RESEARCH DESIGNS
RELATED THE ROLE OF STEM FACULTY IN
STUDENT SUCCESS

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Texas Middle and Secondary Mathematics Project
Stephen F. Austin State University

3 RESEARCH DESIGNS

1. Training Under-Qualified Middle & Secondary Mathematics Teachers (TxMSMP), ’02-’08

2. Training Teacher-Leaders in Mathematics to Mentor & Deliver PD (Texas LIMIT, TxMSMP Leadership), ’09-’14

3. Horizontally Integrating Curriculum in an Alternate Cultural Setting, ’10-

STUDENT SUCCESS

(& QUANTIFYING *PROGRESS* TOWARD SUCCESS)

Definition Successful students will:

- graduate high school (including passing the TAKS/end-of-course exams – Texas' high stakes tests)
- matriculating at high percentages into higher education, college ready
- believe the mathematics classroom to be a supportive environment
- perceive mathematics to be a discipline integrally tied to their everyday lives.

STUDENT SUCCESS

(& QUANTIFYING *PROGRESS* TOWARD SUCCESS)

Progress toward success:

- Improvement at each grade level TAKS math test
- *Sustained* improvement on standardized math tests
- Teacher pre/post test improvement on specific content area (Sanders & Rivers, 1996; Kennedy, et. al., 2008)
- Pre/Post test improvement on conceptual understanding, procedural fluency, strategic competence, adaptive reasoning, productive disposition (NRC)
- Reflect improved perception of mathematics classroom (instruction, learning, supportiveness)
- Reflect more knowledge of careers in mathematics

The challenge is then not only *demonstrating progress* but *linking progress to success.*

TRAINING UNDER-QUALIFIED MATHEMATICS TEACHERS

PROGRAM DESIGN

- Implemented the cohort model – 3 middle, 2 secondary cohorts
- Developed 2 new majors within the Master of Science degree program (with Texas Higher Education Coordinating Board approval)
- Provided a schedule conducive to teachers' schedules (weekend, Saturday only, intensive summer sessions)
- Developed courses of study in which teachers were immersed in intensive studies and provided necessary accommodations
- Required school district commitment
- Held administrator professional development sessions twice a year on campus and intermittently via phone conversations, email, posting of online materials, district campus visits, etc.
- Engaged IHE faculty in development and delivery of courses

TRAINING UNDER-QUALIFIED MATHEMATICS TEACHERS

INITIAL RESEARCH DESIGN

Pre/Post Tests for Teacher:

- Evaluator recommended using the same test, since 2.5 years separated deliveries
- Aggregate scores and specific questions yielded insights

Use the definition of division, $\frac{a}{b} = c$ if and only if _____,
to explain why $\frac{0}{0} \neq 1$.

Sketch the graph of the curve determined by the equation $y = x^2$.

a. Using 8 rectangles of equal width and the right endpoints of the subintervals, find the Riemann sum for the function over the interval [0,4].

b. Evaluate $\int_0^4 x^2 dx$ and calculate the percentage of error between this value and the area approximation found in part a.

TRAINING UNDER-QUALIFIED MATHEMATICS TEACHERS

INITIAL RESEARCH DESIGN

Middle School Cohort 1: (100 point scale)

	Pre-Test	Post-Test
Mean	28	52
Std. Dev.	11	13

Middle School Cohort 2: (100 point scale)

	Pre-Test	Post-Test
Mean	31	63
Std. Dev.	10	10

Secondary Cohort 1: (100 point scale)

	Pre-Test	Post-Test
Mean	25	46
Std. Dev.	13	17

TRAINING UNDER-QUALIFIED MATHEMATICS TEACHERS

INITIAL RESEARCH DESIGN

Longitudinal TAKS Test scores *following students* who experienced a one-year instructional intervention.

Difference between students with NSF teachers vs. Comparable teachers in 2004/05

	2004	2005	2006	2007	2008	2009	
Students Set 1	22	59	67				
Students Set 2	95	-3	66	72			
Students Set 3	5	6	-8	14	24		
Students Set 4	3	-35	-53	-15	-27	-88	grade 11
Students Set 5	100	-3	-33	-27	-74	-55	grade 10
							grade 9
							grade 8
							grade 7
							grade 6
							grade 5

TRAINING UNDER-QUALIFIED MATHEMATICS TEACHERS

INITIAL RESEARCH CONCLUSIONS

Difference between students with NSF teachers vs. Comparable teachers in 2004/05

	2004	2005	2006	2007	2008	2009	
Students Set 1	22	59	67				
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Students Set 4	3	-35	-53	-15	-27	-88	grade 11
Students Set 5	100	-3	-33	-27	-74	-55	grade 10
							grade 9
							grade 8
							grade 7
							grade 6
							grade 5

- Teacher content knowledge uniformly increased
- Student scores improved the year it was delivered
- Intervention in the 9th grade was most effective, followed by 8th& 7th
  - Algebra I makes up ~ 70% of the TAKS test
- The inability to disaggregate data was a hindrance (though it was intended to preserve confidentiality)

TRAINING UNDER-QUALIFIED MATHEMATICS TEACHERS

ADDITIONAL RESEARCH DESIGN

Longitudinal TAKS scores *Following Teachers*:

- Focus on a single district
- Observe whether program permanently empowered teachers
  - "Attribution Error" (Mary Kennedy, 2010) – challenges permanency

Exit scores for 11th graders

- Compare student affected/unaffected by MSP teachers

Gather teacher retention data

- Compare MSP teacher and non-MSP teacher retention
  - "Retention" (Ed Fuller)

TRAINING TEACHER-LEADERS IN MATHEMATICS

PROGRAM DESIGN

- Build mathematics leadership capacity by training well qualified teachers to design and deliver PD in their own district
- 2 cohorts – vertically integrated
- Monthly: 1 full day session during the academic year
- Summer: 3 two-day summer sessions
- Long-term commitment (4 years for MSP Leadership, 5 for Noyce LIMIT)
- Reading and implementing teacher development literature
- Implementing Lesson Study (K. Merseth)
- Actively engaging peers at their campuses
- Direct intervention in leadership development through collaborative efforts with the UT Austin Charles A. Dana Center

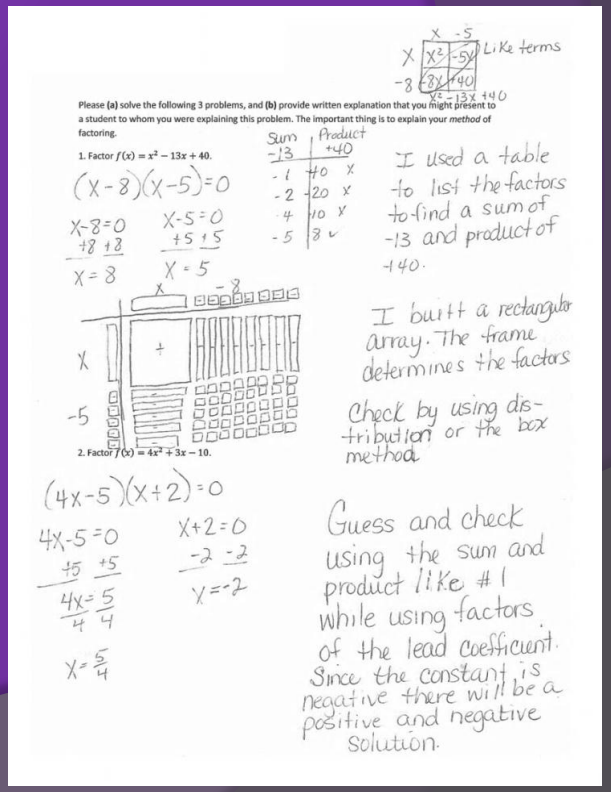
TRAINING TEACHER-LEADERS IN MATHEMATICS

RESEARCH DESIGN

- Initial Qualitative Question:
  How do mathematics educators providing professional development to middle and secondary mathematics teachers interpret and respond to the pedagogical needs of those teachers?

- Each participant gave 5 colleagues within their district* a survey of factoring

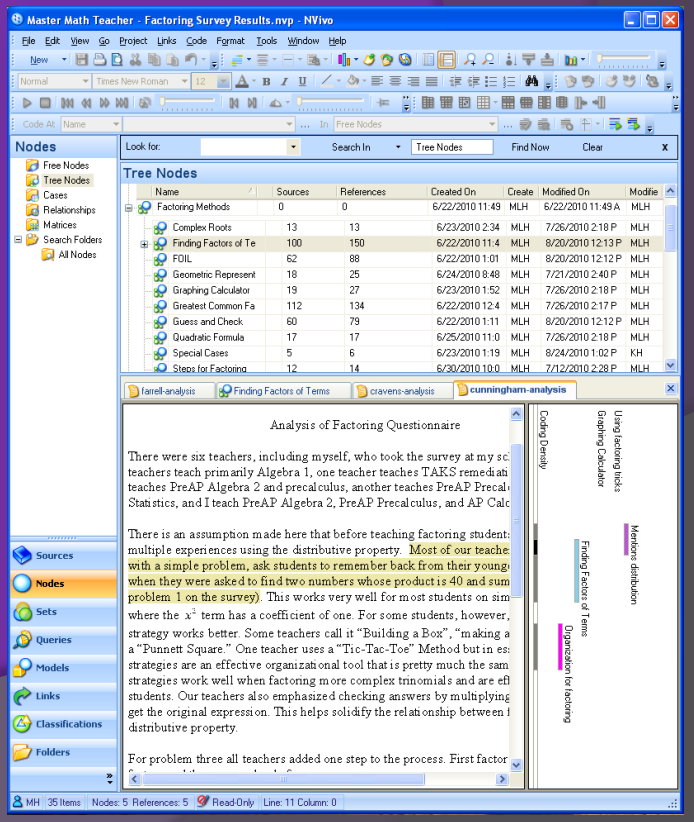
- Each participant identified themes in teacher responses and appropriate responses in PD tailored to the needs of their colleagues

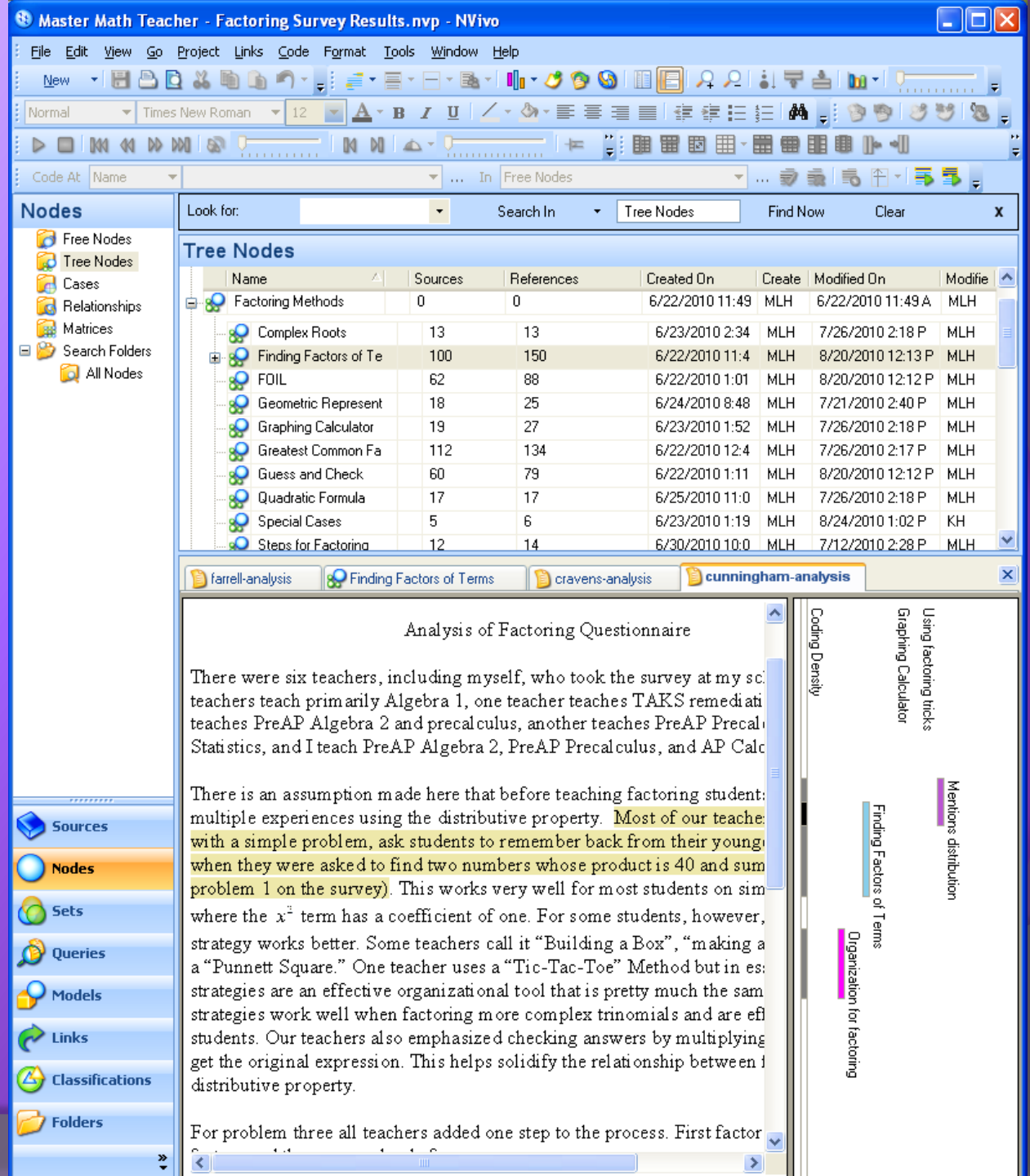


TRAINING TEACHER-LEADERS IN MATHEMATICS

RESEARCH DESIGN

- Linked non-participating teacher responses, with teacher-leader analyses in qualitative analysis software (NVivo)
- Identified themes and traced those themes between artifacts
- Precipitated the creation of an article for teachers on factoring




Master Math Teacher - Factoring Survey Results.nvp - NVivo
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Special Cases 5 6 6/23/2010 1:19 MLH 8/24/2010 1:02 P KH
Steps for Factoring 12 14 6/30/2010 10:0 MLH 7/12/2010 2:28 P MLH
farrell-analysis
Finding Factors of Terms
cravens-analysis
cunningham-analysis
Analysis of Factoring Questionnaire
There were six teachers, including myself, who took the survey at my sc
teachers teach primarily Algebra 1, one teacher teaches TAKS remediati
teaches PreAP Algebra 2 and precalculus, another teaches PreAP Precal
Statistics, and I teach PreAP Algebra 2, PreAP Precalculus, and AP Calc
There is an assumption made here that before teaching factoring student
multiple experiences using the distributive property. Most of our teache
with a simple problem, ask students to remember back from their young
when they were asked to find two numbers whose product is 40 and sum
problem 1 on the survey). This works very well for most students on sim
where the x^2 term has a coefficient of one. For some students, however,
strategy works better. Some teachers call it “Building a Box”, “making a
a “Punnett Square.” One teacher uses a “Tic-Tac-Toe” Method but in es
strategies are an effective organizational tool that is pretty much the sam
strategies work well when factoring more complex trinomials and are eff
students. Our teachers also emphasized checking answers by multiplying
get the original expression. This helps solidify the relationship between
distributive property.
For problem three all teachers added one step to the process. First factor
Coding Density
Using factoring tricks
Graphing Calculator
Mentions distribution
Finding Factors of Terms
Organization for factoring
Sources
Nodes
Sets
Queries
Models
Links
Classifications
Folders

TRAINING TEACHER-LEADERS IN MATHEMATICS

RESEARCH DESIGN

- Link existing qualitative data with student responses on factoring
- Pair past teacher surveys after required PD with future surveys of PD
- After teacher-leaders identify areas for PD in their district, work with them to create pre/post assessment to inform effectiveness

CURRICULUM IN AN ALTERNATE CULTURAL SETTING

PROGRAM DESIGN

- Based in Niger, Africa
- PI developed 6 lessons on conic sections that emphasized the connections between algebra and geometry, along with related assignments
- PI presented lessons to an Algebra II class and a Precalculus class
- PI and instructor of record conducted exit interviews with students

CURRICULUM IN AN ALTERNATE CULTURAL SETTING

RESEARCH DESIGN

- Pre/Post Tests (NRC)
  - conceptual understanding
  - procedural fluency
  - strategic competence
- Exit interviews – preliminary findings
  - Algebra II –
    - Viewed geometry as a necessary prerequisite to understanding the algebra
    - Noted that study habits included memorization and practice
  - Precalculus –
    - Viewed geometry and algebra working together to explain the development and behavior of conic sections
    - Noted that class interaction coupled with group study best developed skills

CURRICULUM IN AN ALTERNATE CULTURAL SETTING

RESEARCH RESULTS

- *Algebra 2*: 8-point scale

	Pre-Test	Post-Test
Mean	3.06	5.88
Std. Dev.	1.25	1.19

- *Precalculus*: On a 10-point scale

	Pre-Test	Post-Test
Mean	3.06	5.88
Std. Dev.	1.25	1.19

QUESTIONS?

Training Under-Qualified Middle & Secondary Mathematics Teachers

- How can data sets of teacher content knowledge most meaningfully be correlated with actual student success?
- When following student past a ‘treatment class,’ how does one control for other teachers? (Not I.I.D.)
- When states change their high states testing formats how should continuity be measured?

QUESTIONS?

Training Teacher-Leaders in Mathematics to Mentor & Deliver PD

- How is qualitative data, such as interviews and surveys, most effectively preserved from overlapping projects to inform future research endeavors?
- How can issues of teacher success, like teacher longevity, quantifiably be linked with improved learning environment?

QUESTIONS?

Horizontally Integrating Curriculum in an Alternate Cultural Setting

- After identifying cultural, ethnic, or socio-economic stratification in best pedagogical practices, what approaches are optimum to educate teachers about these differences and maximize teacher (and district) buy-in for addressing them?

INSIGHTS?

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