



Nebraska
MATH

UNIVERSITY OF
Nebraska[®]
Lincoln

Professional Development Opportunities for Mathematics Teachers

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Getting Started

- Center for Science, Mathematics and Computer Education
 - Established as part of an NSF-funded SSI in the 1990s
- Math and Science Teachers for the 21st Century
 - Established in 2002 as a campus Program of Excellence
 - \$350,000/yr
- LPS-UNL Professional Development Partnership
 - Summer PD math workshops (1999-2003)
- Math Matters (2000-2003)
 - CCLI grant from NSF to revise mathematics education of preservice elementary teachers
 - Institutionalized as the “Math Semester” in 2003



Growing the Partnerships: NSF Funds

- Math in the Middle Institute Partnership - 2004-2011
 - \$5.9 million from NSF as a \$5 million Math Science Partnership Institute with \$0.9 million Noyce supplements
- NebraskaMATH - 2009-2014
 - \$9.2 million from NSF as a Targeted Math Science Partnership
- NebraskaNOYCE - 2010-2016
 - \$3 million from NSF with \$1.5 million UNL match
- Data Connections - 2011-2014
 - \$1.2 million from NSF to help develop statistical models to estimate impact





Math in the Middle

12-course (2 year) masters program that educates and supports teams of outstanding middle level math teachers who will become intellectual leaders in their schools, districts, and ESUs.

SUMMER

- Offer 1 and 2 week classes.
- Class meets from 8:00 a.m. - 5:00 p.m.
- 35 teachers – 5 instructors in class at one time.
- Substantial homework each night.
- End-of-Course problem set
 - Purpose – long term retention of knowledge gained.

ACADEMIC YEAR

- Two- or three-day (8:00 – 5:00) on-campus class sessions.
- Course completed as an on-line, distance education course using Blackboard and Adobe Connect.
 - Major problem sets
 - End-of-Course problem set
 - Substantial support available for teachers



NebraskaMATH

- University-led teacher professional development
- P-16 partnership across the state
 - 4 core partner districts, over 100 total districts
- University partnerships
 - 5 departments: Math; Statistics; Psychology; Teaching, Learning & Teacher Education; and Child, Youth & Family Studies
 - 3 UNL Colleges: Arts & Sciences, Education & Human Sciences, Agriculture & Natural Resources



Primarily Math

- Focuses on strengthening the teaching & learning of mathematics in grades K-3
- Six course, 18-credit hour program leading to a K-3 Mathematics Specialist certificate
 - 3 mathematics courses
 - 3 pedagogy courses
- Optional 7th course focusing on leadership



Nebraska Algebra

- 9 hours of graduate coursework
 - Math 810T: Algebra for Algebra Teachers
 - EDPS 991: Cognition and Instruction for High School Algebra Teachers
 - TEAC 991: Field Studies in Mathematics
- Some districts are able to provide participants with an algebra coach
 - If a coach is not available, we provide a teacher mentor
- Teacher Liaison during the AY



Math 810T: Algebra for Algebra Teachers

- 2 week summer course: 4 hours/day for 10 days
- Students: approx. $\frac{1}{2}$ in-service, $\frac{1}{2}$ pre-service
- “Text”: 20 worksheets (2/day)
- Method of instruction: approx. $\frac{1}{3}$ lecture, $\frac{1}{3}$ small group work, $\frac{1}{3}$ class discussion



Course Objectives

- To give future & current secondary mathematics teachers a “big picture” view of algebra and its historical development
- To help them understand algebra not as a collection of rules, formulas and algorithms, but as a set of methods reasoned from principles governing arithmetic operations



Brief Outline of the Course

- Integers, divisibility and the Fundamental Theorem of Arithmetic
- Modular arithmetic
- A little abstraction: rings
- Polynomials, polynomials, polynomials!



Some Motivating Questions

- If a prime divides a product of two numbers, why must it divide one of the numbers?
- Why is $(-3)(5) = -15$?
- Why do roots correspond to linear factors?
- How is factorization of polynomials similar to the Fundamental Theorem of Arithmetic?



More Questions

- How is a polynomial (as an algebraic object) different from a polynomial *function*?
- What does the Fundamental Theorem of Algebra say?
- What are the irreducible polynomials using only real coefficients?
- Why does the method of partial fractions (from calculus) “work”?



New Teacher Network

- A program for secondary math teachers in their first three years in the profession.
- 24 hours of graduate coursework
 - Start with Nebraska Algebra courses
 - Pairs of mathematics & pedagogy courses
- A community of professionals sharing their experiences as new teachers
- All teachers have a mentor



NebraskaNOYCE

- Focus on increasing the K-12 mathematics achievement in high-need Nebraska schools and addressing Nebraska's achievement gaps
- Partnership among UNL and 3 largest high-need Nebraska districts
- Recruited 30 Master Teaching Fellows (10 from OPS, 12 from LPS, 8 from across Nebraska)
- Recruited 13 Teaching Fellows in 2 years
- Targeted support for high-need schools



Experiences of a Grad Student

- Creating and Co-Teaching the “Geometry for Geometry Teachers” course
- Working with Noyce Teachers



Geometry for Geometry Teachers

- The importance of axioms
 - via non-Euclidean geometries
- Problem solving and proof
 - via interesting, non-trivial problems
- Modeling good pedagogy
 - via hands on group work, discussions, and presentations

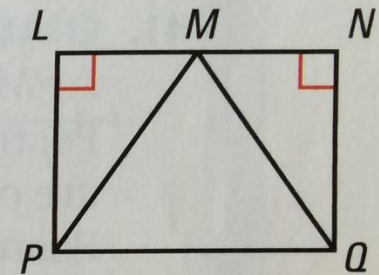


Typical Geometry Proof

34. **DEVELOPING PROOF** Copy and complete the proof.

GIVEN ▶ Point M is the midpoint of \overline{LN} .
 $\triangle PMQ$ is an isosceles triangle with $\overline{MP} \cong \overline{MQ}$.
 $\angle L$ and $\angle N$ are right angles.

PROVE ▶ $\triangle LMP \cong \triangle NMQ$



STATEMENTS

1. $\angle L$ and $\angle N$ are right angles.
2. $\triangle LMP$ and $\triangle NMQ$ are right triangles.
3. Point M is the midpoint of \overline{LN} .
4. ?
5. $\overline{MP} \cong \overline{MQ}$
6. $\triangle LMP \cong \triangle NMQ$

REASONS

1. Given
2. ?
3. ?
4. Definition of midpoint
5. Given
6. ?

Teachers at work.



Working with Noyce Teachers

- Observed and interviewed over a dozen teachers
 - I get to see the experience of teachers in their classrooms
 - They get to see my (more advanced) perspective about the mathematics they are teaching.



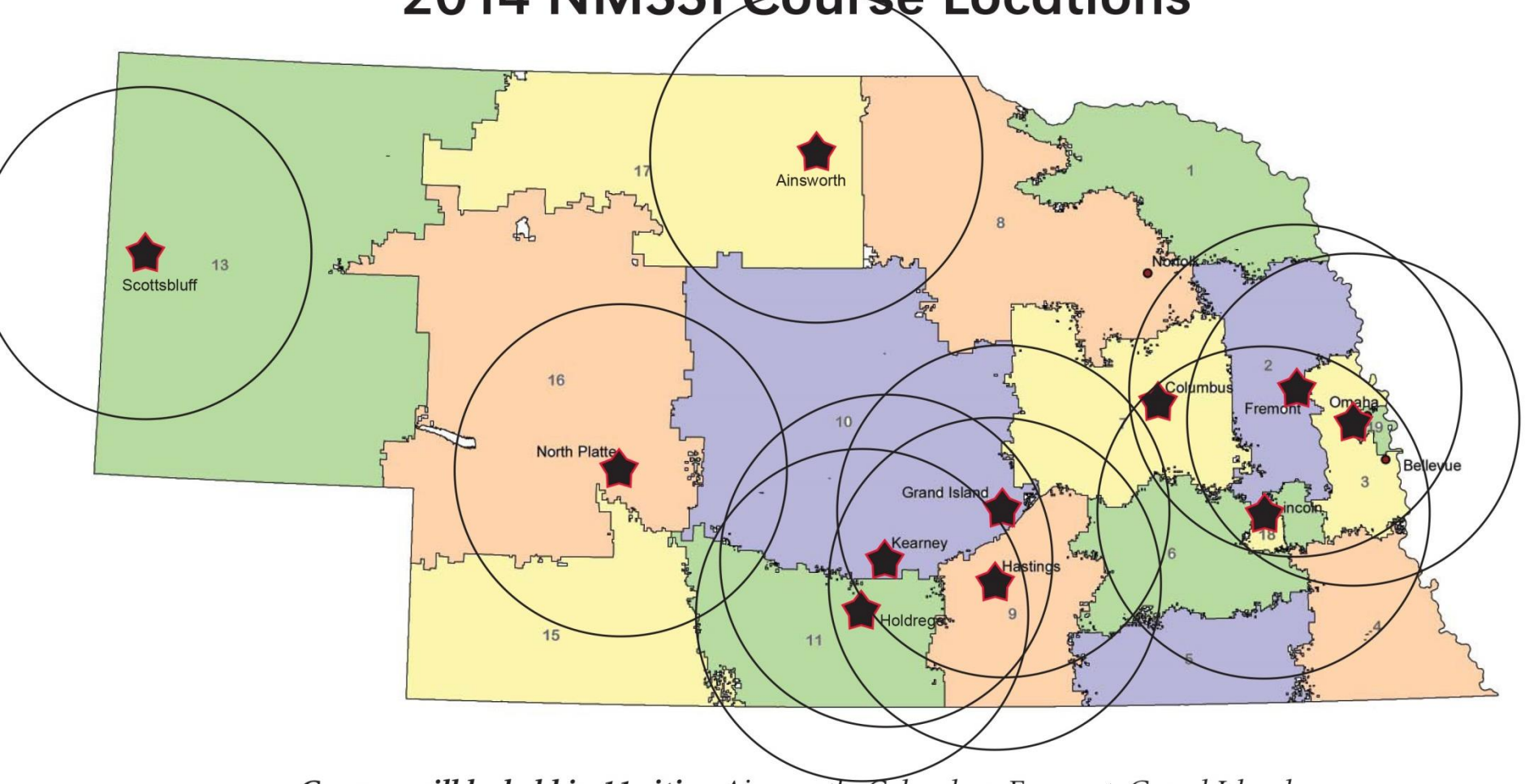
Sustaining the Partnership

- **Nebraska Math and Science Summer Institutes**
 - Teachers get a 20% tuition discount
 - We award about \$75,000 in supplemental fellowships each year to further lower the cost of graduate education
 - In Summer 2013, NMSSI Courses were offered in 12 Nebraska communities. (A total of 30 courses were offered.)
 - Approximately 10 high school teachers are earning a masters each summer taking NMSSI courses.
 - Between NMSSI & grant funded courses – 19.8% of UNL summer graduate enrollment
 - It is now possible to earn a master's degree taking all courses online.



Bringing graduate education to Nebraska teachers

2014 NMSSI Course Locations



Courses will be held in 11 cities: Ainsworth, Columbus, Fremont, Grand Island, Hastings, Holdrege, Kearney, Lincoln, North Platte, Omaha and Scottsbluff.

Growing the Partnerships: Local Funds

- Omaha Public Schools Teacher Leader Academy
 - \$5.45 million from The Sherwood Foundation® & Lozier Foundation
 - Funds math coaches, 4 Primarily Math cohorts, 2 Math in the Middle cohorts, a research program and graduate fellowship for OPS teachers
- The Buffett Early Childhood Fund will fund a research and PD initiative for pre-school teachers (\$528,000)
- Improving Teacher Quality grant to provide PD for teachers in Nebraska's Panhandle (\$70K+)
- UNL-LPS Title I Partnership to fund 6 courses (240 registrations) in Summer for LPS teachers in Title I buildings (\$538,000)





Impact of NSF Supported Professional Development

- Math in the Middle – 185 teachers
156 have earned a master's degree
- Primarily Math – 282 teachers
225 have earned a K-3 Math Specialist Certificate
- Nebraska Algebra – 75 teachers
- New Teacher Network 64 teachers
 - 61 still teaching in Nebraska
- Robert Noyce NSF Master Teachers 30 teachers
- Robert Noyce NSF Teaching Fellows 13 teachers
- **Nebraska Math Summer Institutes 1211 registrations**
 - These courses do not use NSF funds



Impact on UNL

Many people are involved in NebraskaMATH

UNL faculty	36
- 17 from Math	
Other collegiate faculty	15
UNL graduate students	87
- 54 from Math	
UNL undergraduates	33
Master teachers	76



New math courses for middle level and high school teachers

- Experimentation, Conjecture and Reasoning
- Number Theory and Cryptology for teachers
- Discrete Math for Middle Level teachers
- Using Math to Understand our World
- Math in the City for Teachers
- Algebra for Algebra Teachers
- Geometry for Geometry Teachers
- Functions for Precalculus Teachers
- High School Mathematics (I and II) from an Advanced Viewpoint
- Statistics for High School Teachers



Educational Research

- Major grants necessarily include research projects
- Collaboration among different depts
 - Math; Teaching, Learning, Teacher Education; Psychology; Educational Psychology; Child, Youth & Family Studies; Statistics
- Grad/postdoc interdisciplinary seminar for last 4 years
 - Helps build common language & background knowledge
 - Respect for the knowledge traditions of others
- Math in the Middle, NebraskaMATH (Primarily Math)



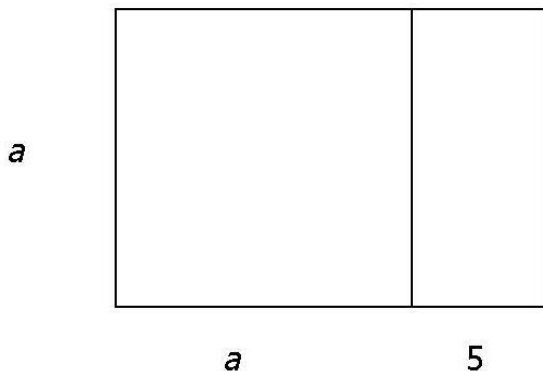
Research Results

- Most teachers take annual:
 - Learning Math for Teaching (LMT)
 - Attitude survey
 - Teaching Practices survey (includes beliefs)
- K-3 students take fall/spring:
 - Test of Early Mathematical Ability, 3rd Ed (TEMA-3)
 - Competence beliefs survey
- Primarily Math collected data from
 - participating teachers, non-participating control group, & teachers in buildings with elementary mathematics coaches
 - student data from subset of participating teachers



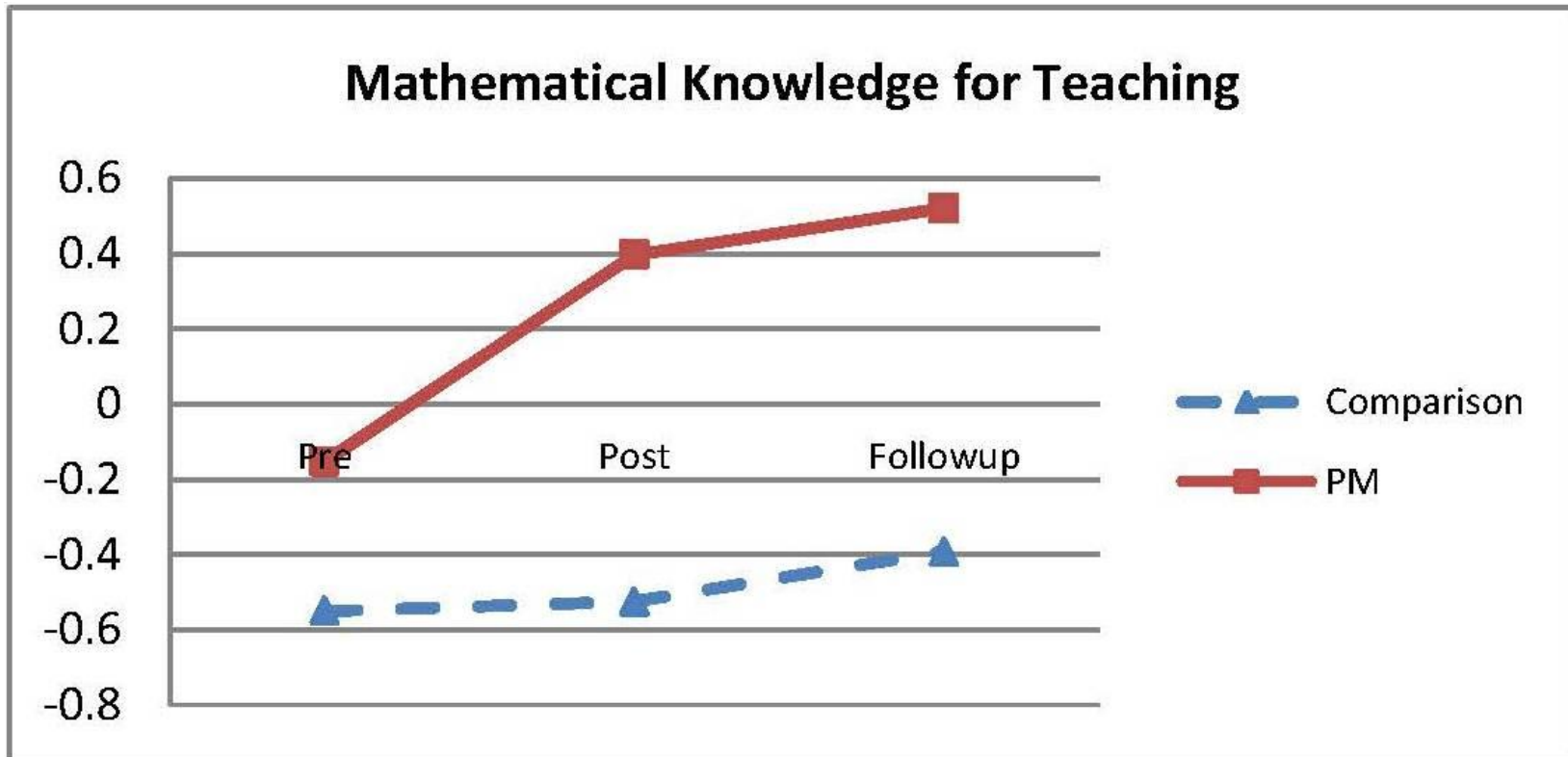
Learning Math for Teaching

Ms. Whitley was surprised when her students wrote many different expressions to represent the area of the figure below. She wanted to make sure that she did not mark as incorrect any that were actually right. For each of the following expressions, decide whether the expression correctly represents or does not correctly represent the area of the figure.

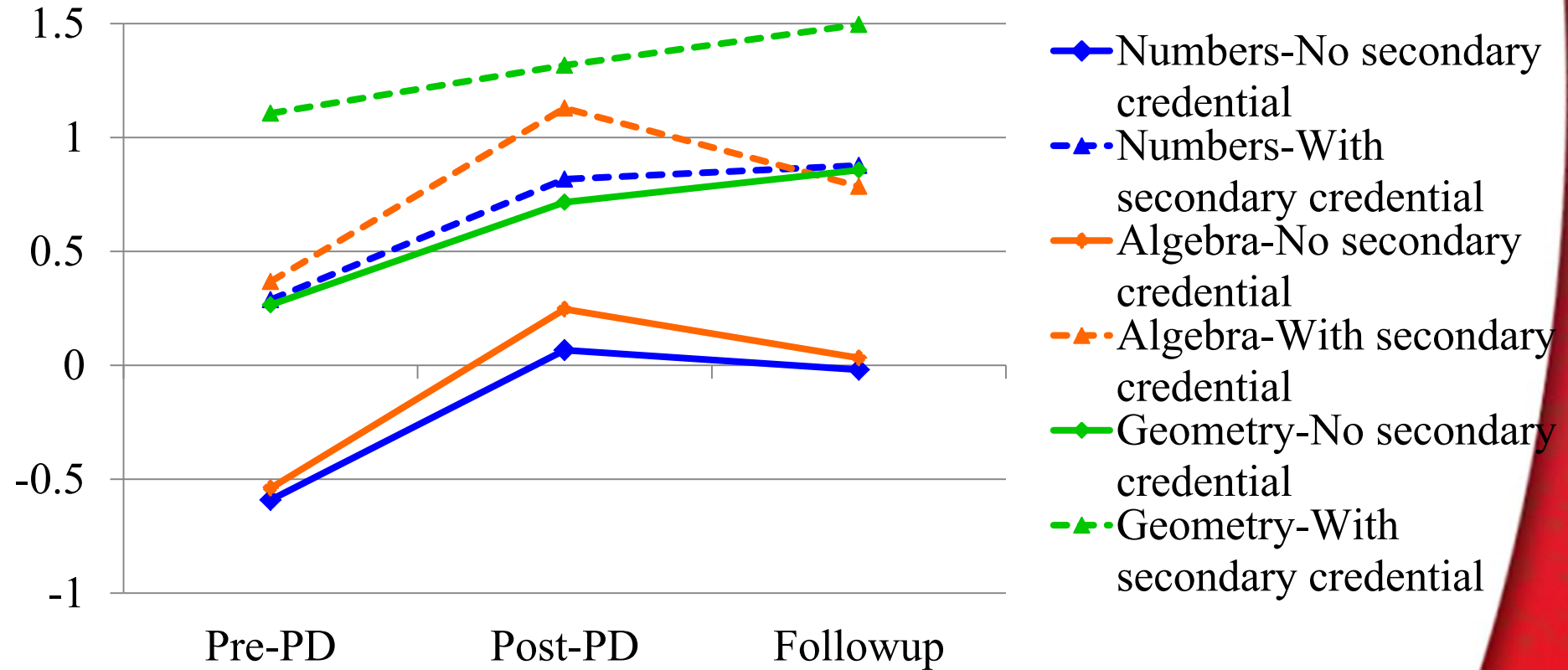


	Correctly represents	Does not correctly represent	I'm not sure
a) $a^2 + 5$	1	2	3
b) $(a + 5)^2$	1	2	3
c) $a^2 + 5a$	1	2	3
d) $(a + 5)a$	1	2	3
e) $2a + 5$	1	2	3
f) $4a + 10$	1	2	3

Primarily Math LMT Scores

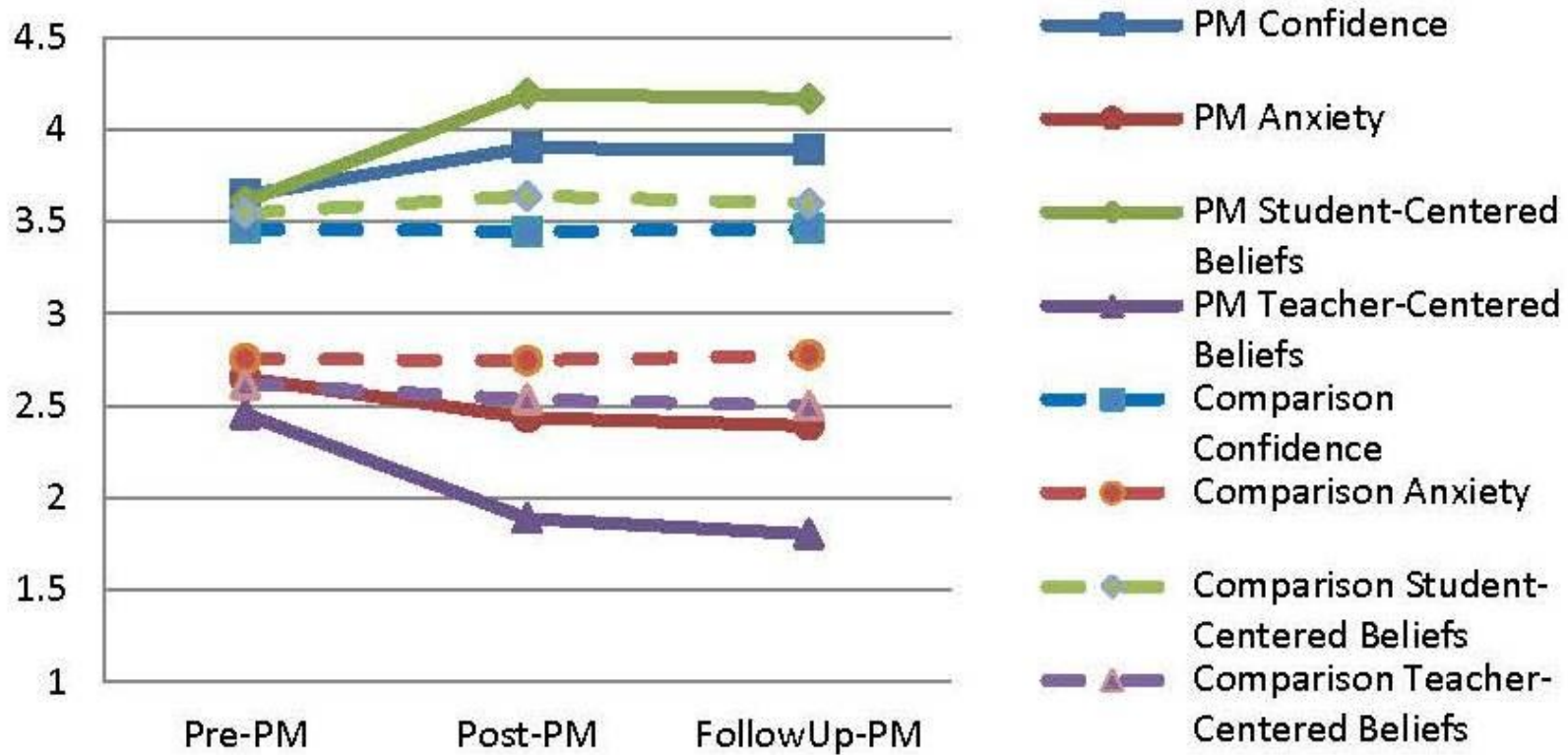


Math in the Middle Teachers LMT



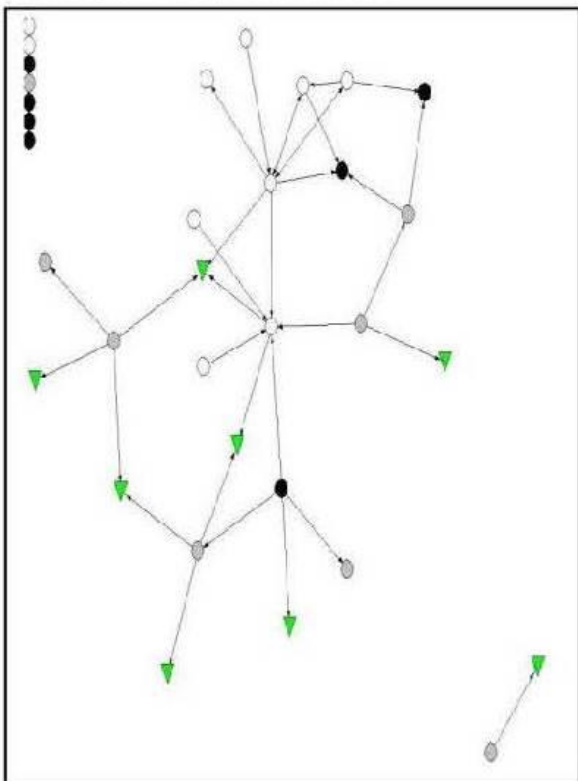
Teachers' Attitudes Improve

Primarily Math and Comparison Teachers' Attitudes and Beliefs

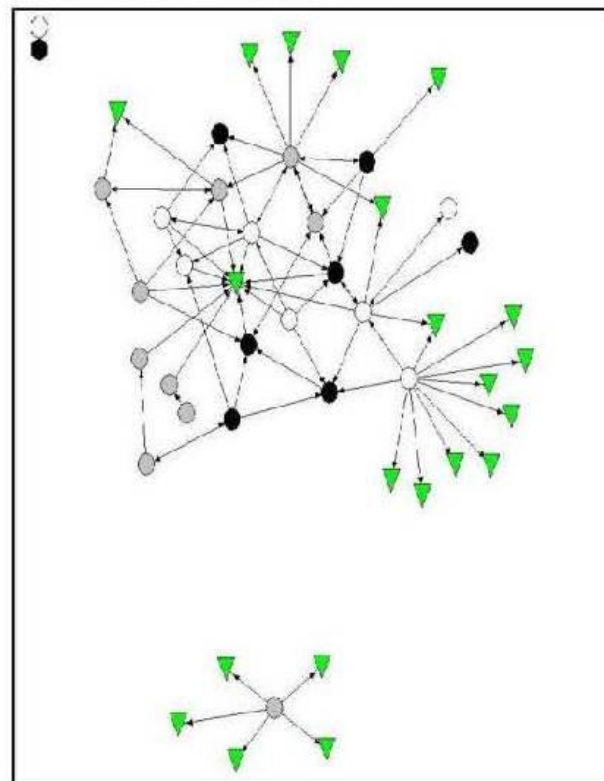


Teacher Community Networks are Denser

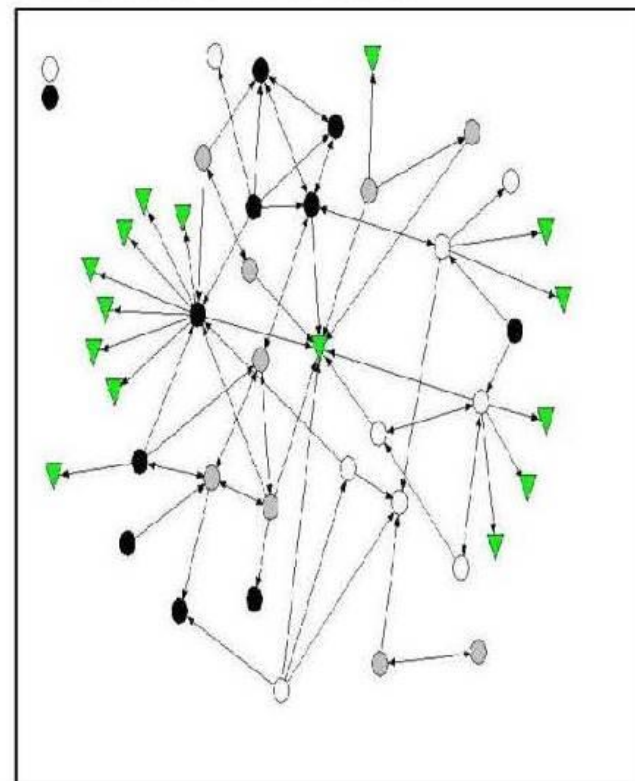
Mathematics Advice Network 2010



Mathematics Advice Network 2012



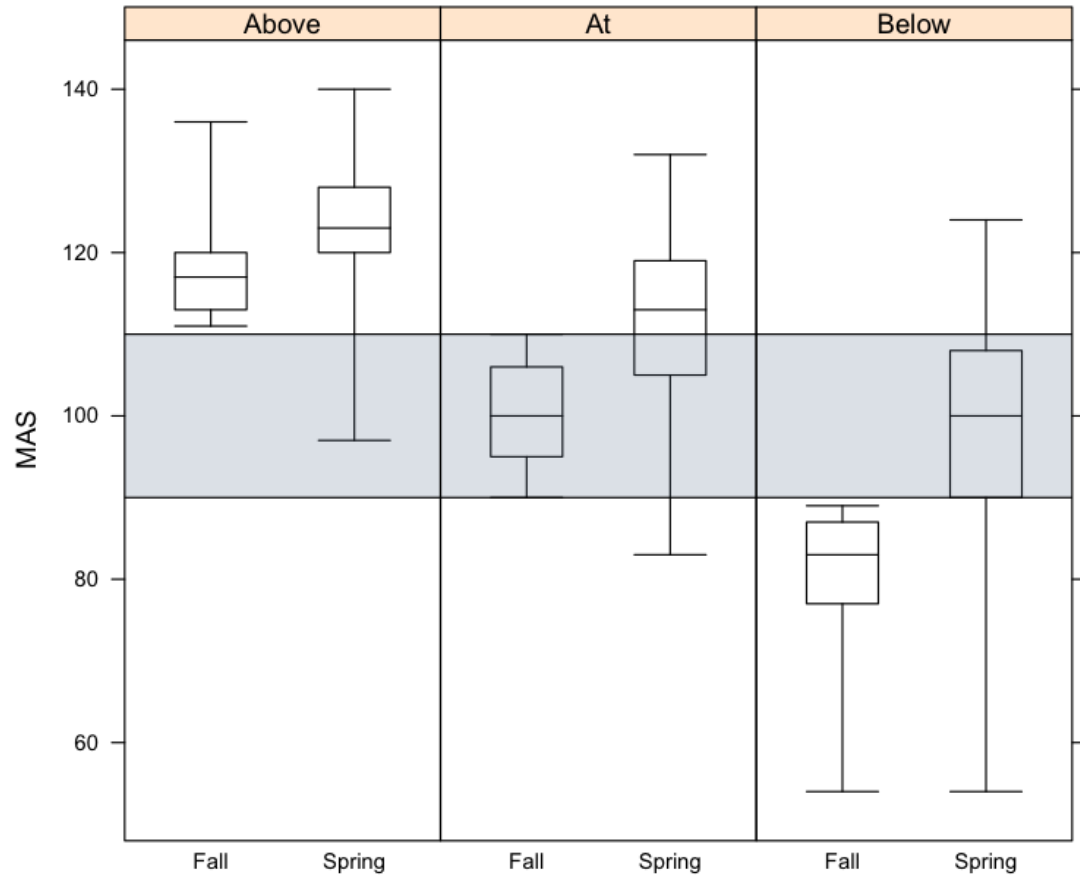
Mathematics Advice Network 2013



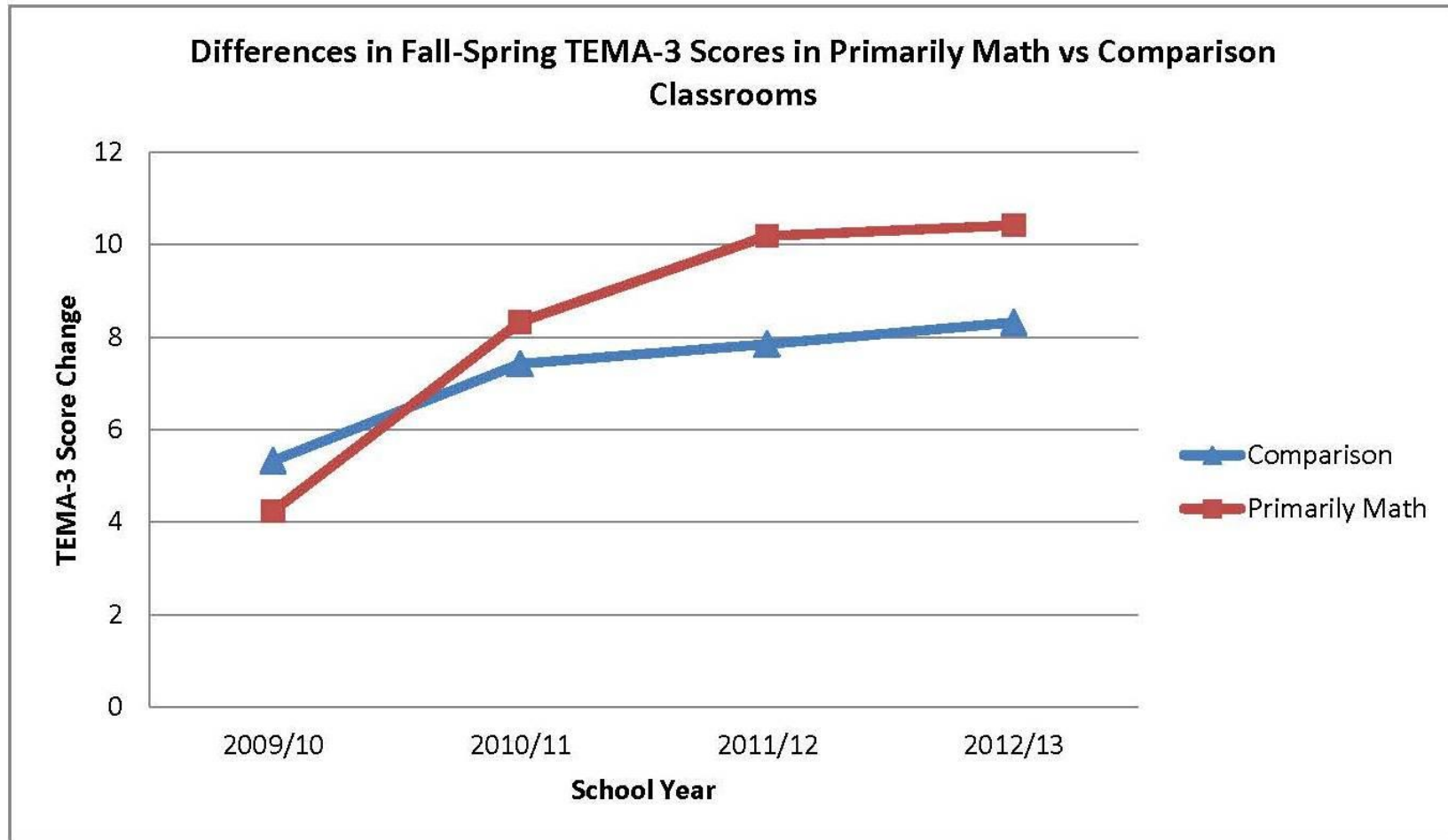
Notes: White circles represent lower (K-2) grade level teachers.
Gray circles represent higher (3-6) grade level teachers.
Black circles represent administrators and special teachers.
Green triangles represent teachers who 1) did not respond to survey and 2) were in other schools.

TEMA-3

Across 3 large districts, 2009-2013, grades K-2, we are seeing consistent and significant increases in TEMA-3 scores, particularly for students who start below average

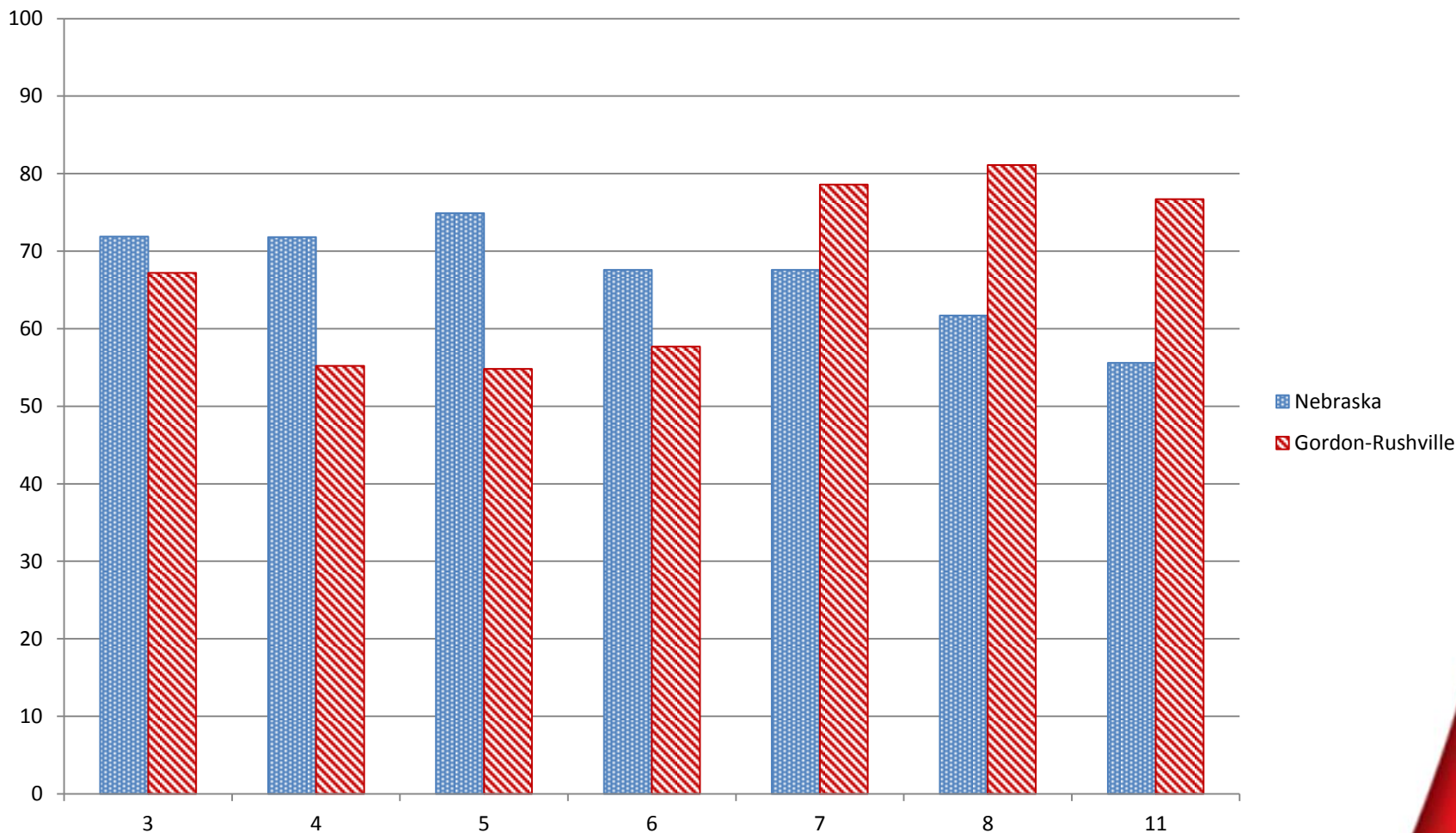


Students Learn More Math



Good Teachers Matter

Comparing state data to one district with good teachers



Growing & Sustaining Partnerships

- Shared vision of increasing Nebraska student achievement in mathematics
- Shared belief that the way to address the vision is to engage teachers in high-quality long-term professional development
- Distributed leadership of projects, with “true” partnerships among stakeholders
- Building a community of professionals



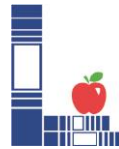
Questions?



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Nebraska MATH

*A partnership to improve
mathematics achievement*



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