USING VIDEO ANALYSIS TO IMPROVE PRESERVICE ELEMENTARY TEACHERS' NOTICING SKILLS

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Prospective elementary mathematics teachers (PTs) were asked to analyze 28 videos of cognitive interviews. The purpose of this study was to determine if experiences analyzing videos would lead to improvements in PTs' professional noticing skills. Using a coding schema that reflected three levels of understanding (periphery, transitional, and accomplished), a frequency table was constructed that allowed PTs' use and understanding of a noticing framework to be analyzed. Findings indicate that experiences analyzing videos leads to improvements in PTs' professional noticing skills.

Keywords: Teacher Education - Preservice, Instructional activities and practices, Mathematical Knowledge for Teaching

Professional noticing, the skill of making complex, in-the-moment decisions regarding children's mathematical thinking has been introduced as a means to improve overall mathematics thinking and instruction (Jacobs, Lamb & Philipp, 2010). The research reported in this paper analyzed prospective elementary mathematics teachers' (PTs) use of the noticing framework, while promoting the exchange and enrichment of mathematics education research across learning environments. The research team consisted of three mathematics teacher educators (MTEs) who work at three different institutions, one in the south, one in the southeast, and one in the western part of the United States. Each MTE's unique experiences and perspectives enhanced the research study.

Theoretical Framework

Despite the fact that many teacher preparation programs require PTs to spend a significant amount of time observing classroom teaching and learning, researchers cannot make specific claims about what they learn as a result of these observations (Brophy 2004). Conducting observations may not benefit PTs, because they may not know what key features to focus on while conducting their observations. MTEs, using video recordings of teaching may provide an opportunity for PTs to develop their noticing skills (Berliner et al. 1988).

According to Barnhart and van Es (2015), without structured support, PTs' analyses of student knowledge typically focus on aspects of the classroom related to management rather than on students' mastery of the content. It is critical that mathematics teacher educators guide PTs in making instructional decisions that align with student understanding (Darling- Hammond & Bransford, 2005; Davis, Petish & Smithey, 2006; Zeichner & Liston, 1996). A body of research has found that PTs can learn to attend to, interpret, and make decisions on the basis of student thinking, skills related to analyzing teaching (Jacobs, Lamb, & Philipp, 2010; Mitchell & Marin, 2014; Santagata, 2011).

MTEs may use video to provide PTs with the knowledge and skills they will need to be effective mathematics teachers. Using videos as a teaching tool saves time, money, and provides PTs the opportunity to learn new skills and to craft their practice without placing real students at risk during the learning process. Star & Strickland (2008) found that viewing videos led to significant increases in PTs' observation skills, particularly in teachers' ability to notice features of the classroom environment, mathematical content of a lesson, and teacher and student communication during a lesson. This study aimed to explore the following question: In the context of a four-week online mathematics course for pre-service elementary teachers, does the experience of analyzing videos of

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students' discussing their mathematical thinking lead to improvements in PTs' professional noticing skills?

The Instructional Activity

In an attempt to answer the research questions, a MTE at a regional public university located in southeastern United States used videos as an instructional strategy to study PTs' noticing skills. Fifteen female PTs in their second to fourth year of their studies to become elementary school teachers were a part of the study. Eleven of the PTs were White, three were Black, and one was Hispanic. Thirteen of the PTs were 20-25 years old, one was 42 years old, and one was 53 years old. PTs previously took between one and two math pedagogical content courses. PTs previous classroom experience includes 30 hours of focused observations in the areas of diversity, classroom management, and teaching strategies in a Survey of Education with Field Experiences course. They also have completed 10 hours of focused observations in diverse classroom settings related to classroom management along with small group teaching assignments in a Classroom Management course.

PTs were enrolled in an online course, Math Through Problem Solving. The study took place during Summer Session II. Therefore, the content of the course, which is typically taught over the course of a 15-week semester, was compressed into four weeks. The course focused on the following units: Number Theory, Fractions, Decimals, and Integers. One week was spent on each unit. In each unit, the first assignment was for the PTs to read the sections in the unit. The information from the book was also summarized in power points on a Supplemental Resources Page. PTs were required to take a Readiness Assurance Test (RAT) focused on the reading. Subsequently, PTs completed the unit homework assignments. Then, PTs took the unit test, there was a practice test to help them prepare for the test. Throughout the week PTs were asked to work on their cognitive interview video analysis assignment worth 10% of PTs' final grade. This sequence of assignments was repeated by PTs in each of the four units. Before the end of the course PTs were required to "pass", 80% or better, a Rational Numbers proficiency test that they have up to three attempts to pass. At the end of Unit 4, the PTs took a final exam.

The MTE developed the Cognitive Interview Video Analysis assignment to capture PTs' professional noticing skills. Over the course of the class the PTs were asked to watch and analyze 28 videos of cognitive interviews. The videos were focused on Number Theory (five videos), Fractions (eleven videos), Decimals (six videos), and Integers (five videos). The research team decided to focus their study on PTs' analysis of three videos, all focused on the concept of ordering, but completed across the span of the course. More specifically, the first video was focused on ordering fractions, the second video on ordering decimals, and the third video on ordering integers.

Before engaging in professional noticing, the PTs read the article A New Lens on Teaching: Learning to Notice (Sherin & van Es, 2003). In this article, the authors provide examples of how in-service teachers reflect on their teaching through noticing. Reading this article helps the PTs realize that noticing will help them make in-the-moment decisions and that there are a variety of ways to use noticing in their future classrooms.

The prompts that the interviewer asked the children in these three videos can be found in Figure 1. For each video, the assignment directions were:

> Post one (1) initial post where you answer each question below. Grading is based on effort (thoughtful and thoroughly explained answers) not accuracy. You are encouraged to read your peers' posts (you must make your initial post before being able to read others' posts) and post replies based on your reactions. Embedded in the book you will find the following video (there is a movie icon in the reading). Watch the video and then respond to each of the following prompts.

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Attending:

- What did the student do?
- What strategies did the student use?
- Interpreting:
- What does this mean about the student's understandings or misconceptions of the mathematics?
- Deciding:
- Based on what you attended to and interpreted, what are the best steps to take next with this student?
- What questions would you ask this student?

The MTE structured the assignment as a discussion for three main reasons. For one, since the course was an online class, there are no opportunities to discuss the videos face to face. Secondly, the instructor wanted to be able to provide PTs with feedback about the expectations of the assignment as well as feedback and guidance for meeting those expectations. Finally, the MTE believed that PTs could benefit from seeing each others' responses and the MTE's feedback on their responses.

$\frac{1}{6}$ $\frac{1}{3}$ $\frac{1}{7}$ $\frac{2}{7}$ 1 $\frac{4}{3}$ $\frac{3}{10}$ $\frac{1}{2}$ $\frac{3}{6}$ $\frac{1}{2}$

1.973 19.73 0.567 0.3 0.87 0.276 0.7 0.70 0.087 0.87

Fraction and Decimal Video Prompt: "For each pair, circle the larger of the two numbers. If they are equal, write =."

|6| |-5| -7 2 -1 11 0 -13

Integer Prompt: Order the numbers from least to greatest

Figure 1: Image of the Tasks Presented to Students

Methodology

This paper reports on the integrated findings of an exploratory sequential mixed methods research design (Figure 2). In sequential exploratory design, qualitative data is first collected and analyzed, and themes are used to drive the development of a quantitative instrument to further explore the research problem (Creswell & Plano Clark, 2011). As a result of this design, three stages of analyses were conducted: after the initial qualitative phase, after the secondary quantitative phase, and at the integration phase that connects the two strands of data and extends the initial qualitative exploratory findings (Creswell & Plano Clark, 2011). In this paper the authors share the results of final integration phase of the research.

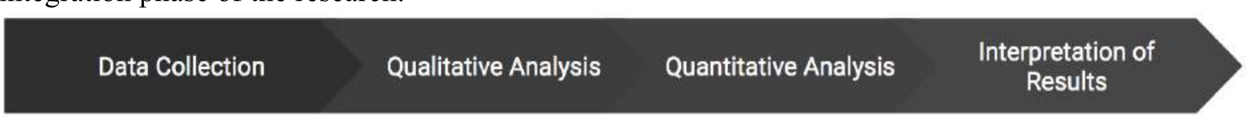

Figure 2: Exploratory Sequential Design (Creswell & Plano Clark, 2011)

The first goal of the coding process was to establish a standard exemplar response to the assignment for each video. To accomplish this goal, we, the team of three MTEs, each completed the Cognitive Interview Analysis assignment individually. Next, we met to discuss any discrepancies in the exemplar responses. We resolved any differences that existed and merged responses to create a standard exemplar response for each video. This task provided us with a standard exemplar to reference during coding. It also provided us with a thorough understanding of the content of the videos.

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Next, we decided to use the coding scheme developed by Author (2019). The coding scheme is described in Figure 3. To analyze PSTs' responses, we used open coding (Corbin & Strauss, 2014) to determine the noticing level for each attending, interpreting, and deciding prompt in the Cognitive Interview Analysis assignment.

Noticing Level	Description
Periphery	Made general impressions (e.g. "Student understands the questions.")
Transitional	Highlighted noteworthy events, general impressions, but included why they believed something occurred (e.g. "The student used logic to reason through the problem."
Accomplished	Used evidence to elaborate on student understanding, made connections between the work and the next steps.

Figure 3: Coding Scheme for Professional Noticing

Prior to coding, all PTs names were removed and the responses were randomized in the spreadsheet to avoid any potential coding biases. The research team calibrated coding by discussing our inferences and interpretations of one PT's responses to each of the five items. Subsequently, each MTE independently double-coded all PTs' responses for two of the three videos, in a blinded format, to ensure the data from each video was analyzed by two MTEs. The percent agreement for the two raters across all items was 75%, suggesting substantial inter-rater agreement. Having computed a satisfactory percent agreement, we reconciled our coding through discussion of the data and the professional noticing framework coding scheme (Figure 3).

Findings

Through the lens of the noticing framework (Attending, Interpreting, and Deciding), the results of the study show patterns of growth related to the noticing levels of periphery, transitional, and accomplished. Once PTs' responses were coded using the scheme (Figure 3), the results of the noticing levels were analyzed for each of the three noticing assignments in the given semester (Comparing Fractions, Comparing Decimal Numbers, and Ordering Integers). The bar graph in Figure 4 shows the overall frequency of each response coded as periphery, transitional, and accomplished within each noticing assignment.

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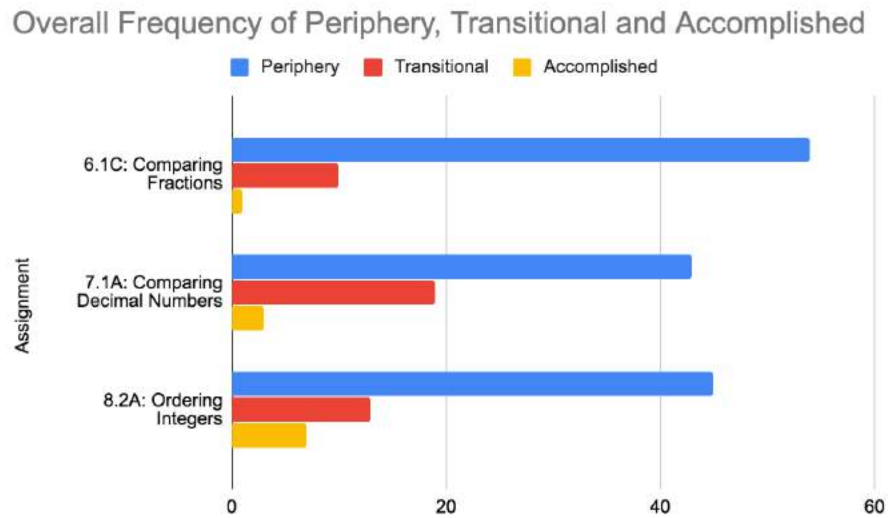

Figure 4: Overall Frequency of Periphery, Transitional, and Accomplished on each Assignment

Table 1 provides overall percentages of responses coded as periphery, transitional, and accomplished within each noticing assignment.

Table 1: Overall Percentages of Periphery, Transitional, and Accomplished

Assignment	Periphery	Transitional	Accomplished
6.1C: Comparing Fractions	0.83	0.15	0.015
7.1A: Comparing Decimal	0.66	0.29	0.046
8.2A: Ordering Integers	0.69	0.2	0.107

The percentage of responses coded as "periphery" decreased from 83% to 69%, whereas "transitional" increased from 15% to 20% "accomplished" increased from 1.5% to 10.7%, indicating that as the semester progressed, PTs' responses moved toward a transitional and accomplished level of interpreting student thinking. As seen in Figure 4, 54 of the PTs' responses were at a "periphery" level on the first assignment (Comparing Fractions) and only 1 PT response was at the "accomplished level on the first assignment. However, 45 PT responses were at the "periphery" level on the last assignment (Ordering Integers) and 7 PT responses were at the "accomplished" level on the last assignment.

These results indicate that the PTs have little experience with examining student mathematical thinking as seen on videos at the onset of this course. But, with practice, PTs' abilities to professionally notice improved as the course progressed. Based on experience and coursework, this seems to be a natural consequence of interacting with the ideas related to the framework. As shown in Figure 5, there is an overall increase of transitional responses in two of the three categories when considering Activity 7.1A. The attending percentage remained constant between Activity 6.1C and 7.1A. There is a slight decrease in transitional responses related to activity 8.2A but it is still down trending related to the introductory activity.

For example, one PT's response to the deciding piece of the framework changed over time. In the first assignment, the student offered the following suggestion, "And for both students I would ask the same questions the instructor did, and I would ask for more examples and review questions". Then,

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on a later video, the PT's level of sophistication changed and their response became, "What strategies are you using?", "How did you come up with that strategy?", "How did you figure out the answer?". As you can see, the later response is focused on conceptual understanding and is student-centered.

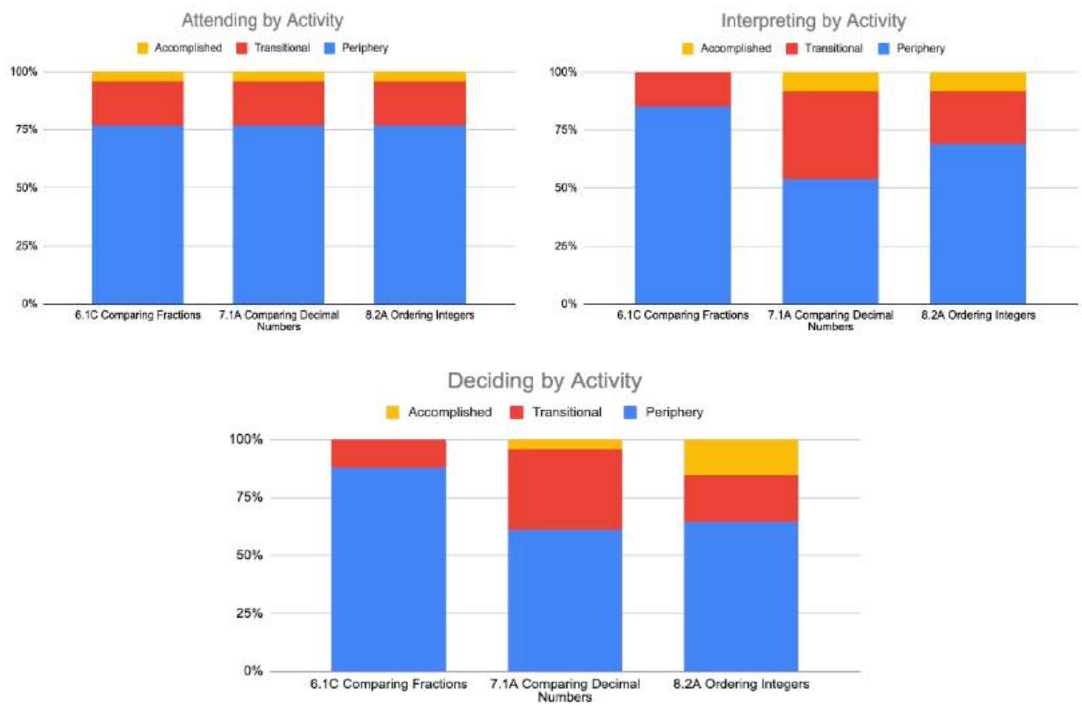

Figure 5. Percent Periphery, Transitional, Accomplished by Video

Three of the fifteen PTs did not complete all three assignments (chapters 6, 7, and 8). Therefore, their data were removed from the participant level analyses, resulting in n = 12. At the participant level, we (the MTEs) counted how many of the questions (out of the five questions) each PT answered at each noticing level for the three (comparing fractions, decimals, and integers) assignments. Next, we calculated the frequency and percent changes in the number of questions each PT answered at each noticing level from the first to the second, second to third, and first to third assignments. Finally, we found the average frequency and percent changes for all PTs.

We found a decrease in PTs' performance at the peripheral level during the course. All twelve PTs answered 49 questions at the peripheral level on the chapter 6 assignment. On the chapter 7 assignment all twelve PTs answered 43 questions at the peripheral level. All twelve PTs answered 40 questions at the transitional level on the chapter 8 assignment. The average number of questions that PTs answered at the peripheral level decreased by a frequency of 0.5, 0.25, and 0.75 from the first to the second assignment, second to the third, and the first to the third assignments, respectively. The average number of questions that PTs answered at the peripheral level decreased by 13.19, 0.69, and 19.44 percent from the first to the second assignment, second to the third, and the first to the third assignments, respectively

We found an increase in PTs' performance at the transitional level from beginning to middle and beginning to end of the course, but a slight decrease at the transitional level from the middle to the end of the course. Nine of the twelve PTs answered ten questions at the transitional level on the chapter 6 assignment. On the second assignment eight PTs answered fifteen questions at the transitional level. Seven PTs answered fourteen questions at the transitional level on the third assignment. The average number of questions that PTs answered at the transitional level changed by

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a frequency of 0.41, -0.17, and 0.25 from the first to the second assignment, second to the third, and the first to the third assignments, respectively. The average number of questions that PTs answered at the transitional level changed by 22.73, -2.27, and 4.55 percent from the first to the second assignment, second to the third, and the first to the third assignments, respectively.

We found an increase in PTs' performance at the accomplished level during the course. Only one PT answered one question at the accomplished level on the first assignment. On the second assignment two PTs each answered one question at the accomplished level. Five PTs answered six questions at the accomplished level on the third assignment. The average number of questions that PTs answered at the accomplished level increased by a frequency of 0.08, 0.33, and 0.42 from the first to the second assignment, second to the third, and the first to the third assignments, respectively. In most cases, the percent change could not be calculated because zero PTs initially answered at the accomplished level (causing a dividing by zero error in the percent change calculations).

Conclusion and Implications

This study, framed by research on noticing, the Coding Scheme for Professional Noticing (adapted from Van Es, 2011) was used to assess the development of PTs' use and understanding of noticing. Since PTs' noticing skills as they participated in the instructional activity was the focus of the study, the results are promising that the use of video to support PTs' understanding of student thinking may be a viable strategy for supporting growth. Preliminary findings indicate that through a deliberate scaffolding of course activities and projects, MTEs can help PTs develop their noticing skills.

Although many PTs' professional noticing skills improved, some PTs' skills did not show an overall increase, and few PTs reached the accomplished level. More research is needed to determine how to scaffold all PTs' skill development to the accomplished level. Analysis of the instructional activity indicates that prior to this course PTs have had little experience describing students' work, interpreting students' understandings, and then deciding how to proceed. PTs' initial interpretations seemed to rely on their own content understanding related to the task and limited the PTs in their ability to apply appropriate strategies to promote conceptual understanding for students. These results indicate the need for MTEs to spend more time reflecting on and discussing implications for teaching. Engagement in this work allowed us to see the PTs' reasoning so that we, mathematics educators, can improve our practice and our PTs' professional noticing skills.

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