Rice University
Mathematics Leadership Institute

Teachers' Professionalism
Students' Achievement
Systemic Change

MSP Learning Network Conference
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Presenters

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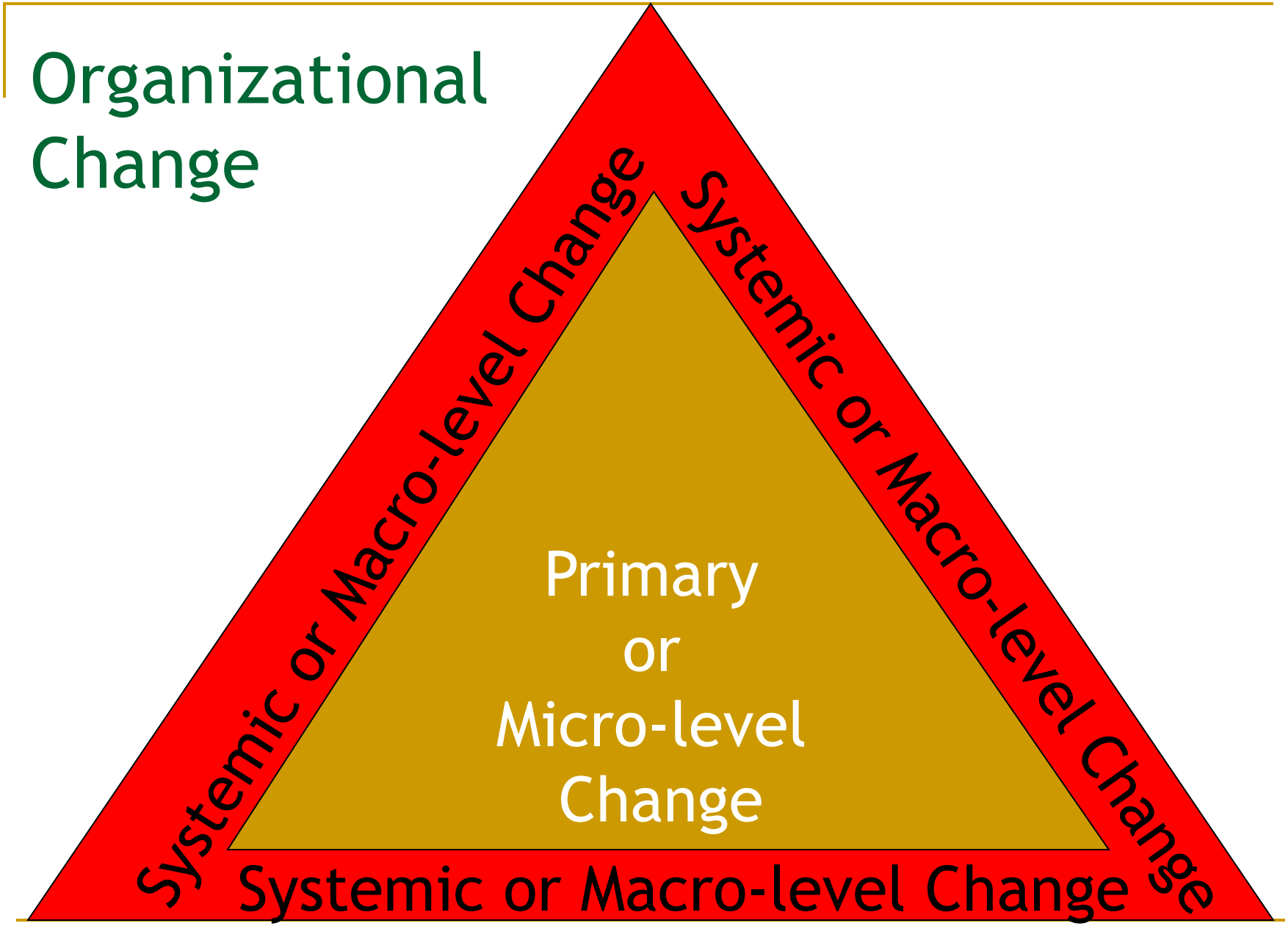
MLI Purpose

Meet the demand for mathematics instructional support and leadership by developing the professionalism of high school lead teachers to improve teaching and learning.

MLI intended to serve as a catalyst to…

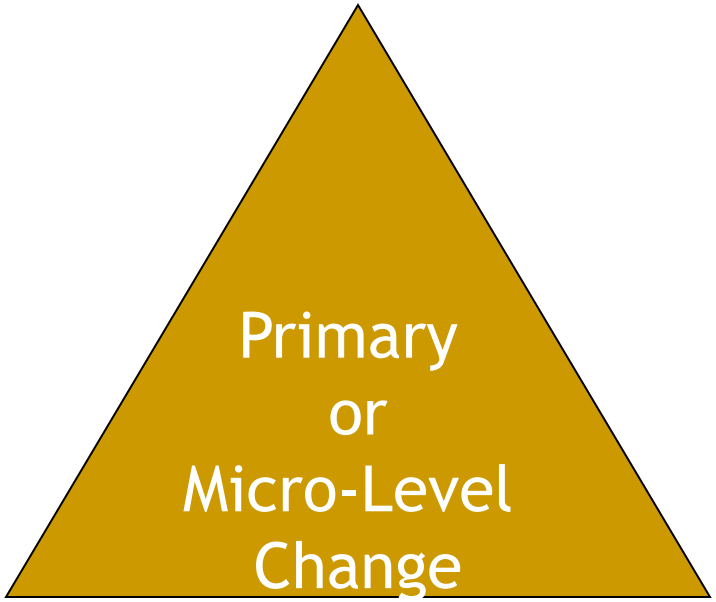
- initiate change at the grassroots level; and
- influence the type and direction of mathematics instruction in participating schools and school districts.

Organizational Change



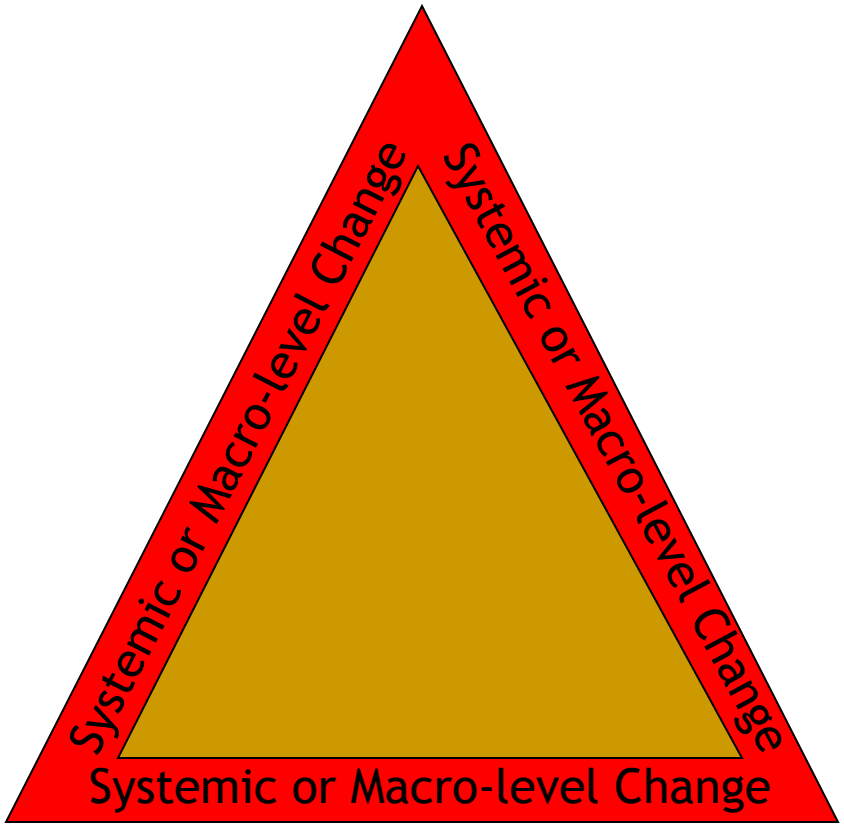
Watzlawick, P., Weakland, J., & Fisch, R. (1974).

Primary Change



- Change that occurs within a system
  - Teachers
  - Classroom practices
  - Collaboration with colleagues and administrators

Systemic Change

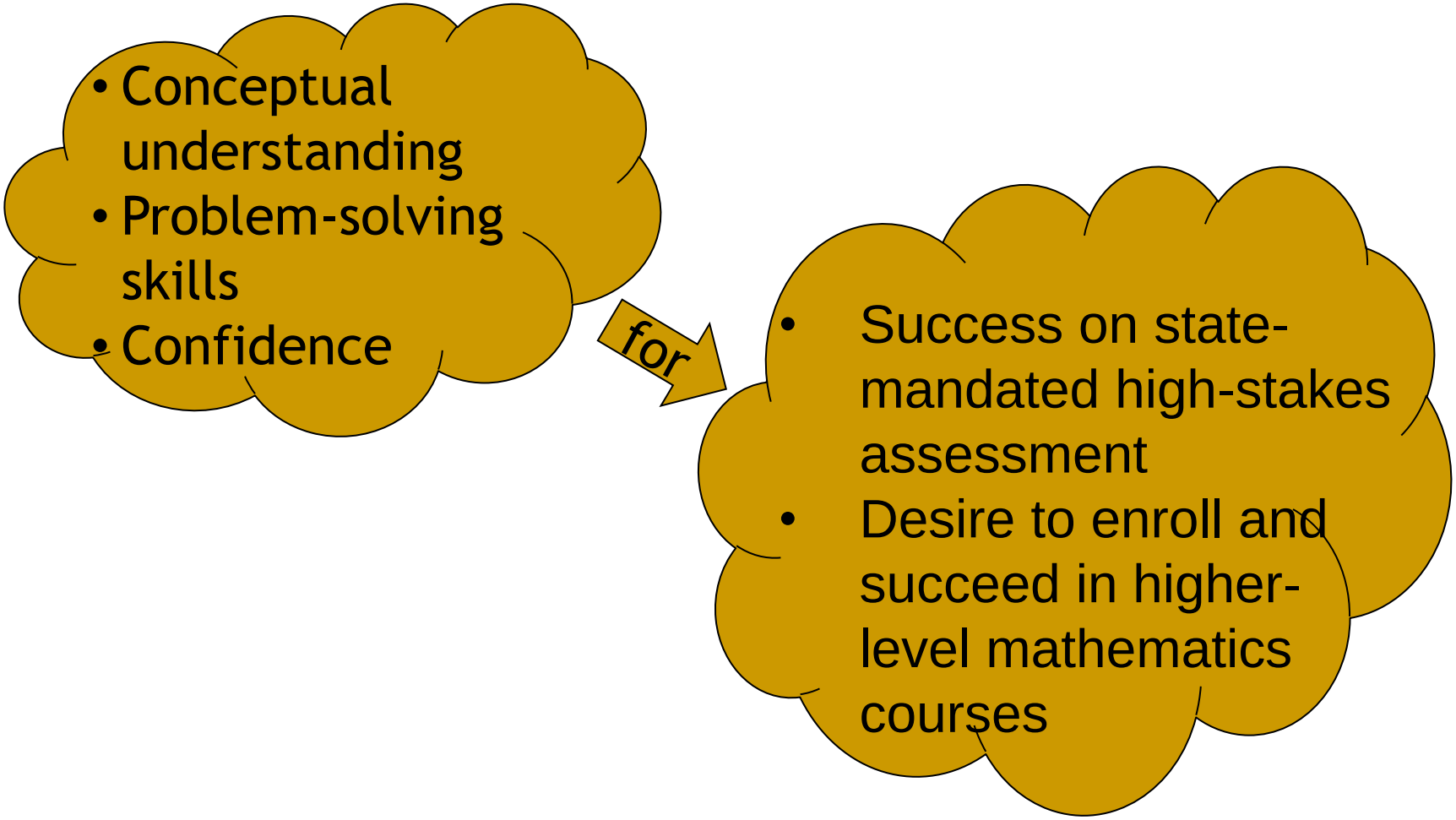


- That which changes the system itself
  - Major shift in the way the larger system functions
    - Discontinuity or logical jump creates systemic change

MLI lead teachers served as change agents to…

advance the type and direction of mathematics instruction and learning to increase student success.

MLI's Definition of Student Success



MLI's Definition of Student Success

- Multi-faceted
- Grounded in theories of learning as a social, student-centered experience that engages students in strong mathematics explorations that are aligned with students' learning styles

MLI's Summer Leadership Institutes focused on…

- development of lead teachers' translation skills necessary for quality instruction; and
- connections between lead teachers' MLI mathematics experiences and the secondary mathematics curriculum they were expected to teach.

What were lead teachers' outcomes as a result of their participation in MLI?

Results from t-tests on all subject-matter pre- and post-test scores indicated that teachers' mathematics content and pedagogical content knowledge improved significantly.

Geometry Test Item

Discuss the reasons behind students' misunderstandings of

(a) area

(b) the Pythagorean Theorem.

Comment on pedagogical approaches to helping students build conceptual understanding of these concepts. Use your knowledge of the van Hiele levels to support your comments.

Algebra I Test Item

List some of the characteristics of non-invertible matrices.

Create a 3 x 3 non-invertible matrix.

What is the significance of knowing if a matrix is a non-invertible matrix in the process of solving a system of equations using matrices?

Combinatorics Test Item

Suppose we have stamps of every cent denomination; how many ways can you arrange stamps in a line (order matters) on an envelope to produce the following totals of postage? (Assume the stamps all have the same orientation.)

1. 5 cents
2. 6 cents
3. 9 cents

Statistics and Probability Test Item

Some people enjoy playing games that offer big jackpot prizes, and others prefer playing games that offer modest prizes where it's much easier to win a smaller prize. In statistics, a game is considered **fair,** if on your investment of *n* dollars into a game of chance, your **expected return** is also *n* dollars. If the cost of entry into game 1 is $1 and the cost of entry into game 2 is also $1, which of the two games below is a fair game? Explain.

Game 1:	**$ you get back**	**Probability of receiving that payment**
	$ 75,000	0.00001
	$ 100	0.001
	$ 0	All other times

Game 2:	**$ you get back**	**Probability of receiving that payment**
	$ 500	0.001
	$ 10	0.05
	$ 0	All other times

What results indicate lead teachers' student success?

Effective Instructional Practice

Active student engagement in rigorous, student-centered mathematical experiences is understood by MLI lead teachers to be an important precursor to and aspect of student success.

Lead teachers' practices observed "sometimes" or "very often"

Teacher….
• had a solid grasp of the subject-matter content inherent in the lesson;
• provided learning goal(s) in student-friendly language;
• demonstrated or lectured with student participation or input;
• used scaffolding questions to facilitate student discussion;

Spring 2009 Observations (n=22)

Lead teachers' practices observed "sometimes" or "very often"

Teacher….
• reviewed language (words, symbols) associated with topic to standardize communication orally and visually;
• corrected misconceptions;
• facilitated whole class discussion to ensure common understanding; and
• acted as a resource person working to support and enhance student investigations.

Spring 2009 Observations (n=22)

Lead teachers' students' learning experiences

Students . . .	% of classes
• talked about mathematics;	100
• shared prior knowledge of the language and/or concept;	95
• justified their conclusions;	95
• used a variety of means to represent concepts;	94
• explained their understandings to a partner or small group;	85

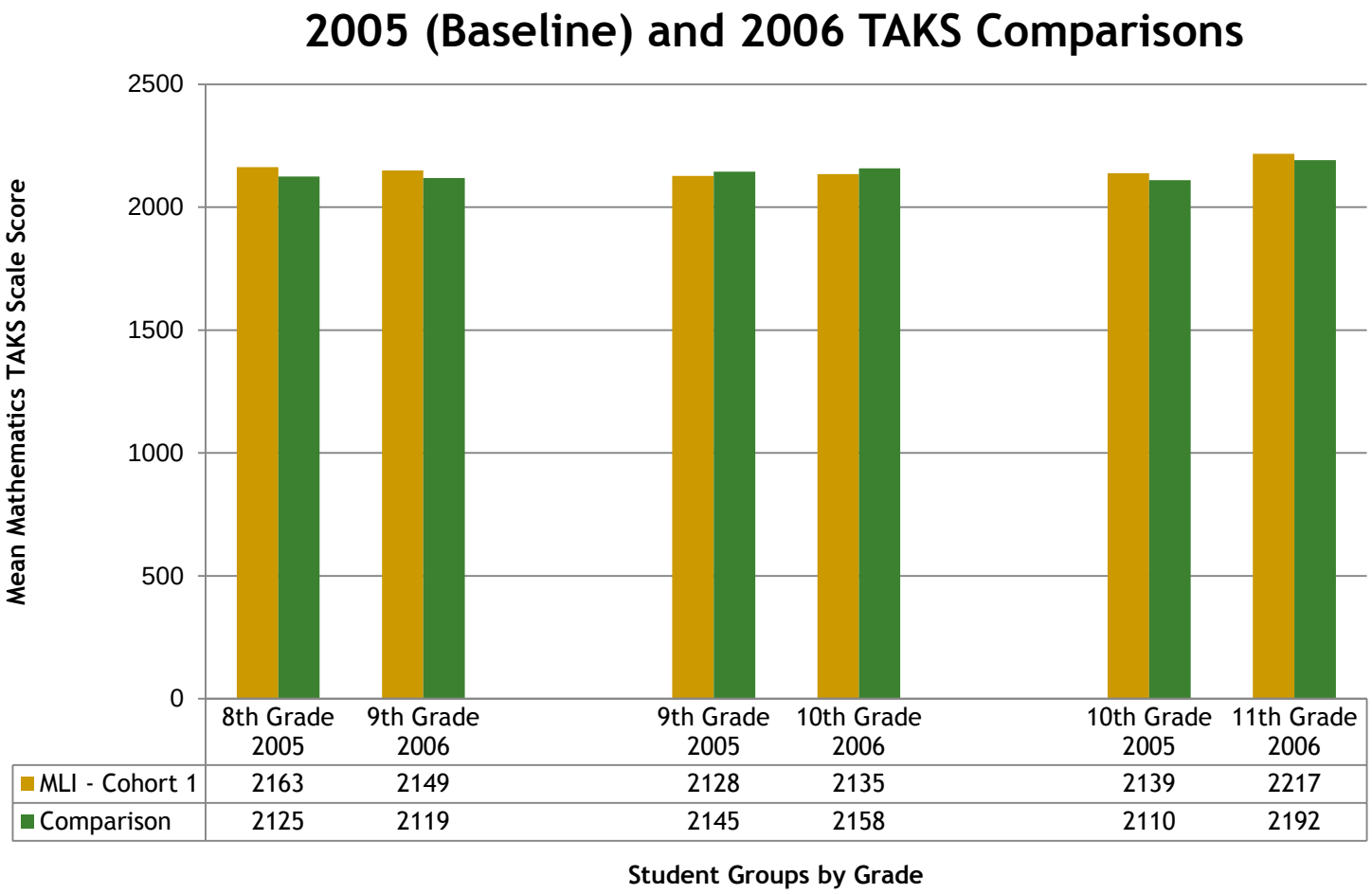
Spring 2009: Observed "sometimes" or "very often"

Lead teachers' students' learning experiences

Students . . .	% of classes
• shared a variety of strategies or explanations or solutions;	77
• actively engaged in thought-provoking activities that often involved the critical assessment of mathematical procedures; and	90
• respectfully critiqued their peers' explanations.	85

Spring 2009: Observed "sometimes" or "very often"

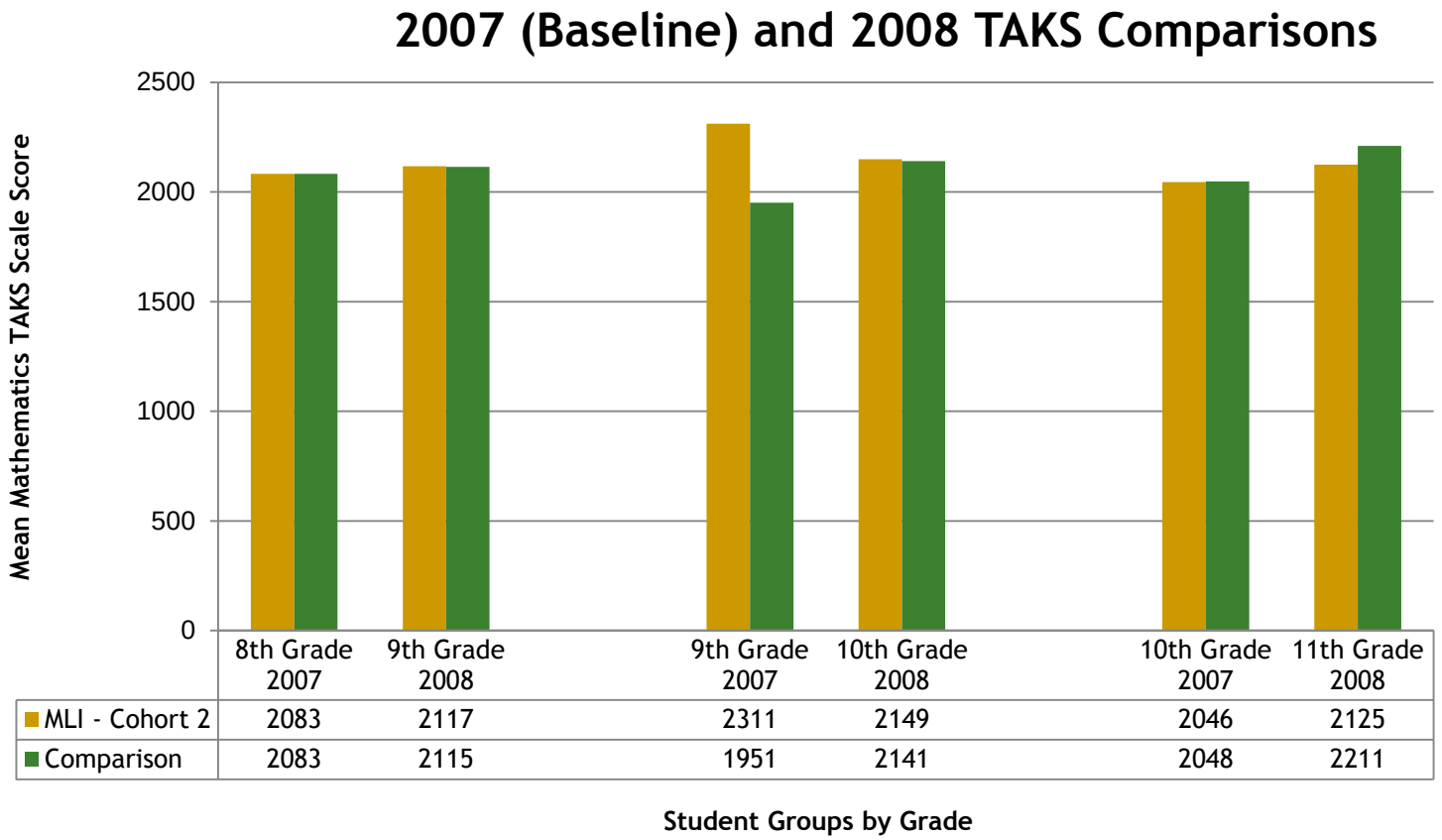
Student Performance on TAKS



	8th Grade 2005	9th Grade 2006	9th Grade 2005	10th Grade 2006	10th Grade 2005	11th Grade 2006
MLI - Cohort 1	2163	2149	2128	2135	2139	2217
Comparison	2125	2119	2145	2158	2110	2192

Texas Assessment of Knowledge and Skills (TAKS)

Student Performance on TAKS



	8th Grade 2007	9th Grade 2008	9th Grade 2007	10th Grade 2008	10th Grade 2007	11th Grade 2008
MLI - Cohort 2	2083	2117	2311	2149	2046	2125
Comparison	2083	2115	1951	2141	2048	2211

Texas Assessment of Knowledge and Skills (TAKS)

Student Performance on TAKS

9th Grade
Mean TAKS Mathematics Scale Score Comparisons

	2005-06	2006-07	2007-08	2008-09
MLI	2149***	2179***	2173***	2105
Comparison	2119	2111	2115	2084

*** p<.0001

Student Performance on TAKS

10th Grade
Mean TAKS Mathematics Scale Score Comparisons

	2005-06	2006-07	2007-08	2008-09
MLI	2135	2170***	2194***	2175***
Comparison	2158**	2139	2142	2129

** p<.001
*** p<.0001

Texas Assessment of Knowledge and Skills (TAKS)

Student Performance on TAKS

11th Grade
Mean TAKS Mathematics Scale Score Comparisons

	2005-06	2006-07	2007-08	2008-09
MLI	2217*	2223	2217	2282***
Comparison	2192	2223	2211	2225

* p<.01
*** p<.0001

Texas Assessment of Knowledge and Skills (TAKS)

What systemic change factors were identified?

Teachers' Implementation Experiences

During the school year did you…	Yes		No	
	N	Percent	N	Percent
create a model classroom?	48	89.09%	7	12.73%
introduce new strategies into your instructional approaches?	56	98.25%	1	1.75%
encourage your mathematics colleagues to use teaching strategies you learned through MLI?	49	85.96%	8	14.04%
have all teachers discuss and agree on the teaching strategies that will be used to introduce and develop lessons?	33	58.93%	23	41.07%
build rapport with and among teachers?	55	98.21%	1	1.79%

Collaboration

"One of the findings from MLI is the importance of developing lead teachers' skills in supporting their colleagues in providing high-quality mathematics instruction for all learners, in particular those traditionally underrepresented in STEM."

Hill, A., McCoy, A., Papakonstantinou, A., Parr, R., & Sack, J. (2007).

Mentoring

"[Geometry teacher] *asked me to offer suggestions for motivating the students. During my observation,* [Geometry teacher] *involved the students by having one student come up to the board and work the warm-up problem… I will give* [Geometry teacher] *feedback about my observation*[s] *during the lesson. I will also suggest hands-on activities, and real world examples to get the students more involved…"*

Mentoring

"… finally convinced him [math teacher] to show his students other strategies on the calculator. He said he would use it…"

Mentoring

"…[New teacher X] had questions about assessing the students' knowledge of the concepts, which are taught. I suggested short quizzes on a frequent basis to gain feedback from the students about their understanding of concepts, which are taught. I also suggested facilitating cooperative learning groups, and peer tutoring to allow the students to have the opportunity to reinforce their learning through discussion."

Four Impediments to Change

- Complexity
- Epistemic
- Structural
- Inertia or Vested-interest

Ben-Eli, M. U. (2010). Why is managing change difficult? Organizational renewal and the cybernetics of effective enterprise. New York, NY: The Cybertec Consulting Group. Retrieved November 30, 2010 from www.sustainabilitylabs.org/.../Why%20is%20Managing%20Change%20Difficult_0.pdf

Impediments - Complexity and Structural

"…at no time was there an opportunity for a novice teacher to visit my classroom. This was not an activity that was encouraged by the department chair or the administrator for curriculum. Upon the return to school from the summer there was no effort put forth to find out or schedule time for a meeting between an administrator, the department chair and myself to see if there was a way to utilize or share my skills or the information that was gained during the summer MLI."

Impediment - Epistemic

"I had the chance to work with the Geometry team, we were successful in planning together having common assessment and having discussions on student success from the common assessment, we even did several grading rubrics for the common assessments. Out of the team of six, four of us worked together [until] the TAKS confusion time. Two had early TAKS panic thus focused on TAKS, which creates a hard task of explaining to the team member that TAKS [is] just one piece of the learning but if we do what we are to do the rest will fall in place over time but not overnight. To them the kid is missing too much to pass the TAKS."

Impediments – Epistemic and Structural

"…in February, I begin TAKS pull-out classes [each class was 50 minutes] all day long with one period off every other day. These pull-outs lasted until April 16, 20xx. I am now able to go back to my teachers' classrooms."

Impediments – Epistemic, Structural, Inertia/Vested-Interest

"…[Geometry Team] tried to address compliance issues and concerns directly affecting mathematics teaching…asked [representative from the Texas Education Agency] HOW to raise the scores, told that it was our business and we [the Geometry Team] needed to handle our business. Teachers need to raise TAKS scores to meet AYP… general complaints about meeting time not being respected by admin…suffer in silence…teachers need to turn to each other, NOT admin…"

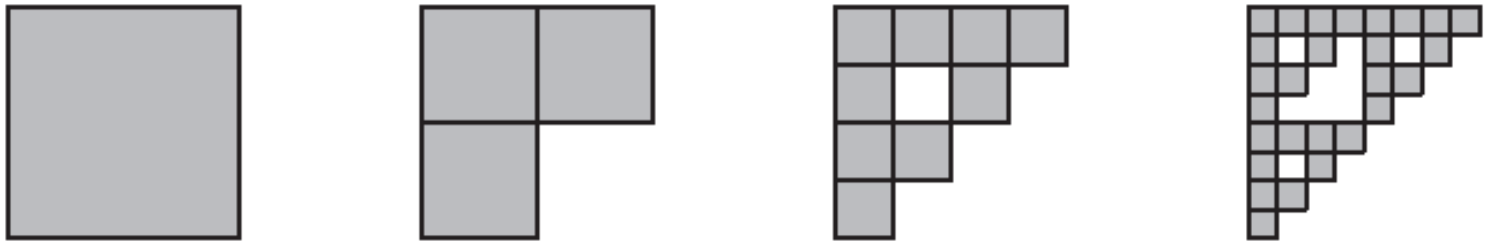
How do lessons learned regarding lead teachers' professionalism, their students' success, and systemic change factors inform the MSP work of MLI and the greater MSP community?

Addressing Impediments

Provided lead teachers with mechanisms to prepare their students for state assessments in creative ways which promoted higher-order thinking.

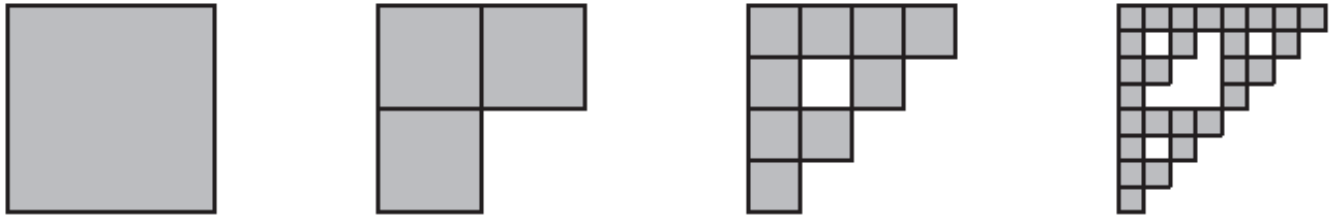
Addressing Impediments

The first 4 stages of a certain fractal are shown below.



Texas Assessment of Knowledge and Skills
Spring 2006, Exit Level

Addressing Impediments

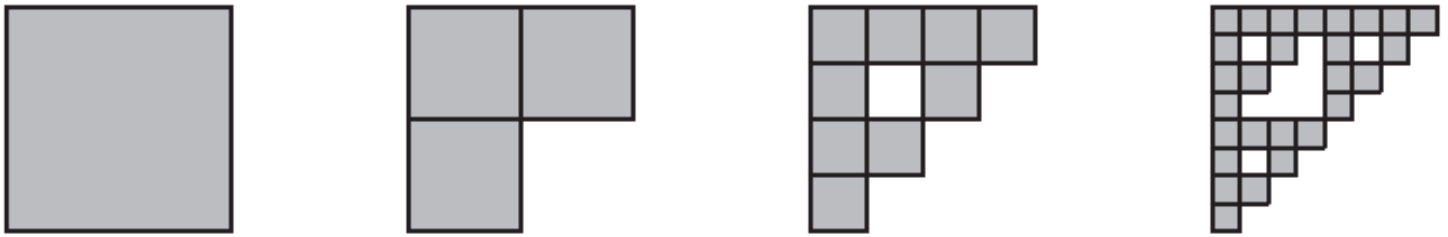


- In the table below, record the number of shaded squares for the first five stages.

Stage	1	2	3	4	5
Number of Shaded Squares					

- Graph the data from the table above.
- If the pattern continues, how many shaded squares are there in Stage 7? in Stage 20?
- Write a rule relating the stage number to the number of shaded squares at that stage.

Addressing Impediments



- Assume that the squares in the diagram above are all drawn to the same scale and the area of the Stage 1 square is 1 square unit. In the table below, record the shaded area for the first five stages.

Stage	1	2	3	4	5
Shaded Area (in square units)	1	¾			

- Write a rule relating the stage number to the shaded area for that stage.
- As the stage number becomes infinitely large, what is the shaded area?

Systemic Changes Needed to Establish High-Quality Professional Learning Communities

- Common planning time for teachers
- Adequate class time for students to discover and explore for the sake of learning

Systemic Changes Needed to Establish High-Quality Professional Learning Communities

- Administrative support to improve student behavior, student learning, and student success
- Structure for accountability
- More remediation for struggling students

Lessons Learned

Teachers would benefit from mathematics courses in:

- mathematical modeling
- number theory
- calculus
- probability
- linear algebra
- mathematical induction
- sequences and series

Lessons Learned

Structures within schools permitting collaboration were necessary to develop collegial exchanges with other educators.

Lessons Learned

The top-down structure and site-based management approach in the districts made it difficult for teachers to openly and effectively advocate for instructional changes on their campuses.

MLI's Sustainability…

depends on its institutionalization as an integral way that both AISD and HISD operate.