Pre-service Teachers' Perspectives on Their Opportunities to Learn about Algebra

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Introduction

Significance

- Importance of Algebra Learning:
  All students should learn algebra and make connections between arithmetic and algebra (Usiskin, 1987).
  Researchers emphasized the importance of algebra and proposed that access to algebra is a "civil right" (e.g., Moses, 1995; Moses & Cobb, 2001).
- In an effort to build on prior research and recommendations related to mathematics preservice teachers' (M-PSTs') opportunities to learn algebra and to learn to teach algebra (hereafter, Algebra OTLs) in teacher preparation programs, we explored Algebra OTLs in five teacher preparation programs.

Research Question

"What opportunities to learn about algebra and algebra teaching were noteworthy to M-PSTs during their teacher education program?"

Methods

Data Sources and Collection

- Ten focus groups of three to four M-PSTs were interviewed about their opportunities to learn about Algebra and about learning to teach algebra.
- Two researchers individually coded each line of the interview transcripts and met to discuss differences until a consensus was reached.

Distribution of Algebraic Topics

- We coded each line that M-PSTs said during the interviews for any algebraic topics they mentioned.
- We then looked at the number of algebraic topics mentioned during each section of the interview: Nature and Structure of Algebra, Functions, Contexts and Modeling, Reasoning and Proof, Connections, Tools and Technology, Equity.

Types of Pedagogies

- We defined eleven different types of pedagogies and coded each line of the interviews as such: activity/task, homework assignment, project/portfolio, presentation, lesson plan, writing, reading, discussion, lecture, field experience, or exam/test.
- Using RStudio, we created ninety-five percent confidence intervals for each type of OTL pedagogy of the true proportion of times it was coded as "learn algebra".

Algebra OTLs Reported as "Positive" in Teacher Education Programs

- Two of our team members categorized the aspects related to algebra of the teacher education programs that M-PSTs claimed were positive or negative.
- The third team member reviewed the categories and the coded data.

Results

Distribution of Algebraic Topics

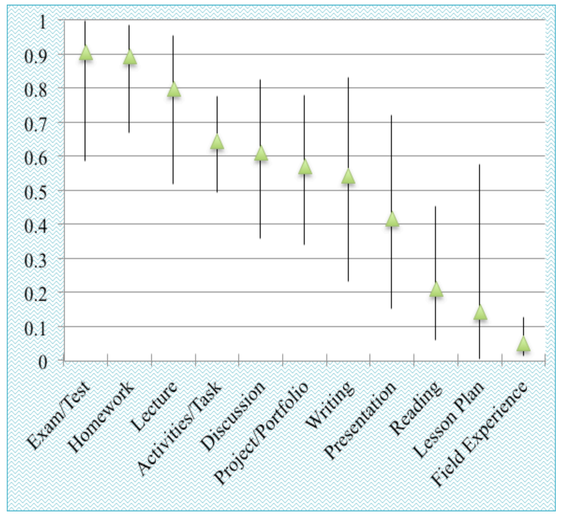
- Overall, M-PSTs at GLU, MUU, and SRU reported specific algebraic topics more frequently than those at MRU and WUU.
- Algebraic topics under the Functions theme (e.g., inverse, one-to-one functions) were mentioned most frequently at all universities, except for M-PSTs at SRU who reported more topics related to the Nature and Structure theme (e.g., number theory, matrices, logarithms).
- Algebraic topics related to the Equity theme were seldom mentioned; in fact, only three incidents occurred (i.e., linear equations, exponential equations, remedial algebra) at GLU and WUU. No algebra topics related to the theme were mentioned by M-PSTs in the other three programs.

OTL Pedagogies	GLU	MRU	MUU	SRU	WUU	TOTAL
Activities/task	12 (13 %)	16 (16%)	2 (3%)	11 (16%)	12 (23%)	53 (14%)
Homework	5 (6%)	6 (6%)	6 (9%)	1 (1%)	1 (2%)	19 (5%)
Project/portfolio	8 (9%)	7 (7%)	7 (11%)	0 (0%)	2 (4%)	24 (6%)
Writing	2 (2%)	1 (1%)	5 (8%)	0 (0%)	5 (10%)	13 (3%)
Reading	2 (2%)	4 (4%)	3 (5%)	6 (9%)	5 (10%)	19 (5%)
Discussion	4 (4%)	5 (5%)	4 (6%)	4 (6%)	4 (8%)	21 (6%)
Lecture	2 (2%)	3 (3%)	6 (9%)	3 (4%)	1 (2%)	16 (4%)
Exam/Test	0 (0%)	3 (3%)	5 (8%)	1 (1%)	0 (0%)	9 (2%)
Field Experience	12 (13%)	29 (29%)	14 (22%)	23 (33%)	5 (10%)	83 (22%)
Lesson Plan	0 (0%)	2 (2%)	0 (0%)	0 (0%)	5 (10%)	7 (2%)
Presentation	0 (0%)	1 (1%)	6 (9%)	0 (0%)	6 (12%)	13 (3%)
No pedagogy mentioned	42 (47%)	23 (23%)	6 (9%)	20 (29%)	6 (12%)	97 (26%)
TOTAL	89	100	64	69	52	374

Table 1: *Frequency (Percent) of OTL Pedagogies in Each Program*

Types of Pedagogies

Figure 1. Confidence Intervals of the Frequency of "Learn Algebra" OTLs for OTL Pedagogies



- M-PSTs reported more about learning algebra through exam/test, homework, lecture and activity/task.
- Readings and field experience were reported as pedagogies for learning to teach algebra.
- Discussion, project/portfolio, writing, presentation, and lesson plan were not found to be significantly more often reported in the context of learning algebra or learning to teach algebra either because these types of OTL pedagogies were used for both learning algebra and learning to teach algebra approximately equally (e.g., Project/Portfolio) or there was not a large enough sample size to conclude anything one way or the other (e.g., Lesson Plan).

Algebra OTLs Reported as "Positive" in Teacher Education Programs

Beneficial Algebra OTL \ University	GLU	MRU	MUU	SRU	WUU	Total
Make algebraic concepts visual	8	4	1	7	6	26
Develop a coherent view of algebra and its place in mathematics	7	6	2	9	0	24
Use technologies to learn or teach algebra	8	5	1	3	3	20
Apply algebraic concepts in real-world contexts	2	6	0	5	0	13
Engage in discovering algebraic concepts	0	4	0	6	0	10
Understand students' approaches to algebra	2	5	1	0	2	10
Collaborate to learn algebraic concepts	0	1	4	2	1	8
Teach algebra lessons in secondary classroom or to peer M-PSTs	0	1	1	0	3	5
Total	27	32	10	32	15	116

Table 2: *Algebra OTL reported as positive by M-PSTs*

Engage in discovering algebraic concepts:
And it was partly due to the professor…We could have been learning about algebra or geometry and he was just… He really looked in depth. We discovered everything. (SRU)

Use technologies to learn or teach algebra:
We used different -- we used GeoGebra and we would use the functions and kind of manipulate them on there, which helps because then if I teach it, now I know how to use GeoGebra and use it. (GLU)

- Making algebraic concepts visual was mentioned most often, followed by developing a coherent view of algebra and its place in mathematics, and using technologies to learn or teach algebra; these OTLs were mentioned by M-PSTs from nearly every program.
- M-PSTs at SRU and MRU reported the greatest number of positive opportunities.

Conclusions

Distribution of Algebraic Topics

- Future research can focused on the relationship between M-PSTs' abilities to articulate algebra learning and teaching using algebraic concepts and their opportunities to learn about these concepts in their teacher education program
- A teacher educator may consider ways to connect algebra with these important which have been mentioned less than others (e.g., Contexts and Modeling, Reasoning and Proof, Connections, Technology, and Equity)

Types of Pedagogies

- Teacher educators may reflect on the types of pedagogies they use to teach algebra concepts based on the pedagogies reported by M-PSTs in this study.
- More research should be conducted to examine if certain pedagogies are more effective to learn algebra and other pedagogies more effective for learning to teach algebra, or both learning and learning to teach algebra.

Algebra OTLs Reported as "Positive" in Teacher Education Programs

- Teacher educators may reflect on the positive aspects of programs mentioned in this study in order to implement more into their programs.

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