS PROJECT
rusmp.rice.edu
University-School District Initiatives
Collaborations
Urban Programs
Curriculum

RUSMP Major Goals

- Work with Houston-area teachers of mathematics to improve their mathematical knowledge.
- Promote and model more effective teaching of mathematics that involves greater student involvement in the learning process.
- Encourage the use of technology and manipulatives in the teaching of mathematics.

RUSMP Teaching Goals

- Develop important mathematical concepts.
- Emphasize student thinking, activities, creativity, and products.
- Make connections with the real world, with other disciplines, and in particular, with science.
- Integrate manipulatives, calculators, and computers.
- Foster discovery and group activities.

LEARNING PLAN

<table>
<tr><td>Exploratory Activities</td><td rowspan="4">Concept

Student Products

Written

Verbal

Kinesthetic

Visual</td></tr>
<tr><td>Concept Development Activities</td></tr>
<tr><td>Basic Facts and Standard Algorithms Formalized</td></tr>
<tr><td>Assessment</td></tr>
<tr><td>Related TEKS</td><td>Materials and Resources</td></tr>
<tr><td colspan="2">Originality and Creativity</td></tr>
</table>

The Next Step: Writing Project CLEAR

- Project CLEAR, Clarifying Learning to Enhance Achievement Results, is the HISD curriculum project, spanning all grade levels and all subject areas.

- The purpose of the curriculum is to insure that the TEKS are translated into classroom instruction.

The Next Step: Writing Project CLEAR

- Project CLEAR format was established by HISD for consistency across grade levels and across disciplines.

- RUSMP was asked to author the Algebra I Project CLEAR document because of our previous work with the Algebra Initiative.

The Next Step: Writing Project CLEAR

- Authors had to make the connection between a conceptually-based syllabus and the objective-based TEKS.

- The HISD Algebra I syllabus contains important concepts that were not stated in the TEKS that the authors felt needed to be included in the document.

The Next Step: Writing Project CLEAR

- The resulting Project CLEAR Algebra I document is different from documents written for other courses.

- The Project CLEAR Algebra I document complements and builds upon the previously developed Algebra I syllabus and learning plans.

Project CLEAR implementation

- RUSMP provided 3-day training for Algebra I Lead Teachers in Summer 2001.

- The training focused on the new material and activities found in Project CLEAR and how the document supports the Algebra Initiative.

The Look of Project CLEAR

- Content Specifications
- Prerequisite Knowledge
- Instructional Considerations
- Correspondence to Textbook
- Assessment Considerations

Project CLEAR Example

Algebra I
Quadratic Functions

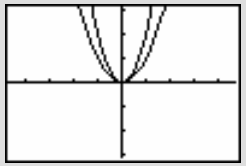
TEKS d.1.B Investigate, describe, and predict the effect of changes in a on the graph of $y=ax^2$.

Content Specifications		**Prerequisite Knowledge**
Teach this objective using the following mathematical representation: graphical. The student will: • Identify the effects of changes in a for $a > 1$ in the graph of $y = ax^2$. • Identify the effect of changes in a for $0 < a < 1$ in the graph of $y = ax^2$. • Identify the effect of multiplying a by –1 in the graph of $y = ax^2$.		The student should have knowledge of the graph of the parent function, $y = x^2$.

Instructional Considerations

Activity #1 Investigating $y = ax^2$ for $a > 1$

Using a graphing calculator, students should graph $y = x^2$ and $y = 2x^2$ in the same viewing window
($-4.7 \le x \le 4.7$ and $-3.1 \le y \le 3.1$) works well.



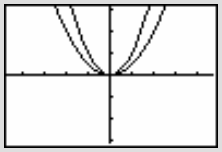
Have students discuss the similarities and differences between the two graphs.
The similarities are that both are symmetric about the y-axis; both have vertices at the origin.
The differences are that $y = 2x^2$ *appears steeper than* $y = x^2$*. Some students may use the word thinner.*

Have students look at a table of values for the two functions and observe their finite differences. Notice that not only do the y-coordinates double, but the finite differences double as well.

Have students graph $y = 4x^2$ on the same graph. Have students make predictions before they graph.

***Activity #2* Investigating $y = ax^2$ for $0 < a < 1$**

Using a graphing calculator, students should graph $y = x^2$ and y = $\frac{1}{2}x^2$ in the same viewing window.



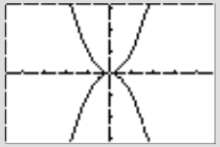
What effect does having a coefficient of $\frac{1}{2}$ make on the graph?
The graph is not as steep; it appears to be wider.

Does it change the vertex?
No, the vertex is still (0,0).
Have students predict where the graph of $y = \frac{1}{3}x^2$ would appear in relation to the first two graphs. Why?

It should appear to be wider than either graph because 1/3 is a smaller number. It is closer to the x-axis and below the other two graphs.

Activity #3 **Investigating $y = ax^2$ for $a < 0$**

Graph $y = x^2$ and $y = -x^2$ in the same viewing window.



How are these graphs related?
They are reflections of each other across the x-axis.
Students may need to be reminded that $-x^2$ means –1 times x^2.

Graph $y = 2x^2$ and $y = -2x^2$ in the same window. Does the negative sign change the steepness of the graph?
No.
What effect does the negative sign have on the graph of $y = 2x^2$?
It reflects the graph across the x-axis.
Graph $y = \frac{1}{2}x^2$ and $y = -\frac{1}{2}x^2$ in the same viewing window. Does the negative sign change the steepness of the graph for these examples?
No. It reflects the graph of $y = \frac{1}{2}x^2$ across the x-axis.

Correspondence to McDougal Littell Algebra I Textbook

Section 8.2, p. 335, “Connection: Astronomy”

Assessment Considerations

Communication Task

Find an equation of a graph that would be “between” $y = x^2$ and $y = \frac{1}{2}x^2$.

Any coefficient between $\frac{1}{2}$ and 1 would yield a graph between the two; for example $y = \frac{2}{3}x^2$.

Connections Task

Explain numerically why the graph of $y = -x^2$ is below the x-axis for all points other than the vertex. In other words, the range is all real numbers less than or equal to 0?

Squaring a number other than 0 results in a positive number; multiplying the result by –1 results in a negative number.

Spreading the Word

- Project CLEAR Follow-Up
- Algebra Academy
- Algebra Initiative Development Group (AID)

Algebra I Model Lessons

- Daily lessons linked to content specifications
- Pedagogy, strategies and activities
- Classroom-ready materials

Materials
No Blackline Master

2 pieces of 8 X 11.5 piece of cm grid paper for each student
Transparency of cm grid
Colored markers for each student
Ruler for each student

At the overhead ask a student to record the table of values. Another student can graph the parent graph.

Save the patty paper to prove that the shape of the parabola does not change when it is transformed vertically.

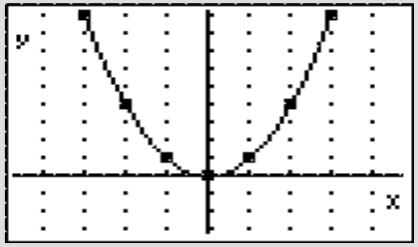
At the overhead, ask a student to record the table of values. Another student can graph the function.

A5 Group Investigation of a and c on the Graph of $y = ax^2 + bx + c$

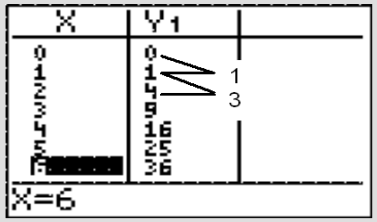
This is a guided practice activity.

Activity 1: Role of c on $y = ax^2 + bx + c$.
Ask students to place the x and y axes in the middle of the grid. Ask them to graph the parent graph $y = x^2$ as you model it on the overhead grid. They need to make a table of values, using values in the domain from -3 to 3. Point out to the students the pattern as they graph the parent quadratic function:

up 1, over 1
up 3, over 1
up 5, over 1



Point out to the students how this pattern matches the finite differences in the table of values. (See the table below.)



The goal is that students can sketch quickly and accurately the parent graph of the quadratic function. Using the patty paper, ask each student to trace the quadratic parent function on the patty paper. Ask them to highlight the integer ordered pairs from -3 to 3 on the patty paper, so both the graph and the integer ordered pairs are visible on the patty paper. Fold the paper to see the axis of symmetry.

Using a different color, ask students to make a table and draw the sketch of $y = x^2 + 2$ on the same coordinate plane.

Next Steps……

- Continue the collaboration between RUSMP and HISD to improve PreK-12 mathematics instruction and learning.
- Develop additional university courses to support teachers.
- Launch a district-wide Geometry Initiative.