IMPACT OF INTEGRATION OF LEARNING PROGRESSIONS IN A MATHEMATICS CONTENT COURSE FOR TEACHERS

Alex Nicholson ❖ Erin Gadient ❖ Dr. Jennifer Harrison ❖ Dr. Ryan Harrison
Mathematics Education ❖ University of Wisconsin-Eau Claire

Abstract

The question of how best to prepare future mathematics teachers has no clear answer. This research project investigated the impact of integrating learning progressions of children's mathematical thinking into a mathematics content course for pre-service elementary teachers. This poster reports on the finding that pre-service elementary teachers demonstrated a substantial shift towards constructivist beliefs about mathematics teaching and learning, as well as the development of more conceptual and accurate analyses of children's mathematical thinking.

Background

There is a significant body of research investigating the knowledge and beliefs that can help facilitate effective mathematics instruction. Carpenter, Fennema, Peterson, Chiang, and Loef (1989) found research-based knowledge about student thinking to have a significant impact on in-service teachers' beliefs about mathematics teaching and learning as well as student achievement. While much is conceptualized about the form and type of mathematical knowledge and beliefs necessary for effective teaching (Ball, Thames, & Phelps, 2008), it is important to investigate methods designed to impact pre-service teacher growth and development.

For this research project, pre-service elementary teachers' (PSTs') mathematical knowledge and beliefs about teaching were explored in the context of an undergraduate mathematics content course intended for future teachers.

Appealing to PSTs' interest in young children while simultaneously reaching the teacher educator's goal of increasing their understanding and desire to teach elementary mathematics content has been found to positively impact their beliefs about teaching, learning, and mathematics as well as improve their mathematical knowledge (Philipp et al., 2007).

In consideration of the above results with in-service and pre-service teachers as well as the emphasis on learning progressions in the design of the Common Core State Standards for Mathematics (CCSSM), we decided to integrate learning progression materials from the Cognition-Based Assessment (CBA) research project into a required mathematics course for PSTs.

The CBA project, in particular, designed learning progressions materials (Battista, 2012) to help teachers:

- Effectively assess how their students currently understand mathematics
- Deeply understand the different strategies that students use to solve mathematics problems
- Understand the typical progression children's thinking follows
- Design instruction based on their students' current understanding of mathematics.

CBA materials have been found to be an effective means by which to promote teachers' development of mathematical knowledge for teaching (Harrison, 2012).

Methodology

Participants included 117 PSTs, all enrolled in their first, of three, mathematics for teachers course at a mid-sized Midwestern University.

Student Written Work Pre- and Posttest

In order to discuss and address specific areas of content such as place value, PSTs were asked to consider written student work and assess the strategy as well as what understanding was demonstrated. Much of the student work used in class came from the CBA materials.

Examples of Student Written Work:

55
+48
913

364
-79
300
-10
290
-5
285

20 × 10 = 200
20 × 6 = 120
320
4 × 10 = 40
4 × 6 = 24
64
320
384

280 ÷ 35
280
-70
210
-70
140
-70
70
-70
0
So, four 70's is eight 35's

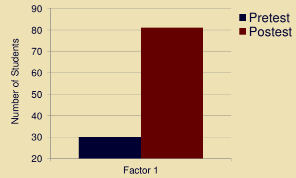
Mathematics Belief Scale (MBS, Capraro, 2001)

All participants completed the 18-item Likert-scale Mathematics Beliefs Scale (MBS, Capraro, 2001) survey at the beginning and end of the 15-week course. Additionally, participants provided qualitative responses to prompts asking them to describe and assess understanding for written student work on each of the four operations. These responses were collected at the beginning and end of the 15-week semester as well. After initial data analysis and categorization of all 117 participants, six participants were chosen to participate in a face-to-face interview to discuss their responses and change or lack of change from the beginning to the end of the semester.

Example MBS Questions:	How much do you agree?					
	Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree
Children learn math best by attending to the teacher's explanations.	(1)	(2)	(3)	(4)	(5)	(6)
Mathematics should be presented to children in such a way that they can discover relationships for themselves.	(1)	(2)	(3)	(4)	(5)	(6)
Children should not solve simple word problems until they have mastered some number facts.	(1)	(2)	(3)	(4)	(5)	(6)

Results

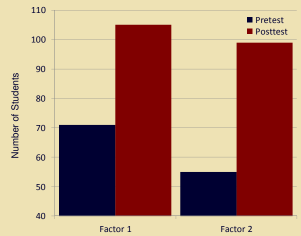
Addition



Addition Factor 1: PST correctly explains student work.

The student work for addition was analyzed for PST's discussion of place value. PSTs needed to explicitly mention how the student handled the 'tens' and 'ones' places, and the consequences of his/her error on the resulting place values in the answer.

Subtraction

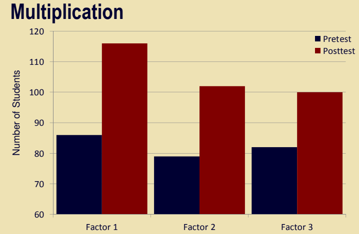


Subtraction Factor 1: PST believes student work is correct.

Subtraction Factor 2: PST gives correct conceptual description of student thinking.

The student work for subtraction was analyzed for correctness, as well as the conceptual description of the student's strategy.

Multiplication



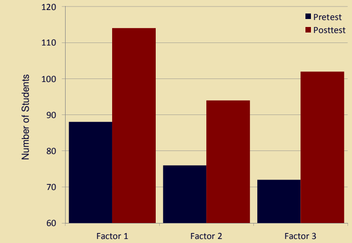
Multiplication Factor 1: PST understands student work.

Multiplication Factor 2: PST believes student work is correct.

Multiplication Factor 3: PST mentions conceptual elements of student strategy.

The student work for multiplication was analyzed for correctness, as well as conceptually accurate description of the partial products approach to multiplication.

Division



Division Factor 1: PST understands student work.

Division Factor 2: PST believes student work is correct.

Division Factor 3: PST connects student answer to the process of repeated subtraction.

Mathematics Belief Scale

MBS Factors	Pretest	Posttest
Beliefs about student learning (beliefs of teachers about how children learn)	3.12	4.04
Beliefs about stages of learning (the role of the teacher in sequencing of teaching both computational and application skills)	3.37	4.33
Beliefs about teacher practices (relationships between teaching computational skills and problem solving skills)	4.17	4.73

*The average PST moved from a neutral, to a "constructivist" range in all three factors.

Discussion

The results on the MBS indicate a shift in thinking for many of the PSTs, moving towards a "constructivist" belief about the teaching and learning of mathematics. While the beliefs instrument measured 'espoused' beliefs outside of the context of actual teaching scenarios, the changes in PST responses on the pre and post survey of children's thinking indicated that many of the PSTs developed the ability to more deeply analyze mathematics. The PSTs demonstrated clear improvement in evaluating student work not simply for correctness, but for conceptual elements such as place value understanding. What was especially encouraging is that while many of the PSTs readily admitted on the pre-test that they did not understand several of the children's strategies, virtually none felt the need to on the post-test. Whether or not this can be directly attributed to exposure to children's strategies in the context of the CBA learning progression materials is unknowable, but it is encouraging nonetheless to know that PSTs can develop more constructivist beliefs and demonstrate improvement in their ability to analyze mathematical work within the context of a mathematics for teachers content course. This finding supports Philipp et al.'s (2007) hypothesis that building off of PSTs' inherent caring about children, by making CBA learning progressions a component of the mathematics for teachers content course, can lead to profound gains in constructivist beliefs about teaching as well as understanding of children's mathematical thinking.

References

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching. What makes it special? Journal of Teacher Education, 59(5), 389-407.
Battista, M. T. (2012). Cognition-Based Assessment & Teaching. Portsmouth, NH: Heinemann.
Capraro, M. M. (2001). Construct validation and a more parsimonious mathematics beliefs scales. Paper presented at the Annual Meeting of the Mid-South Educational Research Association. Little Rock, AR.
Carpenter, T. P., Fennema, E., Peterson, P. L., Chiang, C. P., & Loef, M. (1989). Using knowledge of children'smathematics thinking in classroom teaching: An experimental study. American Educational Research Journal, 26(4), 499-531.
Harrison, R. (2012). Elementary teachers' understanding and use of cognition based assessment learning progression materials for multiplication and division. (Doctoral Dissertation). Available from ProQuestDissertations and Theses Database.
Philipp, R. A., Ambrose, R., Lamb, L. C., Sowder, J. T., Schappelle, B. P., Sowder, L., et al. (2007). Effects of early field experiences on the mathematical content knowledge and beliefs of prospective elementary teachers: An experimental study. Journal for Research in Mathematics Education, 38, 438-476.

Acknowledgments

Differential Tuition
Faculty/Student Research Collaboration
CETL SOTL Summer Grant Program Funding
Participating Preservice Teachers
Office of Research and Sponsored Programs
Learning & Technology Services