LEARNING TO PROFESSIONALLY NOTICE: PRESERVICE ELEMENTARY TEACHERS' ATTITUDES TOWARD MATHEMATICS IN CONTEXT

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The goal of this study is to better understand preservice elementary teachers' changes in attitudes towards mathematics in connection with their participation in a module aimed at developing professional noticing capacities. This module, typically implemented in the mathematics methods course, involves practice with the three interrelated components of professional noticing – attending, interpreting, and deciding. Pre- and post-assessments of participants' mathematical attitudes and professional noticing capacities were administered to measure change in these areas. Participants demonstrated significant growth in their professional noticing capabilities and mostly positive attitudinal change; however, there was no significant correlation between the changes on the respective measures.

Keywords: Affect, Emotion, Beliefs, and Attitudes; Learning Progressions; Teacher Education - Preservice

Introduction

This study focuses on preservice elementary teachers attitudes towards mathematics after participation in an instructional module developed with the intent to increase PSETs' abilities to professionally notice within the context of early numeracy. The instructional module, titled *N3: Noticing Numeracy Now*, was implemented in elementary mathematics content and pedagogy courses at five universities. This research is informed by the literature on preservice teachers' attitudes toward mathematics (Philipp, 2007), Jacobs, Lamb, and Philipp's (2010) definition of professional noticing, pedagogies of practice (Grossman, Compton, Igra, Ronfeldt, Shahan, & Williamson, 2009), and the progression of early numeracy (Clements & Sarama, 2009; Steffe, 1992; Steffe, Cobb, & von Glasersfeld, 1988; Steffe, von Glasersfeld, Richards, & Cobb, 1983). More specifically, we aim to investigate the following research questions:

1. To what extent can PSETs develop the capacity to professionally notice children's mathematical thinking in the context of early numeracy?
2. To what extend do PSETs' attitudes towards mathematics change after participating in a mathematics methods course where professional noticing skills were developed?
3. To what extent does PSETs' professional noticing performance correlate with PSET attitudes towards mathematics?

Theoretical Framework

Preservice Elementary Teachers' Attitudes Toward Mathematics

Research on attitudes towards mathematics has become an increasingly prominent area of study. Attitudes are often defined as a component of *affect* (Philipp, 2007), which has various

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meanings in the field of psychology (Chamberlin, 2010). For the purpose of our study, we draw upon Philipp's (2007) definition of attitudes as "manners of acting, feeling, or thinking that show one's disposition or opinion. ...Attitudes, like emotions, may involve positive or negative feelings" (p. 259). Research on attitudes is critical because students and teachers often develop negative attitudes towards mathematics, which can later result in anxiety (Quinn, 1997). PSETs tend to view mathematics as a system of rules and procedures that must be transferred to students (Ball, 1990; Foss & Kleinsasser, 1996). Moreover, they tend to view mathematics negatively or with neutrality, but rarely positively (Ball, 1990; Bekdemir, 2010; Quinn, 1997), which has the potential to influence the practices they adopt. Research in mathematics education has shown that attitudes often influence teachers' classroom practices (McLeod, 1994; Wilkins, 2008). Thus, it is important to understand the attitudes PSETs hold as an aspect of the types of practices PSETs may develop. Ambrose (2004) argued that too often the view of PSETs' attitudes and beliefs is negative and stereotypical and suggested that mathematics educators focus on the range of strengths PSETs bring, such as the PSETs' view of teachers as nurturers of children. Jong and Hodges (2011) have also found that it is possible for PSETs to experience positive changes in attitudes as a result of completing a mathematics methods course. Our work focuses on PSETs and their development of attitudes towards mathematics by engaging them in professional noticing of children's mathematical thinking in the context of an early numeracy progression.

Professional Noticing

The construct of professional noticing, as defined by Jacobs et al. (2010), is "a set of three interrelated skills: attending to children's strategies, interpreting children's understandings, and deciding how to respond on the basis of children's understandings" (p. 172). The first skill, attending, contains physical evidences observed from the student and teacher, such as eye movements, finger counting, and touching objects to count, just to name a few examples. The second skill, interpreting, is determining how those observations in the attending category can inform the observer on the mathematical abilities of the students. Finally, deciding involves the next steps in the process, which can include diagnostic or instructional decision-making. Jacobs et al. (2010) found that teaching experience alone does not contribute to an increase in professional noticing skills; professional development in the area of professional noticing is needed to adequately develop these skills, especially in the deciding component. Several studies have found that closer attention to children's mathematical thinking can significantly impact student learning (Carpenter, Fennema, Franke, Levi, & Empson, 1999; Kersting, Givven, Sotelo, & Stigler, 2010); however attention to the three individual components of professional noticing is missing from much of the previous research.

Pedagogies of Practice

Defining professional noticing as three components is an example of the decomposition of practice, or breaking the complex practice of teaching into smaller parts to better focus the teaching and learning of practice (Grossman, 2011; Grossman et al., 2009). Decomposition of practice is one of three pedagogies of practice, a framework for describing the teaching of practice. Representations of practice, another pedagogy of practice described by Grossman et al. (2009), are artifacts that make practice visible to others. Video is one type of representation of practice, but representations can also include lesson plans, student work, and teacher reflections about their practice. Inexpensive video equipment makes video an increasingly accessible and rich representation of practice, providing for "opportunities to investigate the complexity of teaching offline" (Grossman, 2011, pp. 2836-2837). Video has been used successfully to focus and hone teachers' attention to children's mathematical thinking (Carpenter et al., 1999; Schifter, Bastable, & Russell, 2000; Seago, Mumme, & Branca, 2004) and to features of a classroom (Star, Lynch, & Perova, 2011; Star & Strickland, 2008). Attending, however, is just one of the three components of professional noticing. Intentional collections of video representing children's work along a mathematical progression, in this case, early numeracy, enriches the representation to allow for development of the other two components of professional noticing, interpreting children's thinking and deciding next diagnostic or instructional steps. Such detailed analysis of representations of practice provide support for PSETs' participation in the third pedagogy of practice, approximations of practice, described by Grossman et al., (2009) as those activities that closely resemble authentic practice but might take place in less intense environments than an authentic classroom. Roleplaying is one example of an approximation of practice.

Early Numeracy Progressions

As a portmanteau of "numerical literacy", the term "numeracy" is typically invoked to describe an understanding of number and arithmetic operations. This area of mathematical learning has been the subject of considerable study over the past four decades (Clements & Sarama, 2009; Fuson, 1988; Gelman & Gallistel, 1978; Siegler & Robinson, 1982; Steffe, 1992; Steffe et al., 1983; Thomas & Harkness, 2013; von Glasersfeld, 1982; Wright, Martland, & Stafford, 2006). From the differing progressions of numeracy development available, we chose to focus on the developmental perspective put forth by Steffe and his colleagues (Olive, 2001; Steffe, 1992; Steffe et al., 1988; Steffe et al., 1983). This progression, referred to as the Stages of Early Arithmetic Learning (SEAL), is the product of extensive teaching experiments aimed at determining authentic student actions and practices when dealing with problematic arithmetic tasks (Steffe & Thompson, 2000). SEAL provides a highly detailed explication of children's changing understanding of quantity and serves as the mathematical backdrop for PSET learning activities in this study.

Supporting Attitudinal Improvements

Situating the professional noticing of children's mathematics in the context of mathematics progressions, illustrated through video representations of children's work, capitalizes on PSETs' nurturing attitudes about teaching but also reveals to them the complexities of the mathematics content. The content of early numeracy, on the surface, seems simple for PSETs to understand, because it encompasses such skills as forwards and backwards counting, skip counting, and addition and subtraction of numbers within 100. As PSETs view video vignettes of children engaged in mathematical thinking along the early numeracy progression, they are exposed to the idea that counting, for example, is not an all or nothing skill. The children in the videos display nuanced understandings and skills that demonstrate the incremental, but important steps through which children progress. Thus, we purport that engaging PSETs in professionally noticing children's mathematical thinking through representations of practice of real children engaged in early numeracy reveals the complexities of the content, and will result in a positive shift of PSET attitudes toward mathematics.

Methodology

Participants

The participants were PSETs enrolled in an elementary mathematics methods or content and methods blended course at one of five participating public universities in a south central state. The module was a component of the methods or blended course at each institution. One hundred twenty-three PSETs completed the pre- and post-assessment of professional noticing and the pre- and post-assessment of the Attitudes Toward Mathematics Inventory (ATMI).

Module Description

The module consisted of multiple in-class sessions in which professional noticing was developed in the context of early numeracy, specifically, SEAL. The decomposition of professional noticing into three interrelated skills allowed for the skills to be progressively nested throughout the module sessions (Boerst, Sleep, Ball, & Bass, 2011). The first two sessions focused solely on the development of attending. Subsequent sessions further developed attending with interpreting and deciding. SEAL was nested within the development of professional noticing and integrated through video cases as representations of practice. The culminating experience was an assignment that required the PSETs to conduct at least one diagnostic interview with a child, an approximation of practice, one of the three pedagogies of practice proposed by Grossman et al. (2009).

The researchers intentionally chose early numeracy as the context through which to develop the PSETs' professional noticing skills. Videos cases of teacher/student exchanges provided opportunities to explicitly attend to and discuss salient features of children's mathematical thinking often unnoticed by novice teachers in real-time classrooms. Because the video clips represented children's thinking along the progression of SEAL, interpreting the nuances of the children's thinking was supported by hallmark examples of each stage of SEAL. Decision-making was also supported by the common progression of children's thinking outlined by SEAL. Using video of real children as a precursor to engaging in their own diagnostic interviews with children provided opportunities for PSETs to anticipate and plan more specifically for what might occur in real-time classroom events.

Data Sources

Professional Noticing Assessment

A pre- and post-assessment was used to measure the changes in professional noticing at the beginning of the semester and again at the end of the semester. A video of a diagnostic interview with a child completing a comparison, difference unknown task (Carpenter et al., 1999) was used and both pre- and post-assessments were identical in prompts and video. The brief, 25 second, video shows an interviewer presenting a first grade student with a partially screened task that extends beyond finger range. The screened component consists of eleven seashells hidden by the interviewer's hand and the visible component is seven red counting bears in a row. The student is asked to determine how many more shells there are than bears. Counting the bears from one and continuing the count on his fingers until he reaches eleven, the student then glances at his raised fingers and correctly responds, "I'm gonna have four left over." A screenshot from the video showing the setting and the child's use of fingers is in Figure 1 (Schack, Fisher, Thomas, Eisenhardt, Tassell, & Yoder, 2013).

Figure 1: Child Completing the Comparison Task (Schack et al., 2013)

After the PSETs watched the video, they were asked to respond to the following prompts and questions: 1) Please describe in detail what this child did in response to this problem, 2) Please explain what you learned about this child's understanding of mathematics, and 3) Pretend that you are the teacher of this child. What problems or questions might you pose next? Provide a rationale for your answer. These prompts were drawn from the work of Jacobs et al. (2010) and each prompt addresses one of the components of professional noticing.

To develop scoring benchmarks for each of the professional noticing prompts, key response details for each prompt were outlined and coupled with emergent themes identified through examination of PSET responses. This process was used for each prompt and resulted in four potential rankings for attending, three for interpreting, and three for deciding. The high rank of four for attending represents an emergent theme from PSET responses that represented an elaboration beyond the salient attending features. A similar elaborating theme did not emerge for the remaining two professional noticing components. Teams of two scorers ranked all data using the scoring benchmarks. Discrepancies in ranks were resolved through discussion and/or a third scorer.

Attitudes Toward Mathematics Inventory

The Attitudes Toward Mathematics Inventory (ATMI) was also administered as a pre- and post-assessment approximately at the same time as the professional noticing assessment. The ATMI is an instrument consisting of 40 Likert-scale items used to measure the following four factors associated with attitudes toward mathematics: value, enjoyment, self-confidence, and motivation (Tapia & Marsh, 2005). The ATMI is a reliable instrument with content and construct validity (Tapia & Marsh, 2004). It has been primarily used with both secondary and college students.

Data Analyses and Results

Professional Noticing Assessment

Our research questions sought to determine changes in PSET professional noticing and attitudes toward mathematics along with the correlation of changes between these areas. The professional noticing data were analyzed using non-parametric statistics because of the ordinal nature of the rankings. Wilcoxon Signed Ranks Tests were employed to determine if there was growth in each component of PSETs' professional noticing. The results, indicating statistically significant increases in all three components, are displayed in Table 1. The larger z-score in deciding can be attributed to the greater frequency of rank 1 in deciding, relative to attending and interpreting, on the pre-assessment, allowing for greater aggregate growth.

Table 1: Pre- and Post-Assessment Results of Wilcoxon Signed Ranks Tests

	Scale	N	z	p-value
Attending	1-4	123	-3.466	$< .001$
Interpreting	1-3	123	-3.841	$< .001$
Deciding	1-3	123	-5.378	$< .001$

Attitudes Toward Mathematics Inventory

To examine PSET change in attitude toward mathematics from pre-assessment to post-assessment paired t-tests were applied to ATMI data. There were significant increases in the enjoyment, self-confidence and motivation factors. Table 2 summarizes the paired t-test results for the 123 paired samples. There was not a significant change in the fourth factor, value, when all 123 cases were included. However, when the 15 cases that achieved the maximum possible score on the pre-assessment were removed, there was a significant increase in the value factor from pre- to post-assessment ($t = 2.181$, $p = 0.031$).

Table 2: Pre- and Post-Assessment Results of Paired t-tests

	N	t	p-value
Value	123	-1.543	.125
Enjoyment	123	-3.070	.003
Self-confidence	123	-5.057	<.001
Motivation	123	-2.733	.007

For each of the four factors, more than 50% of the PSETs increased from pre- to post-assessment. The self-confidence factor had the greatest percent of PSETs increasing with 65% increasing. The 95% confidence interval for the "improvement" rate for this factor was 55.9% to 73.4%.

Correlation Between Professional Noticing Assessment and ATMI

Spearman's rho correlations were employed to examine the correlation between the change in professional noticing and the change in attitudes toward mathematics as measured by the ATMI. While both PSET professional noticing and PSET attitudes toward mathematics, when analyzed independently, showed significant increases from pre- to post-assessment, there was no significant correlation between changes in professional noticing and changes in attitudes toward mathematics. The results of this comparison are found in Table 3 below.

Table 3: Spearman's rho Correlations Between Changes in Professional Noticing Components and Attitudes and Beliefs Factors

		Change in Value	Change in Enjoyment	Change in Self Confidence	Change in Motivation
Change in Attending	Correlation Coefficient	.127	.045	.136	-.009
	P-value	.163	.621	.134	.924
Change in Interpreting	Correlation Coefficient	-.151	-.081	-.127	-.052
	P-value	.097	.376	.161	.566
Change in Deciding	Correlation Coefficient	.023	.102	.033	.091
	P-value	.799	.261	.715	.316

Discussion and Implications

We remain cautiously optimistic that the significant growth in the professional noticing skills and three of the four attitudes factors are indicators that the modules used in these courses are contributing to the significant growth of PSETs' professional noticing and attitudes towards mathematics. Other factors can contribute to this growth so further data using control sites should be collected as a means for justification of the module. The significant increase in professional noticing skills reveals that PSETs can develop professional noticing skills within the context of early numeracy (research question #1). Additionally, the significant increase in three of the four factors of attitudes towards mathematics inventory (enjoyment, self-confidence, and motivation) reveals the possibility that components of their attitudes can increase when experiencing a course where professional noticing skills are explicitly taught, modeled, and enforced (research question #2). Unfortunately, the correlation between the growth in attitudes and the growth in professional noticing were not found to be significant. We suspect that this might be the case due to the assessments being on unmatched ordinal and interval scales. In addition, we realize that the ATMI focuses on attitudes towards mathematics as a discipline, rather than attitudes towards teaching and learning mathematics, which might be more closely connected to gaining pedagogical skills, such as professional noticing. Further investigation on this lack of correlation will be conducted in future studies to better understand this result (research question #3).

As our research focus has been primarily professional noticing (Schack et al, 2013), the data provided for the attitudes toward mathematics is still in the preliminary stages. Additional and more sophisticated statistical tests should and will be conducted using the ATMI data in order to better understand the lack of significant correlation with the professional noticing increase.

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