Examining Teachers' Learning as They Use Learning Map Models to Study Mathematics

Angela Broaddus, PhD
broaddus@ku.edu
The University of Kansas
Center for Educational Testing and Evaluation

THEORETICAL PERSPECTIVE

- Effective mathematics teaching requires teachers to deeply understand the content they teach and to appreciate how students construct mathematical knowledge.[1]
- Many teachers need learning opportunities over and above their initial preparation to develop adequate mathematical knowledge and understanding of student learning.[2]
- Teachers benefit from **professional development** opportunities to develop strong theoretical and empirical backgrounds in the content they teach.[3] They seek professional development focused on maximizing student learning with opportunities to actively discuss their content, instructional methods, and common problems they observe in student learning.[4]
- **Learning map models** provide networked visualizations of connected learning targets, representing the many-to-many relationships among concepts and skills and containing landscapes of learning pathways that are not necessarily linear.[5]
- **Previous research** shows learning map models to have potential as instructional tools, particularly if they are accessible through an online interface and accompanied by instructional resources.[6, 7]
- This study addresses the **research gap** of describing whether and how teachers can use learning map models as professional learning tools.

RESEARCH QUESTIONS

What effect does working with the learning map model to unpack standards have on teachers' mathematics knowledge for teaching?

- What do teachers perceive about their mathematics content knowledge after using the learning map model to unpack secondary mathematics standards?
- What do teachers perceive about their pedagogical knowledge after using the learning map model to unpack secondary mathematics standards?
- What do teachers perceive about their instructional practices after using the learning map model to unpack mathematics standards?

PARTICIPANTS

- Four in-service, secondary mathematics teachers
- Teaching experience: Range 2-13 years
- Education: Bachelor (2), Master (1) Master + 30 (1)
- Courses taught: Grade 6, Algebra 1 & 2, Geometry, Trigonometry, Pre-calculus, Calculus
- Demographics: Females (100%), White (75%)

DESIGN AND METHOD

Activity

- Full time, temporary, paid summer employment
- Highly **collaborative**
- Task - **develop learning map models** for each secondary standard in the CCSSM
- Task - **refine learning map structure** and information as needed

Data Sources

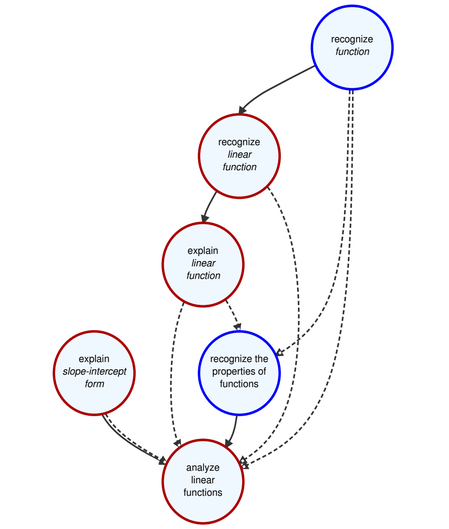
- **Journal** – teachers wrote about how this experience influenced their mathematics content and pedagogical knowledge
  - What topics did you work on today?
  - What was difficult to understand or different from your previous views about the topic?
  - What was straightforward or consistent with your previous views about the topic?
  - What connections were clear and obvious?
  - What connections were surprising? Why?
  - What ideas did you have today about teaching a particular topic?
  - What ideas did you have today about teaching a particular type of student?

Excerpts

- *I have really started to think about the **prerequisite skills** for students to master the concepts I want/need to teach.*
- *The map will help teachers address **misconceptions** in their lessons.*
- *This* (map) *could really help an instructor **differentiate** their teaching.*
- *I am learning about **different approaches** to topics.*
- *I often speak of the **learning gaps** students have. Now I feel I have a better tool to help identify with the goal of filling in those gaps.*

Example Learning Map Model

M.8.F.3: Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear.



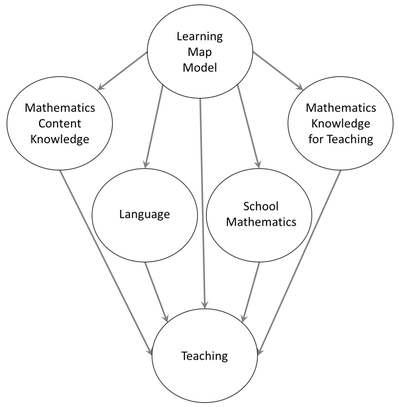
RESULTS

Coding methods applied to journal entries: **In-Vivo, process, concept, affective, values**

Categories derived from the coded data:

- **Mathematics content knowledge:** acknowledgment of critical connections among concepts and skills
- **Language**: difficulty of describing mathematical entities, verbal descriptions used by teachers and students as indicators of their mathematical knowledge
- **School mathematics:** knowledge of academic standards, awareness of progressions in learning, benefits of vertical alignment
- **Mathematics knowledge for teaching:** content connections that support student achievement, diagnosing student difficulties, alternative learning pathways, differentiating instruction
- **Teaching:** alternative ways to teach particular topics, crafting instruction to lay the foundation for content taught in future courses.

Theoretical Model



SUMMARY OF FINDINGS

Findings 1

- **Learning map structure** shows promise as a professional development tool by informing teachers' thinking about mathematics and student learning.
- **Value of the experience:** "*I feel this has great value*!"

Findings 2

- Clear relationships exist among the categories applied in this study and frameworks for Mathematics Knowledge for Teaching.[8, 9]

Limitations

- This study was small and based solely on qualitative data. More studies should investigate the use of the learning map structure in larger scale professional development opportunities and collect feedback in quantitative and qualitative formats.
- This study used data collected only from self reporting. Future investigations should incorporate objective measures of teachers' mathematics knowledge for teaching before and after professional development experiences focused on using learning map models.
- This study stopped with the professional development experience. Additional work should investigate how teachers incorporate their learning from learning maps based professional development in their instruction.

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