



TECHNOLOGY AND ALGEBRA IN SECONDARY MATHEMATICS TEACHER PREPARATION PROGRAMS

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Technology in PTA Project

Collaboration between Michigan State and Purdue to investigate PSTs' OTL:

- Algebra
- Algebra teaching
- Issues in achieving equity in algebra learning
- Algebra, functions, and modeling standards and mathematical practices described in CCSSM

We focus on PSTs' opportunities to encounter technology as they learn algebra and learn to teach algebra.

Note: Technology refers to electronic technologies

Recommendations:

Mathematical
Education of
Teachers
(*METI*)
(CBMS, 2001)

Mathematical
Education of
Teachers II
(*METII*)
(CBMS, 2012)

Interstate Teacher
Assessment and
Support Consortium
(InTASC)
(CCSSO, 1995)

National Council for
Accreditation of
Teacher Education
(NCATE)
(NCTM, 2012)

Method – Participants

University A

- Medium size
- Carnegie classification of RU/H
- 4-year program

University B

- Large size
- Carnegie classification of RU/VH
- 5-year program

University C

- Large size
- Carnegie classification of RU/VH
- 4-year program

Method – Data Sources

Instructor Interviews & Instructional Materials

- 2-3 Mathematics and 2-3 Methods courses
- Required by program
- Recently taught

PST Focus Groups & Participant Notes

- Final year
- Entire program (not only 5 courses)

Additional Materials

- University course descriptions

Discussion of Findings

Brief overview:

- Revisit Goal
- Overview of tech use and algebra
- Rationale for (or against) tech use
- Two Selected Examples

University A

Mathematics:

- course descriptions and tech use
- primarily computational

Mathematics education:

- Limited tech use except in **required:**
 - Teaching Sec. Math w/ Technology
- **For Algebra:**
 - some critical evaluation of technology

5 Courses

Linear Algebra	Secondary Math from Advanced Viewpoint	Middle School Math Methods
Structure of Algebra		Secondary Math Methods

University B

Mathematics:

- few examples: check calculations

Mathematics education:

- integrated technology use
- **For Algebra:**
 - multiple technologies
 - some critical evaluation of technology

5 Courses

Linear Algebra

Analysis

Math Capstone

1st & 2nd Secondary Math Methods

3rd & 4th Secondary Math Methods

University C

Mathematics:

- Graphing calculators prohibited on math final exams
- MATLAB component of Diff. Eq.
- PSTs – tech use in math courses

Mathematics education:

- Limited tech use
- **For Algebra:** some critical evaluation of technology

General education courses:

- Educational Technology course (not math-focused)

5 Courses

Differential Equations

Middle School Math Methods

Abstract Algebra

Seminar

Secondary Math Methods

Practical Concerns

Not useful in certain courses:

- ...It just doesn't strike me as really helpful... [University A, Structure of Algebra]
- It's abstract for a reason. [University C, Abstract Algebra]

Issues of access:

- ...we don't have money in our department to buy them. So, we don't have those and our students... need to know those things. [University A, Secondary Math Methods]

Not enough time or support:

- I do not have time to work all the [PowerPoint] slides... [University B, Linear Algebra]
- ...I think ...we should have a nice computer-simulated programs that make you see the difference [between convergence and uniform convergence of functions]. ... For me, I see it in my head....But I can't see how. I really can't see how. [University B, Analysis]

Impeding learning

Developing Memory

- ... because of the calculator and all these technologies [people] don't ... develop their memory. But then you are asking them to develop their memory on something that is harder than adding or subtracting, you know? [University B, Analysis]

Computational Use Blocks Concept Development

- But I also want them to know the concepts involved so sometimes ... I make a point to tell them that they shouldn't use technology... [University A, Linear Algebra]
- [A]t a college level we're now quite concerned because ... we have students who can't multiply...because they have always had a calculator, you know. There are students who can't tell you what the graph of $y = x$ looks like. ...[T]o be able to think about what $y = x$ and $y = x^2$ looks like -- they can't do without a machine. ...So, we are actually moving to not using technology. [University A, Secondary Math Methods]

Enhancing learning

Making the Abstract More Tangible

- [Technological tools] can bring some of these more abstract things to make them more tangible for students. [University C, Middle School Math Methods]

Allowing Different Perspectives

- I think it ...gives them a way to see the problem from a different perspective...understand it from a learner's perspective and ...to think about how to instruct students in multiple ways... [University B, Secondary Math Methods 1 and 2]

Conceptualizing Mathematics

- All of these tools represent ways to represent and conceptualize mathematical ideas that go beyond the symbolic. They're important tools to really develop a conceptual understanding of mathematics. Moreover, it's critical that our students are prepared to use these same tools ... to foster the same sorts of understandings. [University B, Secondary Math Methods 3 and 4]

It's Complicated...

Which courses could use technology?

- In this course none. ...In other courses that I teach I do use technology... I know that that is kind of counter-intuitive because textbooks always have technology stuff in there and some textbooks are even focused on technology. To me that is not what this [course] is about and the more technology you have in a course like this the less that there is for algebra.
[University C, Differential Equations]

What are instructional consequences of technology use?

- ... there are times where instructionally it may be not the best thing to always use technology and so making that kind of judicious choice is something we talk about as well. [University A, Secondary Math Methods]

Critical Evaluation of Technology

Consider:

- Affordances of technology, e.g.:
 - engagement
 - enhances some concept development
- Constraints of technology, e.g.:
 - instructor's/instructional time
 - impedes some concept development

... you don't just use a tool or technology just because it's going to be fun; but you really have to think about - What does this particular tool or technology afford me in terms of students' understanding the content? ...sometimes when we've used technology it didn't really offer us any more than if we had just drawn [on] a piece of paper.... [University B, Secondary Math Methods 1 and 2]

Existence and Uniqueness Theorems

[Differential Equations – MATLAB]

Through creating graphs of several solution sets, students are asked to:

- explain solutions in terms of the theorems
- explain why an equation did not satisfy hypotheses of the theorems
- claim & explain why a solution must exist & be unique
- investigate limitations of the theorems
- investigate why/how results can be wrong answers
- make & investigate claims about boundedness of solutions

Technology to Enhance the Teaching and Learning of Mathematics

[Secondary Math Methods - Lesson Plan]

Revise a previously written lesson plan to include technologies that enhance the teaching and learning of mathematics.

Discuss in detail:

- the incorporated technologies
- how their utilization enhances students' opportunities to learn mathematics
- include information from the PSSM technology principle and other readings to make the case that technology enhanced the lesson.

Rubric:

- Clear description of technology that improves OTL
- Justification of planned technology use

Limitations

- Pilot Data
 - Sample of convenience
 - Disparate collection of instructional materials
- Interviews and written materials
- No classroom observation
- One instructor per course

Conclusions

When, where, and how should technology appear?

Mathematics courses:

Tech use that supports learning in mathematics courses

- ...more than computation!

Mathematics Education courses:

Tech use and evaluation to support critical framework

Challenge perspectives toward tech use in math,

e.g. :

- only for applied mathematics
- always impedes learning of math

Technology Concerns:

- Time, Support, and Access

Thank you for your attention!

Questions for Main Study Data

Note: Main study data is *already* collected, so:

- instructor interviews,
- instructional materials,
- focus group data

Our Questions:

- What would be useful directions?
- What should we look for in the data?
- What would be useful to you to see in reports?

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MICHIGAN STATE
UNIVERSITY



PURDUE
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Univ. A Overview: Algebra Topics	Content	Methods
Functions & Multiple Representations		X
Systems of Linear Equations	X	X
Logarithmic Functions		X
Matrices	X	
Topics from Calculus	X	
Modular Arithmetic	X	
Extensions on Rational Numbers	X	

Univ. B Overview: Number of Activities	Content	Methods
Generalizing Patterns		X
Maximum Area Problem		X
Ratios and Proportion		X
Parametric Equations		X
Functions and Multiple Representations		X
Linear Functions (e.g., families, slopes)		X
Topics from Calculus	X	

Univ. C Overview: Algebra Topics	Content	Methods
Ratios and Proportion		X
Modeling with Equations		X
Functions and Multiple Representations	X	
Linear Functions (e.g., families, slopes)		X
Topics from Differential Equations	X	