

NE Context ~ 1999

- I was chair of the UNL Department of Mathematics.
- I was chair of the Steering Committee for The Mathematical Education of Teachers.
- I had not taught a class for teachers since 1974.
- I felt an obligation to experience locally, what I was discussing nationally.
- But as Chair, I was reading student evaluations like the following:



Comments from a math class for elementary school teachers: (the course GPA was 2.93)

- This wasn't a course where we learn to teach math. Why do we have to explain our answers.
- tests are invalid. They ask questions we have never seen before. It would help if we knew more about the questions on the exams - If examples in class were used on the exams.
- Her way of assessing her class aren't fair.
- Test materials were not consistent or reliable with the material covered in class. Grading was very biased.



Comments from a Contemporary Math class

- (She) does a good job making the subject matter interesting. She always seems very enthusiastic about the class and and actual work. More teachers should be like her.
- (She) is a great teacher with a love for her subject that becomes addictive. It has really been my lucky pick to have gotten her as an instructor.
- (She) made the class exciting. It is obvious she enjoys math and teaching. She was always clear in her expectations and directions.
- (She) was one of the best teachers I have had here at UNL. She was always available for questions!
- This was a very good class. I failed the class last semester with a different teacher but (she) did a much better job and I am doing great in the class!



My solution: I needed a partner in teacher education

Enter **Ruth Heaton**
a faculty member in
(mathematics)
teacher education.



Ruth and I formed a
partnership that has
lasted 12 years.

Our first joint effort was Math Matters a \$200,000 NSF grant



Barriers to a Successful Partnership

- Students took math courses before admission to Elementary Education Program
- Methods courses grouped leaving no room for a math class
- Math for Elementary Education was often taught by graduate students or part-time lecturers
- Cultural differences in how instruction delivered and students assessed
 - Fall 2000 Undergraduate GPA by Department
 - Math 2.53 (UNL's lowest)
 - Curr & Inst 3.64 (among highest)



(more)

Barriers to a Successful Partnership

- Math expectations seem to overwhelm students in Elementary Education
- Student evaluations critical of math faculty

Type of Course	Faculty GPA	#Students
– Honors class	3.20	1,367
– All faculty courses	3.04	16,693
– Large Lectures	2.88	6,060
– Education Majors	2.48	726



Beliefs of Math and EI Ed Faculty

1 Strongly Disagree 2 Disagree 3 Agree 4 Strongly Agree

El Ed Math Question

- 1.71 2.12 Stated from Traditional Viewpoint
- 2.00 2.92 Algorithms are best learned through repeated drill and practice.
- 1.57 2.55 An advantage of teaching math is that there is one correct answer.
- 2.00 3.22 Frequent drills on the basic facts are essential in order for children to learn them.
- 1.83 2.70 Time should be spent practicing computational procedures before children are expected to understand the procedures.
- 2.83 2.14 The use of key words is an effective way for children to solve word problems.

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Beliefs of Math and EI Ed Faculty

1 Strongly Disagree 2 Disagree 3 Agree 4 Strongly Agree

El Ed Math Question

- 3.27 3.07 Stated from Reform Viewpoint
- 3.29 2.25 Teachers should let children work from their own assumptions when solving problems.
- 3.86 2.78 Mathematics assessment should occur every day.
- 2.71 3.40 Leading a class discussion is one of the most important skills for a math teacher.

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Math Matters

A Mathematics – Education Partnership

Our Vision

- Create a mathematician – mathematics educator partnership with the goal of improving the mathematics education of future elementary school teachers
- Link field experiences, pedagogy and mathematics instruction
- Create math classes that are both accessible and useful for future elementary school teachers

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The Mathematics Semester

(For all Elementary Education majors starting Fall 2003)

MATH

- Math 300 – Number and Number Sense (3 cr)

PEDAGOGY

- TEAC 308 – Math Methods (3 cr)
- TEAC 351 – The Learner Centered Classroom (2 cr)

FIELD EXPERIENCE

- TEAC 297b – Professional Practicum Experience (2 cr)
 - Students are in an LPS elementary school two days per week
 - Math 300 & TEAC 308 are taught as a 3-hour block twice a week
 - TEAC 351 meets at the elementary school

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An example of working together:

I asked this question on a test:
Is 2^{50} a factor of 100^{30} ? Explain your answer.
My students reached for their calculator and got:

8.881784197 E44

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$$\frac{100^{30}}{2^{50}} = \frac{4^{30} * 25^{30}}{2^{50}} = \frac{2^{60} * 5^{60}}{2^{50}} = 2^{10} * 5^{60}$$

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"Why is this stuff so hard?"

I believe this test, this class, this subject, are all difficult because they involve thinking in different ways than what we are used to. We have all been conditioned, in our own education; to believe that things are the way they are, and that's all there is to it. We haven't challenged ideas and proofs nearly as much as we should have. Asking "Why" to an idea or trying to understand the reasoning behind something is just not something most of us are used to doing. That's why this stuff is hard.

Miss A



"Why is this stuff so hard?"

The major problem that I had was my reasoning for the factoring problem. I started off thinking that I should try dividing 2^{50} into 100^{30} , but the large numbers were daunting, so I panicked and tried using my calculator.

The answer it gave me did not look pretty, which I think is what triggered my fall down a road of insanity (see my test for more details). Bad, bad calculatorsonce you started to explain the problem on the board, I wanted to smack myself in the head for being so silly.

Miss P



A special emphasis for all our classes: The habits of mind of a mathematical thinker

Have you ever had two students (or do you know two teachers) who appear to know the same "facts" but for whom there is a marked difference in their ability to use that information to answer questions or solve problems?

Why?

- Do mathematical thinkers approach problems differently?
- And, if so, how do we develop the "habits of mind of a mathematical thinker" in teachers and assist them in cultivating this knowledge among their students?
- To study this question, we developed a working definition based on experience and the work of other mathematics educators (e.g., Cuoco, et al., Driscoll)



Mathematical Habits of Mind Problems

Goals: Give teachers experiences with problems with multiple entry points and solution paths to develop their:

- Strategies for solving problems
- Flexibility in thinking
- An appreciation for the importance of precise mathematical definitions and careful reasoning
- Ability to explain solutions to others
- Persistence and self-efficacy



The Chicken Nugget Conundrum

- *There's a famous fast-food restaurant where you can order chicken nuggets. They come in boxes of various sizes. You can only buy them in a box of 6, a box of 9, or a box of 20. Using these order sizes, you can order, for example, 32 pieces of chicken if you wanted. You'd order a box of 20 and two boxes of 6. Here's the question: What is the largest number of chicken pieces that you cannot order? For example, if you wanted, say 31 of them, could you get 31? No. Is there a larger number of chicken nuggets that you cannot get? And if there is, what number is it? How do you know your answer is correct?*

A complete answer will:

- i) Choose a whole number "N" that is your answer to the question.
- ii) Explain why it is not possible to have a combination of "boxes of 6" and "boxes of 9" and "boxes of 20" chicken nuggets that add to exactly N pieces of chicken.
- iii) Explain why it is possible to have a combination that equals any number larger than N.



Problematic Answers

- **Explain why it is not possible to order exactly 43 pieces.**

Argument #1: You can not have any combination that adds to 43 because it can't evenly divide by 6, 9, or 20. It is not a multiple of 15 and it can't be evenly divided in half.

Argument #2: You are not able to get the number 43 because none of the numbers add equally into that number.

- **Explain why it is possible to have a combination that equals any number larger than N.**

Argument: It's possible to have a combination greater than 43. This is because you can buy all the multiples of the numbers. For example if you buy 18, you can buy 36 and 70. Or if you by 20 you can buy 40, 60, 80, 100, etc.



Ideas for Creating and Sustaining Mathematics – Mathematics Education Partnerships

- 1) Value integration of content and pedagogy.
- 2) Commit to a long-term partnership.
- 3) Build on existing relationships and capitalize on strengths.
- 4) Appreciate mathematics for teaching as rigorous.
- 5) Support one another's goals.
- 6) Understand differences in how instruction is delivered.
- 7) Accept cultural differences in how students are assessed.



How?

- Leadership matters
- Be very specific when first asking a mathematician to be involved
- Promote change gradually
- Respect each other and the contribution of each discipline
- Support and reward mathematicians' work in K-12 educational work



Math in the Middle Institute Partnership

- A 25-month masters program that educates and supports teams of outstanding middle level math teachers who will become intellectual leaders in their schools, districts, and ESUs.
- A major initiative to provide evidence-based contributions to research on learning, teaching, and professional development.
- A special focus on rural teachers, schools, and districts.

M² Goal

Invest in high-quality teachers in order to improve K-12 student achievement in mathematics and to significantly reduce achievement gaps in the mathematical performance of diverse student populations.



Math in the Middle Instructional Model

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



Nebraska**MATH**

Principal Investigators

Mathematics (2)
Teacher Education (2)
Statistics (1)
Psychology/Child, Youth
& Family (1)

Graduate Students

Mathematics (3)
Teacher Education (3)
Psychology (2)
Child, Youth & Family (1)
Educational Psychology (2)



Nebraska**MATH**

More than a grant – A K-12 University Partnership

- Primarily Math
- Nebraska Algebra
- New Teacher Network
- Nebraska Math and Science Summer Institutes
- Robert Noyce NSF Teaching Fellowships
- Robert Noyce NSF Master Teaching Fellowships



Impact on UNL and our partners



Many people are involved in NebraskaMATH teaching and research

(2004-2011) Math - 2011

UNL faculty	26	11
Other collegiate faculty	8	3
UNL graduate students	62	19
UNL undergraduates	19	
Master teachers	44	



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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
- On-going support in the form of study groups lasting 2 years after coursework



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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
- All teachers have a university mentor



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Nebraska Math & Science Summer Institutes



- In 2011 we are offering 18 courses for math teachers in 9 locations around the state.

25 COURSES!

nebraska Math & Science Summer Institutes

scimath.unl.edu/NMSSI

ADVANTAGES FOR TEACHERS

Teachers can take an NMSSI course for \$590, approximately two-thirds the \$870 other graduate students must pay for tuition and fees.

Current Nebraska teachers are also eligible to apply for additional fellowships on a competitive basis.

Nebraska Lincoln



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