PRESERVICE ELEMENTARY TEACHERS' LEARNING FROM VIDEOCASES: RESULTS FROM THE VPEM PROJECT

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While understanding children's mathematical thinking is an important part of what teachers need to know in order to be effective in the classroom, preservice coursework often fails to provide learning opportunities focused on this aspect of teaching. Using a videocase curriculum focused on children's mathematical thinking, the authors examined changes in preservice elementary teachers' knowledge of, beliefs about, and ability to analyze children's thinking. Results from a quasi-experimental study indicate that the videocase curriculum had little effect on participants' knowledge and ability to analyze children's thinking, yet a moderate effect on participants' beliefs about mathematics teaching and learning.

Research points to the importance of attending to children's mathematical thinking as an important aspect of what teachers need to know (Carpenter et al., 1989). Despite the centrality of children's thinking to teachers' mathematical knowledge, there exists little research involving preservice teachers' (PSTs) learning about children's mathematical thinking, with few exceptions (e.g., Philipp et al., 2007). Such research provides evidence that PSTs, if given opportunities to closely study children's mathematical thinking in the form of video clips, can further their own mathematical knowledge in relation to children's thinking (e.g., Philipp et al., 2007).

This study builds on and extends the extant research by examining how the design and implementation of a videocase curriculum supported PSTs' ability to analyze children's mathematical thinking. Specifically, the authors discuss findings from a quasi-experimental study of PSTs' engagement with the videocases in a required mathematics content course across two semesters, focusing on changes in PSTs' knowledge of, beliefs about, and ability to analyze children's mathematical thinking. The authors administered in both semesters a pre- and post-test using a mathematics content knowledge assessment instrument developed to measure mathematical knowledge for teaching, a pre- and post-test using the Integrating Mathematics and Pedagogy (IMAP) Beliefs survey, and a pre- and post-test video activity developed by the authors.

Theoretical Framework

Although most scholars and educators agree that mathematics teachers at all levels need to have a thorough knowledge of the content they teach (e.g., Kilpatrick et al., 2001), there is less agreement about the precise nature of the mathematics content that teachers should learn in preservice education programs. Some researchers have reconceptualized mathematics content knowledge, arguing that teachers need to not only know mathematics content, or common content knowledge, but that they need to know mathematics in ways needed for teaching, or specialized content knowledge (Ball et al., 2008). While common content knowledge refers to the knowledge that bankers or retailers, for example, have to know (e.g., computing percentages), specialized content knowledge refers to the mathematics knowledge that is specific

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to teaching (e.g., analyzing children's errors), and more closely resembles what teachers have to know and do with children in the classroom. If they are expected to support children as they investigate mathematical concepts, PSTs need to have a strong understanding of mathematical knowledge for teaching, which includes both common and specialized content knowledge.

Preservice mathematics coursework, however, often fails to adequately prepare PSTs for the work of teaching, as such courses focus solely on the learning of content with limited attention given to how such knowledge is used in actual teaching practice (RAND, 2003). In addition to knowing the content of the mathematics problems they use with children, teachers also have to analyze unusual solution methods that children may pose, appraise children's explanations, and ask mathematical questions that further children's thinking, teaching tasks for which PSTs are often ill prepared. These kinds of mathematical tasks of teaching (Ball et al., 2008), however, often receive scant attention in preservice mathematics coursework. Given what we know about the mathematics knowledge teachers need to be effective in the classroom (Hill, Rowan & Ball, 2005), mathematics content courses need to include opportunities for PSTs to develop mathematical knowledge for teaching.

Recent research has demonstrated that preservice coursework can provide opportunities for PSTs to develop their abilities to analyze children's thinking in ways needed for teaching. For example, in their experimental study involving PSTs in content courses, Philipp et al. (2007) argue that PSTs' content knowledge and beliefs about mathematics teaching practice can be enhanced if they have opportunities to learn about children's thinking while simultaneously learning mathematics needed for teaching. Assigning PSTs to four different treatment groups, the authors found that PSTs in the two treatment groups that involved the close study of children's mathematical thinking through the use of videos and interviews demonstrated more changes in their beliefs about mathematics teaching and learning as compared to the PSTs in the other treatment groups that involved more traditional field experiences. These findings are particularly important because they demonstrate that although PSTs may begin a content course with beliefs that stand in contrast to reform-oriented mathematics practice, content courses that connect content knowledge with the analysis of children's thinking can foster changes in PSTs' beliefs.

Project Background

Content Course

The content course in question is the first of two required content courses PSTs take during their freshman or sophomore years at the university, and precedes the mathematics methods course that PSTs typically take during their senior year. The content course is designed around developing PSTs' mathematical knowledge for teaching, and includes a focus on whole and rational numbers and operations, place value, proportional reasoning and aspects of number theory. The course also provides PSTs with opportunities to develop their abilities to engage in explaining, representing, and understanding and reacting to mathematical thinking that is different from their own.

Videocase Curriculum

As part of the Videocases for Preservice Elementary Mathematics (VPEM) Project, the authors developed 9 videocases and accompanying facilitator guides to be used in mathematics content courses for PSTs. These materials were designed to support the development of PSTs' understanding of the mathematical knowledge needed for teaching whole and rational number concepts and proportional reasoning by providing PSTs with opportunities to examine children's mathematical thinking in the context of actual classroom lessons. The videocases were implemented at regular intervals across the semester. Each videocase included a video clip(s) - focused on children's discussions of certain content and taken from actual classrooms - and a facilitator's guide - designed to support instructors in facilitating PSTs' discussion of the videocase, including focus questions. During the content course, PSTs first worked on the mathematics problems discussed in the video, and then viewed the videos through the lens of the focus questions. Table 1 below includes descriptions of the 9 videocases, including mathematical topic and mathematical tasks of teaching foci.

Videocase Title	Mathematics Topics	Mathematical Tasks of Teaching
Finding Patterns	Algebra	Evaluating the plausibility of children's claims Asking productive mathematical questions
Counting Strategies	Meaning of addition, subtraction; Addition, subtraction problem types	Evaluating children's mathematical explanations Asking productive mathematical questions
Understanding Place Value	Counting; Place value	Analyzing children's thinking
Modeling Double-Digit Subtraction	Subtraction algorithm	Linking representations to underlying mathematical ideas
Debating Remainders	Division; Remainder interpretation	Evaluating children's mathematical arguments Asking productive mathematical questions
Student Errors with Multiplication & Division Algorithms	Place value; Standard, alternative multiplication & division algorithms	Analyzing children's errors
Pattern Block Fractions	Relationship between improper fractions and mixed numbers	Analyzing children's thinking Analyzing children's errors
Why is 1/20 not equal to 20%?	Relationship between percentages and decimals	Analyzing children's errors Linking representations to underlying mathematical ideas
Making Predictions Using Multiple Solution Strategies	Fractions; Liner functions	Evaluating children's mathematical explanations

Table 1. Videocase design overview

Methods

The authors employed a quasi-experimental design to the study of changes in PSTs' knowledge of, beliefs about, and ability to analyze children's mathematical thinking to understand the overall effectiveness of the videocase curriculum.

Participants

Participants were recruited from PSTs who enrolled in two sections of a required mathematics content course for PSTs at a large midwestern university during the Spring 2010 and Fall 2010 semesters. PSTs from the sections of the course taught by the first author served as the treatment group (i.e., videocases), while PSTs from the other section of the course served as the control group (i.e., no videocases). 22 PSTs were in the treatment group and 17 PSTs were in the control group during the Spring 2010 semester; 30 PSTs were in the treatment group and 24 PSTs were in the control group during the Fall 2010 semester.

For both semesters, in the treatment course, PSTs viewed the videocases, answered focus questions related to the videocases, engaged in small group and then whole group discussions of the focus questions, all facilitated by the instructor. For both semesters, in the control course, PSTs worked on tasks similar in content focus to the tasks in the videocases in lieu of watching the videocases. However, in the Fall 2010 semester, the implementation of the videocases was modified in order to improve the quality and duration of videocase discussions, and PSTs' responses to the focus questions. These changes included the following: 1) PSTs watched videocases from the course website as part of homework assignments; 2) focus questions were revised to be more succinct; 3) guidelines for responding to the focus questions and a rubric for evaluating responses were developed to scaffold PSTs' written responses to the focus questions; and 4) PSTs' written responses were graded using the rubric in order to provide feedback for improvement.

Measures

As the study focused on changes in PSTs' knowledge of, beliefs about, and ability to analyze children's mathematical thinking, we administered the following measures pre-post in both semesters. First, we used a mathematics content knowledge assessment instrument developed by the Learning Mathematics for Teaching Project. Items not only capture whether teachers can answer the problems they use with children, but also how teachers solve the special mathematical tasks that arise during teaching (e.g., given 3 different multiplication strategies, determine which method can be used to multiply any two numbers). Second, as teachers can have differing conceptions of mathematics and mathematics learning which may or may not align with ideas about teaching and learning underlying recent reform efforts, we administered the IMAP Beliefs survey that was specifically designed to capture the characteristics of beliefs most closely related to understanding children's mathematical thinking: beliefs about mathematics as a discipline, beliefs about learning and knowing mathematics, and beliefs about children's learning and doing mathematics. Finally, we administered a video activity developed by the authors designed to analyze PSTs' ability to analyze children's thinking as depicted in video format.

Results

Mathematics Content Knowledge Assessment

Identical content knowledge assessments were administered in the first and last weeks of classes in both the treatment and control courses. The authors conducted a one-sample T-test to examine the gains from pre- to post-course on the assessment. Table 2 shows the results of a one-sample T-test for each group.

Semester	Group	N	Mean	SD	T	Df	Sig. (2-tailed)	Cohen
Spring	Treatment	22	.60	.58	4.82	21	.000	1.03
2010	Control	15	.70	.67	4.07	14	.001	1.05
Fall	Treatment	28	.85	.70	6.38	27	.000	1.20
2010	Control	25	.91	.58	7.89	24	.000	1.58

Table 2. One-sample T-test on content assessment gain scores by group

These results indicate that for the treatment group in Spring 2010, for example, the equated average IRT change score or the gain score from pre- to post-test was 0.60 logits with SD = 0.67. A one-sample T-test indicates that PSTs' content knowledge increased significantly during this semester, $t(21) = 4.82$, $p < 0.05$, $d = 1.03$. As displayed in Table 2, both treatment and control groups in both semesters demonstrated significant development in their mathematical knowledge for teaching. An independent T-test was conducted to examine the differences between treatment and control groups for each semester. However, we found no significant difference between treatment and control groups. One reason for no difference between treatment and control groups may be that the overall content course design and materials used in both courses were well aligned with the goals of learning mathematical knowledge for teaching. Indeed, both instructors were members of a planning group around the two content courses who collaboratively plan and design the course (Castro Superfine, 2010), thus making the two courses almost identical with the exception of the videocases.

IMAP Beliefs Survey

Identical online IMAP belief surveys were assigned as homework assignments for the first and the last weeks of classes in both courses. All PST responses were collected with the exception of the pre-test IMAP survey from the control group in Spring 2010. All responses were double coded blind using the IMAP belief rubrics in Ambrose et al. (2004). The survey data were then analyzed using the methods reported in Philipp et al's. (2007) work. Table 3 shows the distribution of beliefs score changes for the treatment and control groups in Spring and Fall 2010 by belief. Table 4 shows the percentage of PSTs in the treatment and control groups that demonstrated large increases, small increases, or no increase in terms of changes in their average belief scores across the seven beliefs.

Group		Large Increase	Small Increase	No Change or Decrease
1. Mathematics is a web of interrelated concepts and procedures (and school mathematics should be too).				
Spring	Treatment (n=22)	32%	18%	50%
Fall	Treatment (n=30)	17%	37%	47%
	Control (n=24)	21%	29%	50%
2. One's knowledge of how to apply mathematical procedures does not necessarily go with understanding of the underlying concepts.				
Spring	Treatment (n=22)	0%	19%	81%
Fall	Treatment (n=30)	7%	7%	87%
	Control (n=24)	4%	21%	75%
3. Understanding mathematical concepts is more powerful and more generative than remembering mathematical procedures.				
Spring	Treatment (n=22)	18%	27%	54%
Fall	Treatment (n=30)	33%	20%	47%
	Control (n=24)	25%	29%	46%
4. If students learn mathematical concepts before they learn procedures, they are more likely to understand the procedures when they learn them. If they learn the procedures first, they are less likely ever to learn the concepts.				
Spring	Treatment (n=21)	27%	27%	46%
Fall	Treatment (n=30)	13%	23%	63%
	Control (n=24)	17%	21%	63%
5. Children can solve problems in novel ways before being taught ho to solve such problems. Children in primary grades generally understand more mathematics and have more flexible solution strategies than adults expected.				
Spring	Treatment (n=21)	14%	23%	64%
Fall	Treatment (n=30)	14%	31%	55%
	Control (n=24)	13%	13%	75%
6. The ways children think about mathematics are generally different from the ways adults would expect them to think about mathematics. For example, real-world contexts support children's initial thinking whereas symbols do not.				
Spring	Treatment (n=21)	18%	14%	68%
Fall	Treatment (n=30)	27%	17%	57%
	Control (n=24)	13%	38%	50%
7. During interactions related to the learning of mathematics, the teacher should allow the children to do as much of the thinking as possible.				
Spring	Treatment (n=21)	18%	14%	68%
Fall	Treatment (n=30)	37%	27%	37%
	Control (n=24)	17%	8%	75%

Table 3. Beliefs-score-change percentages by belief, group and score-change category

We found the following patterns from the distribution shown in Table 3. First, treatment groups, in both Spring and Fall 2010, had the greatest percentage of PSTs with large increases on every belief. Second, for Beliefs 2, 3, 6, and 7, the treatment group in Fall 2010 had a large percentage of PSTs with large increases as compared to the treatment group in Spring 2010. Finally, for Belief 7, there is a relatively large percentage (i.e., 63%) of PSTs with large and small increases in the Fall 2010 treatment group, compared to PSTs (i.e., 25%) in the control group for the same semester.

	Spring	Fall	
	Treatment	Treatment	Control
Large Increase	18%	21%	16%
Small Increase	20%	23%	23%
No Change or Decrease	62%	56%	62%
Ratio Large/No	29%	38%	26%

Table 4. Average percentages of PSTs in each beliefs change-score category (with ratio of percentage with large change to percentage with no change) by group

As Table 4 indicates, the treatment group in Fall 2010 had the largest ratio of large increase to no increase in the average belief scores. Taken together, the IMAP beliefs survey data seem to indicate that engagement with the videocases influence PSTs' beliefs about mathematics teaching and learning, and reflect findings from previous research (Philipp et al., 2007).

Video Activity

A video activity assessment based on a video clip from an actual classroom was designed to assess PSTs' ability to attend to and analyze children's mathematical thinking in video format. As part of the video activity, PSTs were asked to watch a video clip and then to respond, in writing, to prompts about children's thinking: (1) What do you notice about student's mathematical thinking in the video? (2) Identify the different strategies used by students in the video, and (3) How are students' strategies different? Identical pre- and post-video activities were administrated in the first and the last weeks of class in both courses. All responses were double coded blind using a rubric developed by the authors, and focused on differentiating between the level of sophistication of PSTs' analysis of children's thinking. Level 1 indicates a general statement about the strategies was given (e.g., the child used addition). Level 2 indicates that a response included a mathematical focus, but yet was not specific enough to explore the underlying concepts. Level 3 indicates that a response included a mathematical focus and specifically unpacked the mathematics in the different strategies. Level 4 indicates that, in addition to the criteria for Level 3, the response also included the use of critical words (e.g., repeated addition, repeated subtraction, evenly distributed). Codes of G, U, and B denote responses focused on general aspects of the video, children's understanding, or children's behavior, respectively.

		Fall				Spring			
		Treatment		Control		Treatment		Control	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Question 1	3SS-1	11	7	16	6	9	7	10	8
	3SS-2	8	11	5	5	9	9	1	0
	3SS-3	5	5	2	2	2	3	0	1
	3SS-4	0	0	1	0	0	0	0	0
	3S-G	10	9	8	15	5	9	6	3
	3S-U	6	8	0	1	6	5	6	10
	3S-B	2	0	1	0	0	0	0	0
Question 2	6-1	0	1	0	0	1	1	0	0
	6-2	2	1	0	3	2	3	1	1
	6-3	6	5	5	3	2	6	7	7
	6-4	20	23	23	17	17	11	9	9
Question 3	7-1	4	3	3	5	3	8	5	5
	7-2	19	20	23	17	15	11	7	9
	7-3	5	7	2	1	4	3	4	2

Table 5. Frequencies of PSTs' video activity responses by question and by level

As Table 5 indicates, while there were small shifts from pre- to post-course on certain questions, overall there were minimal differences between the treatment and control groups for the three questions on the pre-post video activity.

Conclusion

A primary aim of this study is to explore the potential of a videocase curriculum for supporting PSTs' learning about children's mathematical thinking as part of a required mathematics content course. Overall, results of the study indicate that, besides differences on the pre-post belief survey, there were no marked differences between the treatment and control groups. In other words, use of the videocase curriculum seemed to have a minimal effect on PSTs' knowledge of and ability to analyze children's mathematical thinking, yet the videocases did have a moderate effect on PSTs' beliefs about mathematics teaching and learning. We posit that one reason for such results may be that the content courses in the study were collaboratively designed and implemented by a group of mathematics educators and mathematicians around the idea of developing PSTs' mathematical knowledge for teaching (see Castro Superfine, 2010). Thus, the treatment and control courses were essentially the same course using the same tasks, in-class activities, homework assignments, and exams, with the exception of the videocases. In this particular course context, one would not expect the videocases to have a significant effect. As the videocases did have an effect on PSTs' beliefs about mathematics teaching and learning, there seems to be some potential for effecting change. However, the collection of videocases needs to be implemented in different course contexts in order to fully test the potential of the videocase curriculum.

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